The Spatial Experience of Visually Impaired and Blind: An Approach to Understanding the Importance of Multisensory Perception

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Abstract Design has long focused on the visual sense, with the neglect of other human senses. Currently, there is a growing body of literature that presents how perception is actually multi-sensory in nature. The visually impaired and blind rely on their other senses which make them appreciate other spatial qualities. The aim of the study is to understand how they experience and perceive the built environment through their compensatory senses. More specifically, the study intends to determine the spatial qualities that can enrich the multisensory experience in the built environment. A phenomenological research approach is adopted. The study relies on two different types of narratives. First, the autobiography of Taha Hussein "The Days" as a past experience of a blind person was selected. Second, in-depth semi-structured interviews and guided tours with visually impaired and blind informants were conducted. Instead of looking at what they are limited to, the study identifies their sensory capabilities that were enhanced by the surrounding environments. Through the exploration of such capabilities, the paper extracts multi-sensorial spatial qualities that cater for such capabilities. The paper identifies specific physical characteristics that were perceived by the visually impaired and blind informants regarding the surrounding spatial envelope. Findings of this study also show that sensory perception of physical characteristics acted as a dominant theme helping in cognitive processes such as constructing

mental imagery, cognitive maps, and operating in the built environment. The findings of the study were discussed in light of previous research and literature. Such findings are expected to provide relevant insights for a multisensory design approach that engages all the senses, and helps designers provide users with richer experiences.

Keywords Multisensory Perception, Spatial Experience, Visually Impaired, Autobiography, Spatial Qualities

1. Introduction

The experience of architecture is a perceptual process, in which the quality of space, matter and scale is assessed through the combination of multiple senses [1]. Architectural design should provide a multi-sensory experience for people in order to enhance their holistic experience. Such a multisensory approach was argued to promote users' social, cognitive, and emotional development [2]. On the other hand, a significant number of researches highlighted several negative health consequences when neglecting multisensory stimulation [3], [4]. In contrast, emerging research in a variety of fields suggests that vivid experiences are more likely to occur

when different senses are stimulated [5]. Accordingly, designing spaces that engage more senses will enhance the quality of life, and create more immersive, engaging experiences, which leave the user with more memorable vivid multisensory experiences [6]–[8].

Architecture has long focused on the visual sense with the neglect of the other human senses, to a degree that architects' design processes attribute a visual bias;

“Architecture at large has become an art of the printed image fixed by the hurried eye of the camera. The gaze itself tends to flatten into a picture and lose its plasticity; instead of experiencing out being in the world, we behold it from outside as spectators of images projected on the surface of the retina” [9, p. 30].

After highlighting that architecture nowadays is dominated by the visual sense, the phenomenological approach results in the consideration of architectural experience as an embodied experience that is generated through sensory perception. Consequently, many architects and theorists called for a connection with a built space that engage much more than the sighted related experience. Holl's experience of the Ryoan-ji Temple went beyond the appreciation of the space's visual beauty. The space entered his body not only through his eyes, but also through his feet, his ears, and his nostrils [9]. As he describes, “...realized how cold it was as moved through the paper-screened walkway and felt the cold boards through thin cotton socks” [9, p. 122].

Since we engage in the world through all of our senses not only vision, consequently there is a need of including in the spatial analysis of different sources of spatial information other than only the visual sense. At this point emerges the need to search for complementary investigation to support future design actions, since the traditional methods of study and observation of the built-environment are essentially based on vision. Hence, the present study is an attempt to learn from people who perceive and understand the spatial structure through other senses than the visual sense.

Accordingly, the present study will focus on the visually impaired and blind who perceive the built environment, relying on other sensory modalities than the visual sense. Such investigation can add a new spectrum of sensory spatial qualities into the field of architecture that might create engaging, memorable and multisensory experiences for sighted, visually impaired, and blind users.

2. Sensorial Experience in the Perception of Visually Impaired and Blind

It was previously confirmed that a blind person interprets the world around through his/her compensatory

systems such as haptic, hearing and olfactory. Nevertheless, in order to better explore such a phenomenon, it is important to first explore the definition of both terms “visually impaired” and “blind”. Indeed, “blindness” and “visual impairment” are very broad medical categories and different scales are used across countries to classify the extent of a visual deficiency. However for the sake of the present study, which is concerned with the perception of the built-environment, total blindness refers to absence of visual perception of light and form, whereas visually impaired refers to those who have percentage of light perception. While for both, their vision cannot be fully corrected by glasses, contact lenses, refractive surgery, or other surgery [10]–[12].

Apart from the different types and classifications of visual impairment, another important variable to the study objective is the age at which the person became visually impaired or blind. This is due to the fact that it may influence cognitive development and performance and affect the person's perceptual visual memory. It was classified according to the age of losing sight, whether “adventitious” or “congenital” [13, p. 60]. Adventitious is when a person loses his/her sight after they had a certain amount of experience with it and after the visual memory has been already formed. Adventitious blindness happens usually due to genetic or accidental reasons. While congenital blindness describes the visual impairment condition that exists from birth before visual memory is established [14]. Another classification is by referring to blindness as early and late blind. Early blind individuals refer to individuals either born blind or that lost any visual capacity in the first days, weeks, or months of life, while late-blind individuals refer to individuals that lost their visual capacity after childhood [15].

Regardless of the different types and classification of visual impairment, there are a significant number of previous studies that explored visually impaired capabilities and limitations. Although it was previously argued that we gain knowledge about our surroundings through all sensory modalities yet, we depend primarily on our visual sense in our everyday life [16]. Consequently, it can be believed that people with visual impairment are limited in most of these abilities [17]. Previous research suggests that when a person is affected at any age or born with a visual impairment, he or she is likely to experience severe limitations in spatial abilities. However, it was confirmed that haptic and hearing cues contribute to the perceptual and cognitive mechanisms for visually impaired and blind. Perceptual and cognitive tasks include being able to draw vivid and rich mental images, detect obstacles and sense distances [18]–[20]. Inclusively, it was reported that blind person's experience is as rich as sighted, depending mainly on hearing and touch sense [18].

Generally, there is theoretical knowledge providing information about how design decisions can create barrier free environments. Yet, there is a limited number of research that explores the relation between visually

impaired individuals and the built-environment that focuses on the capabilities that the compensatory senses offered rather than the limitations of impairment or blindness, to be able to inform/ concretize a multi-sensory architectural design approach in architecture.

The study goal is to extend on the current knowledge to examine in which ways different multi-sensorial spatial features inform about the place, thereby supporting not only orientation and movement but spatial understanding providing a more holistic experience for both sighted and visually impaired.

3. Methodology

3.1. Research Design

In order to investigate the possibilities of a multisensory architectural design approach, it seems logical that such investigation could benefit from *exploring visually impaired and blind lived experiences*. The importance of interaction of blind and visually impaired in the design process is previously argued to help reach a greater understanding of the users' needs rather than just the preconceived action taken by the designer [21]. To reach a holistic understanding of the lived experience of the visually impaired and blind, and to explore the multi-sensory spatial qualities needed for better built environments, *a phenomenological research approach* is adopted that aims at finding common themes from different visually impaired and blind chosen sources. As previously discussed, designing spaces that engage more senses will create more immersive and engaging experiences leaving the user with memorable vivid multisensory experiences. Hence, this study investigates sensorial capabilities recalled from *remote/past experiences* and others from *present ones*. Consequently, the study relies on the analysis of an *autobiography of a blind author* as a source of remote/past experience, and *in-depth semi-structured interviews* and *guided tours* exploring present and past experiences of visually impaired and blind people.

Autobiographies are among the most significant and valuable ways for exploring the human realm in all its depth, complexity, and richness. Autobiography refers to a person's written story of their own life. As the story is written, some aspects will stand out in the author's memory and others will be forgotten or suppressed, perhaps because they are not considered important or did not leave a vivid memory [22]. Autobiographical studies and anecdotal theorizing use narrated moments to build a theoretical understanding from the bottom up, drawing upon the personal as a lens through which new perspectives on rationality can be brought into view [23]. In the health sphere, autobiographies accounts of ill patients' narratives, were used as qualitative data and have significantly informed clinical literature [24]. Humanities/social studies

used women's narratives to reveal the ways that women experienced health and illness [25]. Additionally, tours guided by visually impaired and blind informants are believed to provide the research with first-hand information about the process of multisensory perception and understanding of space in the absence of visual sense. The *guided tours* are based on the observations done by the researcher on the informants' actions and the built-environment. In addition, data was collected through *in-depth semi-structured interviews*, which is a common tactic for data collection in qualitative research and specifically phenomenological approaches [6]–[29]–[37]. In-depth interviews allow for a greater scope in the responses provided by the informants. The interviews are conducted either during the guided tours to encourage informants to provide clarifications and more information about the presented actions done by the informants, or further explorations of informants' past/previous experiences.

3.2. Data Collection

For the research objective, the first source of data is "The days" autobiography by Taha Hussein, which is a narrative describing the lived experience of a blind author. Hussein lost his sight at the age of three due to a medical condition. According to the literature, he has the experience of a congenitally blind person as he was a juvenile adventitiously blind person. This means that he used to have the same kind of behavior and attitudes as the congenitally blind due to the incomplete imagery background. Hussein's autobiography, "The Days" [26] is divided into three parts of descriptions of his experience in the rural Egypt in 1929, Al-Azhar University in Cairo in the early 1939, and about his story on to his final accomplishment of a doctorate at the Sorbonne, France in 1973 that was full of narratives about the surrounding sensory stimulants. The book provides description of multi-sensory experience. The narrative exploration could provide multi-sensorial insights that could inform the architectural field.

The second source is guided tours along with in-depth semi-structured interviews with 10 visually impaired and blind people. Due to the fact of COVID-19 pandemic, and to cause fewer disturbances to the center of visually impaired and blind people approached, the study was conducted in a relatively long period of time that was between January 2020 and March 2021. It should be mentioned that a large number of visually impaired and blind people were approached, among which only ten of them accepted to participate in the study. Selection of the informants who participated in the study aimed to achieve diversity in gender, age, among both visually impaired and blind, and between early and late blind (Figure 1). The ten informants were willing to participate in the study and gave approvals for the study, and required that their names be kept confidential. Prepared open-ended questions were

used to guide the interview during or after the guided tours. They allowed the informants to have freedom, in relation to issues discussed in order to obtain rich data. During the interviews, prompts were used to encourage informants to provide clarifications and more information. In addition to the interviews, data collection also included the physical inspection during guided tours by each informant. Throughout that tour, each informant was invited to guide the researcher to their most favored and least favored places while explaining the reasons behind their perceptions. The observations during the guided tours were recorded via taking down notes, sketches and photographs

by the researcher. As previously discussed, each informant was asked to give a guiding tour around the center environment after or during the interview upon their convenience. The tour for each informant spanned between 30 minutes to 90 minutes depending on their willingness to speak, and the guided tour distance. The researcher had visited several locations in the center premises for several times during the collection of data to complement the findings of the collected data. Furthermore, in order to complement the findings of the initial data gathered, follow-up in-depth semi-structured interviews were conducted.

Informant	Referred in-text	Age Group	Gender	Early/Late	Familiar/unfamiliar	General comment and background
Informant 1	I-1	25-35	Female	Early	Unfamiliar	She has never been able to see objects, but has been able to discern light from dark- which enabled her to carry out certain tasks in the past but she cannot do that any longer. And she don't prefer using her cane while walking around.
Informant 2	I-2	25-35	Female	Early	Unfamiliar	She has never been able to see objects, but can to a certain extent differentiate light from dark. She depends on canes while navigating around places especially unfamiliar ones.
Informant 3	I-3	45-55	Male	Late	Familiar	He had full visual capacity to the age 15 and until recent he had a strong visual memory even when dreaming but gradually he has no visual representation. He highlighted that he used to depend on a cane but recently he only depended on his senses in most of the his daily tasks
Informant 4	I-4	35-45	Male	Early	Unfamiliar	He had visual capacity till the age of 2 before forming any vivid visual memory and now he is completely blind. During the guided tours he used his cane while moving around.
Informant 5	I-5	35-45	Female	Early	familiar	She never had any visual capacity
Informant 6	I-6	45-55	Female	Late	familiar	She has never been able to see objects. But lately, she lost her ability to differentiate light from dark.
Informant 7	I-7	25-35	Male	Late	Unfamiliar	He a full visual capacity till and had a strong visual memory formed and used up till now in perceiving and describing things around him.
Informant 8	I-8	45-55	Female	Early	familiar	She has never been able to see objects, nor to differentiate light from dark. She was unfamiliar with the centre premises.
Informant 9	I-9	35-45	Male	Late	Unfamiliar	He had sight in both eyes up to the age of 17 until he had an accident and lost all his visual capacity.
Informant 10	I-10	45-55	Male	Early	Unfamiliar	He has never been able to see objects, nor to differentiate light from dark.

Figure 1. Showing diversity of Informants according to age group, gender, type of impairment, and familiarity to places visited during guided tours

3.3. Data Explication

In phenomenological studies, while describing the different data analysis stages, the term that is usually used is “explication” of the data instead of data “analysis” [27], [28]. It was argued that the reason behind preferring this term is because the word analysis has a connotation of “breaking into smaller units” with the fear of losing the whole phenomena, that is contrary to the term explication that refers to looking to the data and understanding it in a more “holistic nature of the phenomenon”, while keeping the whole in context, especially while having several sources for the data.

The extracted narrations from the autobiography, transcription of the audio recording of interviews, along with the observations during the guided tours were analyzed qualitatively using a hermeneutic phenomenological data analysis method adapted from Nancy Diekelmann [29]. In hermeneutic phenomenology, the “parts” inform the “whole” and the “whole” informs the “parts”, which means that data emerge and change during explication of different data collection from different sources of the study.

As previously mentioned the first source for the study was the autobiography for Taha Hussein, which was first read several times in Arabic language (the original language that the autobiography is published in) in order to acquire familiarity and understanding. When engaging with the text, the authors started questioning to identify passages relevant to the purpose of study. These questions can be directed at eliciting answers to the study questions and achieving the study aims, or for answering questions raised from the informants in the semi-structured interviews conducted. Similarly, the interviews were conducted and audio-recorded in Arabic language, later, translated and transcribed in English. Informants’ responses during the guided tours were observed and considered to recognize the nature of the sensory perception of the visually impaired. Based on their favorable and unfavorable responses and actions with reference to the spaces of the center’s premises reported during the study tour, the most favoured places and disfavoured places were identified to study the corresponding spatial physical characteristics and qualities. The findings were analyzed in order to find out the multi-sensorial spatial qualities.

First step of data explication after the transcription of the interviews and identifying relevant passages from the autobiography was reading and re-reading both the transcriptions and the extracted autobiography narrations, in order to acquire familiarity and understanding. The second step was about realizing the preliminary meanings focusing on the research topic as “the whole”, within each “part” informed by the researcher deepened understanding of the different accounts of the informants and Taha Hussien’s account. Then, common themes and categories reflecting shared experiences between at least five

interviews and the autobiography are then classified. This step is done by comparing and contrasting the situated meanings within the different accounts. The fifth stage aimed at a holistic understanding through investigating the interrelationships among themes. This is a key feature of hermeneutic analysis that offers a holistic and insightful interpretation from different “parts” that inform the same phenomenon which is “the whole”. Figure 2 summarizes the above explanation of the different stages of data explication conducted in this phenomenological study.

Figure 2. The Data Explication Stages

4. Findings and Discussion

This section presents and discusses the study findings. These findings describe sensory capabilities associated to the visually impaired and blind lived experiences. As reported from the informants and the extracted narrations from Taha Hussein autobiography both Hussein and the informants perceived signals through their compensatory senses/modalities such as touch, smell, taste, hearing, and other basic orientation senses. They utilized those sensory

cues perceived to describe the spatial structure of the built-environment through the perception of physical characteristics.

Physical characteristics of the built-environment are easily perceived through the visual sense however, through the explicitation of visually impaired and blind narratives, it was shown that they were able to depend on other compensatory senses instead of the visual sense to acquire information and understand the outer world. Similarly, Hermann von Helmholtz, one of the founding fathers of psychology, defined perception as an active way of drawing “unconscious inferences” from sensory data [31].

Both Taha Hussein and the informants lack the capacity for perceiving with a single glance all the objects in their

surrounding environment. Yet, the extracted descriptions show how visually impaired compensatory systems such as *tactile, auditory, olfactory, and other basic orientation systems* helped them in perceiving different physical characteristics of the built environment including *volumetric configuration, geometric configuration, openings (size and location)/ building layout and orientation, objects locations (detecting obstacle), and materials/textures*. Hence, this assists in understanding the spatial structure, which then influences the perception of several *spatial qualities* such as *sense of enclosure, legibility, acquiring a mental imagery, sense of position in space, and legibility* (Figure 3).

Figure 3. Diagram showing the study findings

Findings of the present study also show that sensory perception of physical characteristics not only catered for a holistic understanding of the surrounding spatial structure but also such understanding acted as a dominant theme helping in cognitive processing such as constructing a *mental imagery and cognitive maps*. As shown in Figure 3, the perceived physical characteristics acted as *sensory landmarks* giving both Hussein and the informants the ability to construct mental images such as *drowsiness environment, beautiful scenery, peaceful street, an old/tumbledown house, time of the day (dark/light), season of the year (winter/summer), poor/rich, and clean/dirty*. Furthermore, it assisted in recognizing a *certain ambience or atmosphere* such as *tranquil, secure, hope, rest, happy, fearful, tenseness*. It also helped in constructing sequential cognitive maps and spatial cognitive maps (Figure 3).

Perceived sensory physical characteristics, that acted as representations in the form of mental images and cognitive maps stored in the memory, which acted as a reference structure for *operating in the built environment*. The described spatial structure, mental images and cognitive maps acted as *sensory signs* that helped in *navigating and orienting* in the built-environment (Figure 3).

The following section presents and discusses the dominant theme that has the highest importance in the experience of the visually impaired and blind which is the understanding of the spatial structure through the perception of physical characteristics of the built environment. Explication and discussion will be held through the illustration of direct quotes from the autobiography, guided tours and interviews, discussing them in relation to relevant findings of previous research and literature. This could help in extracting the multi-sensory spatial qualities that have stimulated the different senses.

4.1. Volumetric Configurations

Hussein and the informants hearing sense compensated for the absence of vision by providing inputs for the perception of the *volumetric configuration*, in judging the *ceiling height indoors*, and the *presence or absence of an over-head plane in the outdoors*. As described by Hussein “He walked straight on for a few steps before crossing a damp, roofed-in space... then he came out into an open passage-way”. Similarly, as described by I-10 during the guided tours and confirmed by the author’s observation, I-10 was able to notice the differences in *ceiling height, scale and proportions* between spaces through *auditory cues*; “Here in this office I feel the ceiling is low” and then following him to the next space which was a meeting hall he continued,

“I think it has a higher ceiling... Same sense as I go to a mosque... I can feel it from the sound of my footsteps and tapping of my cane and even if it is silent, I can still sense the spaciousness ...same as

walking in a narrow corridor is different than in a spacious space...”

It was confirmed through observations during the guided tour that the *difference in proportions* (corridor and space), and the *difference in finish floor material* (*carpeted and tiled*) between the two mentioned sequential spaces acted as sensory stimulants in the built environment by producing *difference in the returning sound* to provide the informant with information of the *ceiling height* and the *proportion* of space. For sighted individuals, it was previously shown that their sense of spaciousness is associated to physical elements such as physical boundaries or properties of horizontal planes (floor materials or perception of proportion) [6], [32]. It has been previously recognized by a significant number of studies that blind individuals and visually impaired produce sound and utilize the returning sound to provide them with information about their surrounding environment [18], [33]. Similarly, in one of the published interviews of Chris Downey, he elaborated that he was able to perceive the *surrounding dimensions and physical boundaries* (*ceiling – wall*) of space; “You can often tell how high a ceiling is by listening for the reverberation of a tap or a clap off the ceiling or the bounce-back off a distant wall”[34]. Likewise, I-7 was capable in perceiving the difference in the surrounding street blocks though his hearing sense “I hear the echo of my footsteps changed and I know I reached a residential area and that I am surrounded by walls.” It is believed that *echoes* played an essential role in understanding the *space dimensions*, and *proportions* for most of the informants. Similarly Downey described his experience to a carpeted airport as “dead” or “flat”, as he didn’t hear the “liveliness of the space” [35]. Additionally, for I-7, he utilized the returning sound of his own footsteps in recognizing his *position in space* hence increased his *navigating skills*. As for I-10, the different ceiling heights between sequential spaces, made him able to *construct a mental imagery* of a mosque when reaching “a spacious space”. For Hussein, he perceived the presence of the overhead plane and the location of the café through haptic, smell, and hearing. Cues such as *the sloped damp floor* and *the roofed-in space* acted as *sensory landmark* that helped him in constructing a cognitive map “*walked straight on for a few steps before crossing a damp, roofed-in space*” [26, p. 105]. Additionally, the floor contour and material affected his sense of safety and security “impossible to stand firmly”. Furthermore, it was previously found that there is a strong relationship between the degree of movement difficulty and distance evaluation. For example, moving around two similar spatial dimensions but with different floor slope directions can create different distance evaluation [10].

Overall, proportions of physical features of the built-environment such as physical boundaries (walls-ceilings-floor), or horizontal planes qualities (finishing materials-flooring-contour), played an important

role in the production of different auditory cues produced by *echoes* in different spaces. As summarized in Figure 3, such difference in *sound and echoes* catered for the spatial understanding and capability in perceiving *volumetric configuration* (ceiling height – narrow/wide spaces). Consequently, perceived difference in *volumetric configuration* acts as spatial landmarks that further cater for cognitive tasks.

4.2. Geometric Configurations

Both informants' responses (during the guided tours) and the authors' observations showed a high capability in describing the layout and geometric configuration of the center's premises and previously visited places. Geometry and layout were perceived through environmental references such as *spatial organization, order, and boundaries* that acted as sensory stimulants to other senses than the visual sense. As described by I-9: "the overall shape of the lobby, I think it is like this..." and he started to use his hands that it is not straight and continued "umm it is like pentagon or hexagon...." (Figure 4). He emphasized that what made him able to perceive such geometry was the order and spatial organizations "see along the route the important spaces are organized in the junctions where we change direction of movement along our tour." He explained that *spatial organization* had a *strong relationship* with the *circulation network and movement direction*. He first started to explain that *his perception of spatial organization* was greatly related to different *sounds and smell associated to different activities*. He added that his *rhythm of movement* was greatly affected by the *spatial organization* and this made him capable in perceiving the

geometric configuration of the lobby. Such information, obtained through his compensatory senses, were in turn the reason for him being *capable in constructing spatial and sequential cognitive map* for the whole center. Additionally, he was able to describe the symmetry of the geometry in reference to his own body. Similarly, previous research highlighted that blind informants were able to describe more accurately and remember configurations that were symmetrical compared to those that were not [18].

During a novel experience for I-1 she highlighted the importance of auditory and mobility cues to interpret the *configuration of the circulation*; "in the dorms that I was not that familiar with, in the ground level it had a lot of columns that I bump in..." However I-1 continued,

"in the past I used to depend on my capacity to see light and dark but now since I no more do, I start to move around and focus more on my hearing sense to be able to interpret the shape of the route I should be taking and get more familiar with the space..."

I-1 further described that she was able to interpret her route, by generating *sounds* through "...my cane? and tapping my tongue". Hence *soundscape* played an important role in both sources of the study for the perception of geometric and circulation configuration. In a previous study, it was confirmed that the *sound of footsteps* in a white massive space with minimal visual stimuli, created a repetitive sound giving *sense of directionality* for a sighted individual. However when subject of the previous study arrived to a space that was full of visual cues, her visual sense was so busy. Although the footsteps sound was still there however she perceived the space as quiet [6].

Figure 4. Sequential shots showing the configuration and change in movement direction of the lobby

Source: Adapted from Picinali, et al. [36]

Figure 5. Showing high level of compatibility between, a reconstruction of the configuration of an experienced environment using LEGO blocks and the annotated sketches done by the authors

Likewise, the narrative of “The Days” revealed Hussein’s capability of perceiving unfamiliar room configuration, dimension and layout; “*He entered a room like a hall, ... This led on to another room, large but irregular in shape,*”[26, p. 107]. Consequently, Hussein’s perception of the *difference in the geometric configuration* between two sequential spaces, acted as landmarks for him to *construct sequential cognitive map*. Similarly, Picinali, et al. [36] reported that, visually impaired informants were able to reconstruct the configuration of an experienced environment using LEGO blocks. Their reconstructions showed a high level of accuracy with the annotated sketches done by the authors (Figure 5). Annotations were done by the authors after informants’ verbal descriptions, such as door presence, change in surface, changes in the ceiling heights, open space versus long corridors, etc. [36]. The findings of the present study and Picinali, et al. study confirm the *significance of movement* as an important attribute in the *perception of volumetric and geometric configuration*.

It was previously confirmed that sighted individuals’ perceptual distinctions are partly a result of movement [37]. Temple [38] previously highlighted that the perception of

particular geometries while moving seems greater than only evoking the visual sense. Such geometric perception enables informants to move through architectural space with less effort [38]. For Hussein and several informants, they were skillfully able to orient through the built environment depending mostly on motor and hearing systems in the perception of geometric configuration. Similarly, social activity sound was highlighted by Hussein as a sensory sign for orienting:

“...but at a certain point he caught the confused sound of conversation through a half-open door on the left; then he knew that a pace or two further on he must turn to the left up a staircase which would bring him to his lodging.”[26, p. 106]

Generally, *spatial organization*, when moving through spaces made informants experience *different sounds and smell associated to different activities/function* and difference in movements directions, encounters, rest periods, and repetitive cycles which illustrate specific rhythms of movement. As shown in Figure 3, such an experience increased the capacity in the perception of *geometric configuration*, which in turn enhanced the

navigation and orientation capacity.

4.3. Opening Size and Location/ Building Orientation

It was highlighted that natural elements (sun, wind, birds) help in shaping the surrounding environment in other ways than just recognizing position in space. Both Hussein and the informants were able to perceive sensory stimulants from the natural environment such as wind/breeze flow and direction, and heat intensity and direction of the sun, depending on their haptic and hearing sense. Haptic cues from the environmental factors helped I-4, one of the early blind informants, in perceiving window location in a room that he was not familiar to;

“...feeling sunlight heat so I start to know that there is a window in that placelike this room we are in now. I know now that the window is on my right.....and here at the staircase there is sunlight... I always felt the heat of the sun coming from high above.”

Figure 6. Showing the presence of a clerestory window and skylight that were the reason for several informants to feel sun heat intensity during the guided tours

Through observations, it was confirmed that such feeling of heat of the sun, which he felt coming from above, was due to the presence of a clerestory window and skylight (Figure 6). Similar to the heat intensity and direction of sun light that acted as sensory stimulant for I-4, haptic system and air flow were highlighted by I-7, one

among the late blind informants that has a very high perceptual skill depending on other senses, during guided tours. *Difference in the intensity of the air flow* acted as a stimulant that helped in the perception of not only the *window location* but also its *scale and size*; “also I was able to know the scale of the opening from the air flow ... The more its big the more natural air enters.” Likewise, previous visually impaired research mentioned another indicator to a wall opening which is wind and airflow [10]. The intensity of heat helped I-7 in interpreting the orientation of the apartment that was novel to him. “For me I don’t see light, but I feel heat from the sun ...So for example the very first time I entered my apartment I knew its orientations from the heat coming from each side... walls and windows...”. Additionally, through perception of such stimulants Hussein and the informants were able to construct *mental images* such as *the time of the day, winter or summer or even a certain ambience*.

Additionally, most of the informants’ responses with sensory experiences in natural environments contained the term “*see*” and “*looked*”, describing the built environment with words like “*looked beautiful*”. I-2, one among the early blind interviewed informants, when asked about a previous experience she highlighted the importance of the sense of smell in drawing a *beautiful imagery* for her university context although she was never able to see objects, “*Since it was surrounded by a lot of plants and looked so beautiful ...it was the smell of basil and a lot of plants and flowers and mint that helped me draw this image in my mind*”. It was highlighted through the explicitations of several early blind informants’ narratives that despite their *early blind* experience, yet they were able to *construct mental images* for the surrounding built environment especially when they are experiencing *natural environment*. Likewise, I-9, a late blind informant, depended on sensory stimulants from his past experience before losing his visual sense. When asked to describe a mental image of his old house and his experience before and after losing his sight he said, “*the most picture I still have in my mind about that house till present is the natural scenery and tranquility ... no pollution no sound of cars.*” He further elaborated that after losing his sight, gradually those images started to disappear or contain-less details. However, his experience was yet based on cross sensory perception between haptic system and auditory system; “*silence and fresh air are things that gave me the same tranquil feeling*”. Previously, imagery was found to be as a quasi-perceptual experience that is processed through multiple sensory modalities-mainly visual, haptic and auditory inputs [39]. Similarly, previous study comparing autobiographical memory in sighted and blind, showed that early blind informants reported only tactile, auditory and spatial features in their memories (with no reference to visual details), whereas sighted informants reported mainly visual details [18]. For Hussein, *environmental factors/Natural elements* such as wind/breeze, sun (heat intensity, direction), and social sounds were mentioned as

sensory stimulants that helped him in remembering the *time of the day*;

"To the best of his belief, the time of day was either dawn or dusk. That is due to the fact that he remembers feeling a slightly cold breeze on his face, which the heat of the sun had not destroyed... he did not feel around him any great movement of people stirring, but he only felt the movement of people waking up from sleep or settling down to it." [26, p. 9]

Sensory stimulants from natural environment such as *sun* (heat intensity-direction), *wind/ air* (flow-pressure-direction), and *contextual smell-scape* (vegetation), were experienced and perceived by Hussein and the informants, unexpectedly reaching their bodies through *passive touch* as defined by [40] and their *olfactory system*. This in-turn, as shown in Figure 3, leads to the capability of understanding *building orientation*, and *opening* (size and location). Additionally, such natural factors acted as sensory landmarks and were the reason for both Taha Hussein and the informants' capability in constructing mental images such as *beautiful scenery*, *time of the day* (dark/light), *season of the year* (winter/summer), *poor/rich*, and *clean/dirty* surroundings.

4.4. Detecting Obstacles

Most of the recent studies argue the importance of technological aids for visually impaired in order to be able to detect obstacles while navigating in the built-environment. However, the study shows that the built-environment catered for audio-haptic sensations for the informants to detect obstacles. I-1, a blind informant who does not prefer using the cane as walking aid, reported that she depended more on her hearing sense around unfamiliar places to utilize returning sound in order to enhance her capability in detecting obstacles as discussed earlier in the geometric configurations section.

During guided tours, most of the narratives and observations showed that haptic cues perceived from natural elements, revealed a high level of capability in detecting obstacles while moving around unfamiliar places by utilizing information from air flow. Other static obstacles such as a piece of furniture, and a partition were mainly detected by their canes. It was yet highlighted by four of the informants that the use of *different floor material* near static obstacles could help them in the *perception of an obstacle better than just using a cane*. As narrated by I-7,

"I think this is a partition...too annoying... I think they should have done anything before that partition in the floor material so it can help me avoid it ...also the thickness of the partition is so thin, sometimes the cane can help me know its place. but in other cases it is quite difficult."

Similarly, previous research highlighted the significant role of implementing different sensible materials for surfaces at the beginning and end of pedestrian crossings for disabled and visually impaired [41]. For non-static objects for example, during the guided tour by I-8 around the center's premises that she was not that familiar with, she started to highlight whenever she feels she is approaching a closed door and when asked how she said, "I think I feel it because of the difference in air flow" Both early and late blind informants were able to detect obstacles not only through *haptic cues* such as *difference in air flow*, but also *hearing cues* such as utilize the *returning contextual soundscape* from the surrounding environment to detect static obstacles or even dynamic like the presence of other individuals hence, were able to have sense of position in space. Similarly, a previous research showed that blind people who used echolocation found it easier to move around in novel places [20].

As summarized in Figure 3, sensory stimulants from *change and transformation* of wind/ air (flow-pressure) were experienced and perceived, unexpectedly reaching their bodies as haptic and olfactory cues. This in-turn leads to the capability of the perception of a dynamic obstacle. While for static obstacles, informants utilized *echoes* as a source of stimuli in the built environment to detect them. It is argued that surrounding *finishing materials* had a great role in enhancing or hindering the echoes produced hence, affecting the detection of static obstacles. Furthermore, it was shown that the capability in perceiving obstacles has a great significance for the informant not only for the sense of safety and security but also catered for their orientation and navigation skills (Figure 3).

4.5. Finishing Material

For sighted individuals, a distant glance of a texture can give them information about the type of material without fully engaging in all the senses. However for visually impaired and blind individuals, recognizing materials depend on the felt weight, texture, temperature, sometimes smell and the qualities of sound it reflects producing different echo. Hence, the perception of material for visually impaired and blind requires the engagement of most of the senses (hearing-haptic-movement-smell). Hussein had a strong vivid memory created by the sensory perception of the texture of the material of a staircase;

"It was an ordinary sort of staircase,... and its steps were of stone; but since it was used very frequently in both directions, and no one troubled to wash or sweep it, the dirt piled up thickly and stuck together in a compact mass on the steps, so that the stone was completely covered up, and whether you were going up or coming down the staircase appeared to be made of mud..." [26, p. 106].

It is believed that he was able to perceive the material

through haptic and motion cues. Moreover, he was able to *construct a mental image* of a staircase made of mud. While for I-7, he was able to know the difference in floor materials used around him *though auditory cues* produced by others' foot-steps; "...also through the sound of others footsteps, I started also to know even the fine details of the place such as the type of materials of flooring..." Likewise, Chris Downey, a late blind architect, highlighted in one of his published interviews that he was able to recognize the difference in floor material through the sound of him hitting the floor with his cane, which helped him in recognizing that he is walking on a concrete material. In addition, he utilized the returning sound of other people footsteps describing it as "delicate, crisp" sound generated by the gravel finish floor material. Furthermore, Hussein's sense of happiness was created by the *transformation of floor material* qualities (smooth/rough, warm/cold) that he sensed by his bare feet and his resting back, as he described his first journey inside Al-Azhar mosque;

"How happy he was when he put off his shoes at the door of the mosque and walked first on the straw-mat, then on the marble and then on the thin carpet, which was spread over the floor of the mosque. How happy he was when he took his place among the circle on this carpet by the side of a marble pillar. He touched the pillar and liked its glossy smoothness," [26, p. 83].

Additionally, feeling the floor materials and morning breeze on his skin, he was able to generate mental imagery of a *drowsiness environment* in his novel experience of the mosque [26, p. 115]. Furthermore, the *material, material connection, scale and location* of a physical boundary left Hussein with a *strong clear image in his mind* which also affected his sense of *accessibility and confinement*;

"... if there has remained to him any clear distinct memory ... it is the memory of a fence which stood in front of him and was made of maize stems and which was only a few paces away from the door of the house. He remembers the fence as though he saw it only yesterday. He remembers that the stalks of which this fence was composed were taller than he was and it was difficult for him to get to the other side of it.....He also recalls that the stalks of this fence were close together, as it were stuck together, so that he could not squeeze between them." [26, p. 166]

For Hussein haptic and motion cues left him with a vivid experience however, most of the previous studies that targeted sighted informants, claimed that olfactory system is the most related system to memories, showing that when the sense of smell is stimulated odors can provide a rich holistic experience that create long lasting memory pictures [42]. While in a previous study comparing sighted with early blind experience, it was shown that early blind

individual's strong memory was significantly connected to environmental sounds but not odors [43].

Informants described how they used the underground transportation system floor independently, by *feeling the different tactile floor pavers* used on the ground, allowing them to understand their location and orientation. For I-2 the *change in floor materials* acted as *sensory signs* and *landmarks* for her to *construct a sequential cognitive map* as well as a great capacity in *operating in the built-environment*.

"while going back to the dorm, first after going out of the door I go down the pedestrian walk way then move forward until I meet another step and move forward I feel grass beneath my feet then from here I understand that I arrived... that's because I memorize the place very good."

Similarly I-7, recognized *sensory signs through motion cues* to provide him with the capability of knowing where his exact location is;

"I know where is my exact location for example by knowing how many speed bumps I passed.....if I passed this bridge where will I reach....For example when I skip "Banha" I know it when there is a certain bridge with a certain feeling while I go down its slope ..."

The overall narrative explication, strongly suggests that perceived transformation of floor contour (difference in floor level – steps/sloped/bumps) and material (different textures; rough –smooth / cold- hot) acted as source of stimuli in the built environment to give a great sense of position in space, hence increase the capacity of navigation and orientation skills (Figure 3). Informants were able to identify a certain direction and/or taking decisions upon decision points/ junctions through proprio-haptic cues from the built environment.

5. Conclusions

In conclusion, visually impaired and blind narratives helped reaching the main study objective which is the understanding of the experiential, multisensory qualities of architectural spaces. The study confirmed that the attention for non-visual perception in the experience of visually impaired and blind individuals, can significantly inform multisensory design approaches for both sighted and blind individuals. It was confirmed that multisensory cues in the built environment stimulate the senses of visually impaired and blind, hence contribute to their perceptual tasks (the understanding and making sense of the built-environment), and make them able to form beliefs and make decisions (cognitive tasks and operating tasks).

Overall, it was highlighted that the visually impaired and blind individuals' experiences are as rich as sighted experiences. Most of the visually appealing features

recognized by the sighted people in the built environment would not catch the attention of blind individuals. However, the study showed that visually impaired world of darkness is yet full and rich of sensory stimuli. Multisensory cues in the built environment stimulate their compensatory senses which in turn help them in perceiving physical characteristics. Among these multisensory cues are *floor qualities* (finishing texture, contour), *natural factors* (wind, sun, contextual vegetation), boundaries (*proportion and scale*), spatial organization (different sensory cues associated to different activities), and *rhythm of movement* (difference in movement directions, encounters, rest periods, and repetitive cycles) all acted as sources in the built environment that catered for the perception of different physical characteristics such as *volumetric configuration*, *geometric configuration*, *openings (size/location)/building orientation*, *detecting obstacles*, and *finishing materials*. Hence, such perception of these physical characteristics catered for the understanding of the spatial structure, which then influences the perception of several spatial qualities such as *sense of enclosure*, *legibility*, and *sense of position in space*. This in turn acted as prerequisite to several other *cognitive processing* and *actions* in the built-environment, such as constructing mental imagery, cognitive maps, and orienting/navigating in the built environment.

Methodologically, this study has demonstrated the value of the phenomenological research approach in describing the experience of visually impaired and blind individuals. Visually impaired and blind narratives, through different study sources, allowed the consideration of users of architectural spaces who rely mainly on non-visual cues in the built-environment. This is expected to contribute to an increased awareness of the need for multi-sensory design. In turn, multi-sensory spaces will provide users with more holistic and richer experiences.

Accordingly, such findings of this study opened a venue for some implications for practice that could inform the future of multisensory design approaches in architecture in order to heighten the senses and enhance the experience of the visually impaired, hence, automatically enhancing the experience of the sighted. These implications include the integration of the built-environment with natural surroundings and layout orientation that considers cross ventilation and sun path direction. In addition, spatial organization that considers rhythm of movement, auditory and olfactory perception. And implementing of physical features enables a sense of touch- haptic perception. Furthermore, implementing finishing material for boundaries (wall- ceiling-floors) that consider echoes needed in the perception of the surrounding environment. As for venues for future research, more sensory channels such as taste and smell, which was not significantly addressed in this study, need to be investigated. Also engaging more data collection sources such as autobiographies for other sensory disabilities, personal reflections, and documentation of films featuring sensory

issues might help in finding deeper understanding of multisensory experiences.

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