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Research Paper

The Process of Perceiving the Physical Environment by Total Blind People Using Sensory and Subjective Perception*

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ABSTRACT

Congenitally blind people require finding solutions and relying on environmentally-compatible behaviors to understand and perceive their surrounding environment and acquire physical and social independence. In addition to their external senses, they need to use their internal senses of memory, imagination and subjective perception. Therefore, perception for these people is a kind of understanding the external world that comes from combing sensory data and thinking mechanisms and may differ from objective reality. This study aimed to respond to the question: "How is the perception of the environment made by congenitally total blind people?" For this, the study aimed to understand their process of environmental perception, which can be used as a better design foundation for the feasibility of greater presence in public spaces and the creation of equal chances for blind peoples, and also for providing them with unconstrained, safe and independent accessibility to the environment, disregard of their physical and sensory abilities. The present study fell under qualitative research in terms of nature and was an applied study in terms of goal. It also used a descriptive analytical procedure and qualitative content analysis, together with a deductive reasoning approach. Data were collected by investigating scientific documents and their qualitative content analysis. This study used the inferential method to investigate blind people's process of the physical environmental perception through two sensory and subjective perception categories, and finally provided recommended solutions to facilitate the blind peoples' perception within the urban environment. Findings revealed that total blind people use non-visual sensory perception as well as auditory, tactile, and kinetic visualization-based subjective perception, which is dependent on various individual, social and cultural factors, to perceive their surrounding environment. For this, it is critical to focus on these factors in designing the physical environment to help all people of the community, especially the blind, to perceive the environment and utilize the facilities contained in there.

Keywords: Physical Environment, Total Blind People, Perception Process, Sensory Perception, Subjective Visualization.

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1. INTRODUCTION

According to the World Health Organization, the number of people with visual impairment across the world exceeds 180 million, of whom, 76 million are totally blind (World Report on Vision 2021). According to a report by the National Association of the Blind, there is an estimated 120000 total blind people and 600-700000 with visual impairment or partial loss of sight in Iran, which ranks 16th in terms of the number of people with blindness or partial loss of sight, as based on the report provided by the blind training and rehabilitation experts at the 102nd Meeting of Tehran's City Council (Iran Blind NGO 2020). Total blind people require finding solutions and resorting to environmentally-compatible behaviors to understand and perceive their surrounding spaces and acquire physical and social independence. In addition to their external senses, they need to use their internal senses of memory, imagination and subjective perceptions. Therefore, perception for these people is a kind of understanding the external world that results from combing sensory data and thinking mechanisms that may differ from objective reality. This study aimed to understand the process of environmental perception by total blind people through their abilities and perception so that a better basis was laid for providing an independent life without the need for others' help and engaging them in daily activities in a safe and convenient way, which could help increase social participation and greater presence in society and physical environments.

The study, as suggested above, aimed to respond to the question: "On which process is the environment perceived by congenitally total blind people?" There are also two secondary questions: "How does the blind's sensory perception affect environmental perception?" and "How does the blind's subjective perception affect environmental perception?"

2. METHODOLOGY

The study was qualitative and its goal was applied. The method used was based on qualitative content analysis, which can help understand the congenitally total blind people's perception of the environment and serve as a basis for promoting the readability and perceptibility of the physical environment. The study involved three stages: the first stage includes the collection of data related to perception, in general, and the sensory and subjective perception of the blind, in particular, through available scientific documents and the analysis of views and their qualitative content analysis. In the second stage, the inferential method was used to investigate the blind's process of the physical environmental perception, while the third stage, summarizes and concludes the process of the physical environmental perception by the blind based on sensory and subjective perception.

3. LITERATURE REVIEW

Following the development of postmodernism epistemology and theoretical domains and post-structuralist worldviews in the 50s, more focus was directed at perception processes in various fields of psychology, epistemology, philosophy, architecture and urbanization. In 1960, Kevin Lynch raised the prospect of the clear perception of the city and the adjustment of the environment to the sensory and subjective abilities and cultural structures of the city residents and that how they could visualize and perceive the environment at some specific times and places. In Lynch's study, the general images the individual's mind takes from the environment not only produce some instantaneous sensations but are also based on his past memories and experiences. For him, the visual clarity of the environment allows for easy movement, which makes him feel secure and increases his deep human experiences (Lynch 2003).

Contemporary American anthropologist Edward T. Hall (1966) did a study on sensitivity to thermal or radiant light among the blind and investigated the effects of windows and airflows around them on the blind's movements and their perception of positions in the space using frequent samples. He concluded that the sense of heat was more effective than the sense of hearing on environmental perception, with the brick façades of buildings in the urban environment leaving an identical function on the pavement width through its diffusion of heat (Holl, Pallasmaa, and Gomez 2015).

In 1985, Ian A. Bentley, the British architect and urban designer and an advocate of the Lynch theory, asserted that in addition to the sense of vision, being the dominant sense, other senses, including the senses of movement, smell, hearing and touch, were quite effective on design requirements, arguing that the people's subjective perception of the certain properties of physical spaces enjoyed some commonalities upon which a unified subjective perception map could be outlined (Bentley et al. 2019).

In a study on blind people, Lowport (1997) found that the blind's sense of hearing is not only stronger than that of the sighted people but it also helps them be capable of visualizing the three-dimensional images of the space that they can obtain using their sense of hearing. They also found that low-vision people detect the place where sound is generated at a less accuracy than the total blind people. In other words, the strengthening of other senses, especially hearing, depends on the degree of blindness (Lowport and Miller 1997).

The book entitled "Psychology and Training of Blind People" by Dr. Parviz Sharifi Daramadi (2000), a professor of psychology in Iran, examined congenitally blind children and found that blind children were used to dealing with the environment in a certain objective method and were more capable

of perceiving its tangible aspects. Therefore, to compensate for the delayed cognitive development of totally blind people, it will be critical to create a subjective image that results from the recreation of something, which has already been perceived, through strengthening hearing, smell and touch actions and also through subjective-hearing visualization, as well as perceiving spatial relations using two concepts of the surrounding space and the space of action that appear when moving (Sharifi Daramadi 2000).

In the end, in a study entitled "Determining the Perceptual Constraints and Qualities of the Artificial Environment Through the Touch Sense in the Congenitally Blind People", Herssens and Heylighen (2011) found that the classification of signs, passages, nodes edges and limits, described by Lynch's visual domains, could be generalized to touch perception, with the only basic difference being that the sense of touch and the sense of vision interact with the environment at the micro and macro scales, respectively (Herssens and Heylighen 2011).

4. CONCEPT OF ENVIRONMENTAL PERCEPTION

Perception is characterized by wide-ranging dimensions and meanings. Psychologists maintain that perception is concerned with some subjective or mental processes, perceived by man when sensory experiences, affairs and objects take on meaning. In this connection, sensory experiences and arising imaginations, as well as individual motives and the situation where perception occurs are involved in the perception process. Perception does not occur following separate feelings; rather, it is understood by the individual's mind as a meaningful and interrelated set, with prior perceptual hypotheses, experiences and teachings, as well as motivational states playing determining roles at the moment of perception (Irvani and Khodapanahi 2015).

From an architectural and urbanization point of view, perception goes beyond simple senses. Perception refers to an active process through which the surrounding world can be understood (Lawson 2017), as numerous factors such as the feelings created by colors, forms, mobility, the diversity of light, smell, sounds, and the sense of touch, or even exposure to the ground magnetic field can help understand the environment (Lynch 2003). As well, factors such as age, gender, ethnicity, lifestyles, the duration of residence in a cultural, physical and social environment where the individual has grown and lived can affect perceptual differences (Carmona et al. 2015).

According to Thurstone, peoples' perceptual differences are relative and simply quantitative and are largely dependent on their physiological processes, interests, tendencies, desires, their familiarity with the situation, education and intelligence (Vernon 1980).

Therefore, establishing relations with the surrounding world cannot be done similarly by all people because there are many differences with the environmental needs of people and cultures, without understanding of which, the process of transfer from one perceptual world to another is impossible (Holl, Pallasmaa, and Gomez 2015). Hence, the spatial world of the blind is practically different from that of the sighted people, and in a society where the primary tool of gaining direction data and understanding the environment are adjusted to vision, the blind need to rely on their non-visual senses (Namani, Roshanaei and Torabi-Milani 2017).

For Jon Lang, environmental sound-making by selecting appropriate materials for various levels and using the natural characters of some elements can affect the quality of environmental perception, with positive sounds such as waterfalls, fountains, etc., eliminating negative sounds such as traffic sounds (Carmona et al. 2015). Table 1 below gives the factors affecting the formation of environmental perception from the views of experts.

Table 1. Factors Affecting Environmental Perception from the Views of Theorists

Researcher	Factors Affecting the Formation of Environmental Perception
Grutter (2018)	Social and psychological factors and cultural characteristics
Lang (2014)	Experiences, needs and motives, cultural characteristics, individual characteristics
Rapaport (2005)	Experiences, social classes, cultural characteristics
Weichert (2008)	Physical factors of the environment, interests, feelings, memories and expectations, social background, time
Santos et al. (2009)	Physical factors of the environment, social characteristics, individual characteristics
Naghizadeh (2004)	Society's awareness and expectations, individual abilities
Holl (2013)	Individual abilities, gender, cultural characteristics
Carmona et al. (2015)	Social and cultural developments, individual experiences, personality differences

Researcher	Static Factors (Fixed in the Background)	Dynamic Factors (Variable when Perceiving)	
Naghizadeh & Ostadi (2014)	Environmental quality: Group characteristics (culture, social values and norms, sensory experiences, history); individual characteristics and general conditions (age, gender, education, job and language); value characteristics (worldview, beliefs, ideals, insight and attitudes) and mental-personal characteristics (memories, subjective experiences)	Time, angle of vision, rate of movement	Motivational, affective and emotional states, expectations, decision and will, fears and hopes

5. PROCESS OF ENVIRONMENTAL PERCEPTION

Perception is an active and purposeful process concerned with gaining information from the surrounding environment. Environmental perception relates with a complex process of understanding environmental stimuli. From the perspective of architecture and urban development, the interaction between man and the external world occurs through sensory perception (Pallasmaa 2016). In fact, perception goes beyond simple senses and refers to an active process by which the surrounding world can be understood (Lawson 2017). From the angle of environmental psychology, gaining environmental data are stimulated by perceptual processes through mental schemata, which are partly intrinsic and sometimes learnable and are directed by human needs. These schemata establish a link between perception and cognition and direct emotions and spatial behaviors. Reciprocally, these processes and reactions, as illustrated by Figure 1, influence mental schemata as the result of the behavior perceived. In this process, human senses and behaviors are confined by environmental conditions (natural and man-made conditions), as well as the cultural conditions of the environment and peoples' internal characters (Lang 2014).

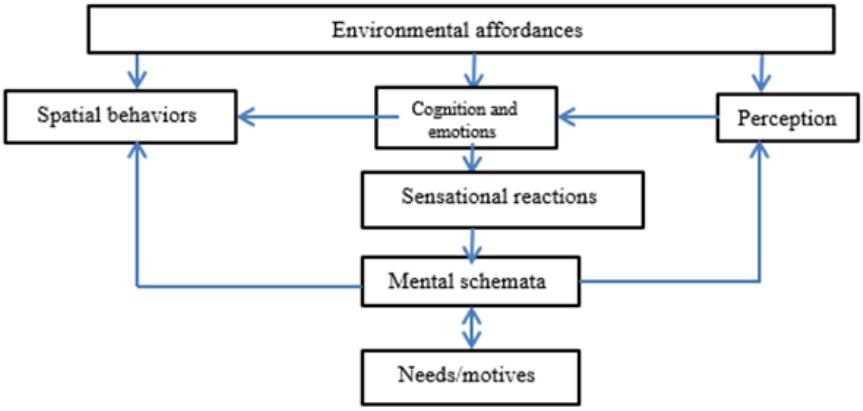

Fig. 1. General Process of Perception and Cognition

(Lang 2014, 95)

Perceiving the meaning of the environment denotes perceiving the type of appropriate behavior and activity in the environment, which is critical for the blind people, as it can be increased by improving their perceptual abilities. Excluding the visual element, the non-visual elements of the environment (touch, hearing, smell, etc.) involve meanings that depend on both the physical quality of the environment and individual knowledge and social beliefs, which can be examined by associative memory acquired by people. Experts have also presented various perspectives about the process of perceiving the environment, a summary of which is given by Table 2.

Table 2. Summary of the Process of Environmental Perception from the View of Experts

Researcher	The Process of Environmental Perception
Lang (2014)	Cognition and emotions, sensational reactions, mental schemata, needs and motives
Mortazavi (2001)	Individual Psychological factors (individual character at the moment of perception); physical factors (the physical conditions of the environment), cultural factors
Irvani & Khodapanahi (2015)	Individual background (needs, differences, attitudes, expectations, experiences and past learning, habits, personality characteristics), social background (cultural economic activities, language, social influence, social space, social imagination, individual perception)
Motloch (2000)	Inspiration, decoding environmental implications
Gardner (1980)	Perceiving past concepts, superficial investigation, individual's inner factors, environmental factors, understanding the situation, imagination (Vernon, 1980)
Itelson	Cognition, sensation, interpreting acquired meanings and concepts, valuation (Carmona, 2015)
Pakzad & Bozorg (2012)	Attention, learning, memorization, conceptualization, meaning exploration, thinking, association, mental image
Carmona (2011)	Feelings acquired from the objective environment, subjective environment, cognition
Carmona (2011)	Feeling acquired from the objective environment, perception (sensory and intellectual) acquired from the subjective environment, cognition acquired from the objective environment, behavior

6. PERCEPTUAL CHARACTERISTICS OF BLIND PEOPLE

The environment should be understood and perceived to create mutual effects on the environment. This is made possible by human senses (vision, hearing, smell, touch) and his mobility that underlie activities, behaviors and communications in urban spaces. Although human senses are not his only way of understanding the environment, they are the rudimentary means for communicating with the environment. Human communication with the environment is a function of a set of various factors that naturally function to coordinate together. Although vision is a major and predominant sense and transfers the highest amount of environmental information, it cannot alone help perceive the urban environment. According to Baker, changing a visual image is only the initiation of a sensory experience, with changes from light to shade, heat to coldness, sound to silence, smell related to outdoor spaces and the quality of surface reliefs contributing to collective impacts (Carmona et al. 2015). Psychologically speaking, the people who lose their eyesight like congenitally blind people before the age of 5 have no objective understanding of the useful pre-imagination of the visual world, and thus acquire experiences using remaining sensory tools such as hearing and touch (Afrooz 2019). A blind individual uses his other senses quite extraordinarily in order to compensate for his loss of eyesight. They can detect sounds, smell and taste and employ their touch senses better than other people. This sensation can be due to the greater engagement of senses and constant thinking about the small and large subjects (Zanganeh 2013). These people who have had no history of eyesight rely on their internal senses and imagination, in addition to their external senses, to understand and perceive the environment. Therefore, for these people, sensory perception is a kind of knowledge about the external world that arises from combining sensory information and thinking mechanisms and may vary from objective reality. Confronting new situations, blind people make uses of their past experiences and the more they succeed in gaining these experiences, the more they become self-confident and the more they will employ previous skills and methos (Namani, Roshanaei, and Torabi-Milani 2017).

6.1. Auditory Perception among Blind People

Hearing plays a major role in urban design and architecture. Sound is everywhere and each element produces its own sound. Music, sneezes, laughter, the burning of a piece of wood, water spray, birds, a coin falling on the ground, stones, peoples' voice tones, vehicles, resonance from a wall, commotion, etc. have their own sounds. Auditory perception remains in the mind background as an unconscious experience, and the individual can distinguish the sound roughness of an abandoned or half-constructed house from the gentleness of a residential house, where sound is refracted and softened by means of various furniture surfaces (Pallasmaa 2016).

The hearing sense is actively functional in the lives of the blind. Barazlton (1990) asserts that a blind individual, as compared to a sighted one, tends to focus on the sequence, note, and interruption of sounds or its implications, because there are specific sequences and implications in the voice of every individual that draw the attention of blind people than sighted people (Sharifi Daramadi 2001). Some of the blind are accustomed to drag their feet over the ground to get aware of surface obstacles and to make sounds by clapping their hands or calling to detect vertical obstacles or the depth of space. It is clear that sound reflection in an empty space or contacting obstacles like wide walls and columns or even a standing person could be very different. For this, the blind partly detect their positions by these measures (Zanganeh 2013). The extent to which space is perceived by space among the blind based on the type of sound (functional, natural, industrial sounds, etc.) and the genus of sound (power, frequency, rhythm, etc.) indicates that special sounds of some places, spaces, materials, and the function of each space, which have unique characteristics, are not only perceivable for the blind but are also deemed as signals for them. Focus on the reflection and resonance of sound for understanding the severity and the depth of sound for perceiving the distance of the acoustic source, as well as focus on the direction of the acoustic source enable the blind to perceive their situation and the surrounding environment (Hill and Ponder 2001). Thus, the following is said to be perceived by blind people's auditory sense in the environment:

- Detecting the direction and the estimating the distance from an acoustic source using experience;
- Detecting the stillness or mobility of an acoustic source, which is a combination of direction detection and sound distance, and
- Detecting the genus and properties of materials, space sizes and its emptiness or fullness (Grutter 2018).

6.2. Tactile Perception of Blind People

Following the sense of hearing, the sense of touch is the second factor that can transfer environmental processes to the mind of the blind (Zanganeh 2013). The skin surface re-reads such cases as the genus, dimensions, texture, roughness and gentleness, weight, density and temperature of materials (Pallasmaa 2016). Therefore, the changing texture of natural and artificial elements of the environment, heat and humidity, the resistance of a surface on which movement is done, as well as the physical characteristics of passages such as slopes, along with muscular stimulations affect the blind's touch sense (Holl, Pallasmaa, and Gomez 2015). Usually, hands require touching smooth surfaces and feet require non-smooth and uneven surfaces to understand the environment. Ground surface differences can be perceived by the touch of the feet and can help find directions as they move (Herssens and Heylighen 2011). Feeling coldness, heat, pressure and pain are also regarded as the quality of the touch sense, as they are scattered all over the body. Light and rising temperature can also be perceived by the touch sense and help directions (Clark 2005). The touch sense perception can be divided into three categories of active touch (touching), dynamic touch and passive touch (being touched), the details of which are illustrated by Figure 2. Active touch enables people to carefully remember the abstract and absolute objects, previously touched, whereas passive touch halves this possibility.

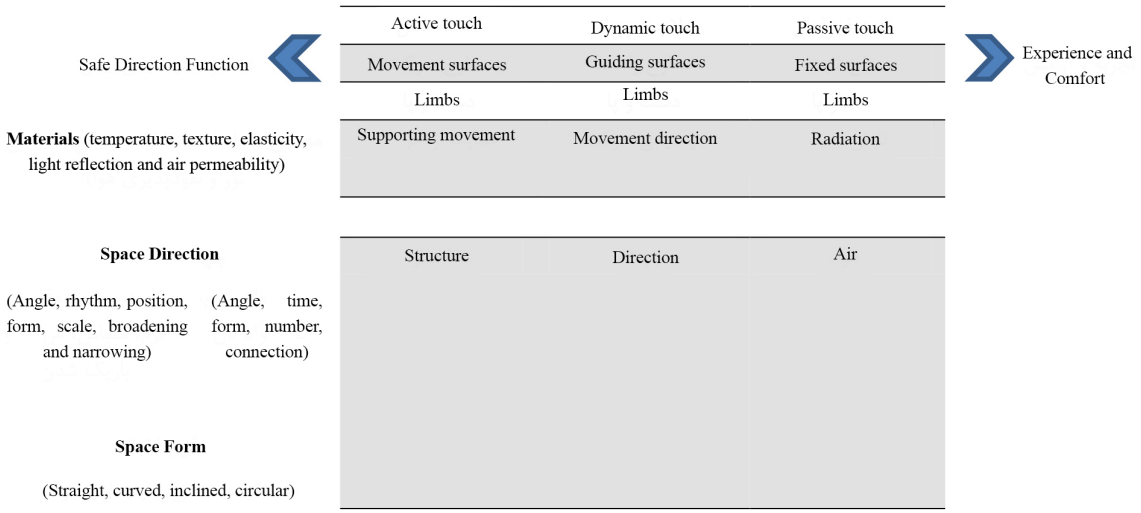

Fig. 2. Touch Perception in the Blind in three Categories of Dynamic, Active and Passive Part
(Herssens and Heylighen 2011, 6)

6.3. Olfactory Perception of Blind People

The sense of smell is one of the primary senses of human being and is more capable of transferring deeper information than vision and hearing senses (Holl, Pallasmaa, and Gomez 2015). Smell leaves an instantaneous effect and is highly capable of detecting sequential memory recognitions for seemingly simple combinations of odors (Bell 2015). Blind people are very much sensitive to smell and establish a part of their communication with the surrounding environment through the sense of smell. The sense of smell helps them better perceive the environment, the location of objects, the presence of people, and generally the detection of a spatial position. This sense is not only seen as a solution to know about possible dangers in advance but it can also be regarded as a factor for the mental comfort of all people, including the blind (Zanganeh 2013). An olfactory experience can only be perceived by moving through the environment. Each city or neighborhood has its smell, with changing environmental odors creating a pleasurable sense by moving through old and narrow neighbors and passages (Pallasmaa 2016). Controlling space by the sense of smell in air-flowing places such as windows and doors creates a fluid network of odors that can be perceived by the blind and help them recognize directions. This odor may belong to some specific places or objects or can link with the odor of the flowing air, which, in any case, can be a perceptible sign of that space, like the special odor of a clothes closet, kitchen, lawn and green spaces, each of which representing a safe and secure passage or a sign for the blind (Bemanian, Khameneh, and Ahmadi 2015).

6.4. Thermal Perception of Blind People

Blind people have considerable perceptual sensitivity to temperature and thermal radiation. In frequent interviews that Edward. T. Hall and psychoanalyst, Dr. Warren Brady had with blind people, it was determined that airflow around the window enabled them to perceive their position inside the room and maintain their contact with the space out of the room. Findings led to the conclusion that the sense of heat for the blind was more superior than the hearing sense. Using the sense of heat, blind people can successfully move in the space. For example, an experiment concluded that brick walls on one of the streets acted as a sign for the blind, due to the heat it released on the entire surface of the pavement (Holl, Pallasmaa, and Gomez 2015).

6.5. Kinetic Perception of Blind People

The movement of blind people significantly depends on their abilities in perceiving temporal and spatial distances, which can also affect their performance (Sharifi Daramadi 2000). They can perceive the volume of an interior space by distinguishing the difference of the type of air (odor, temperature, humidity, etc.) and the type of environmental sounds and sound reflection. In addition, they are capable of using the airflow to safely move through the environment without sticks (Farzin and Sheybani 2010). Since movement is relative and can only be perceived when it is neither too slow nor too fast (Grutter 2018), the experience of the sense of movement is mainly acquired in large spaces where greater rates of movement take place (Bentley et al. 2019). Information acquired by the blind in outdoor spaces is limited to a circular radius of 60 cm to 3 m, with their average pace of movement in the environment limited to 0.4 m/s (Holl, Pallasmaa, and Gomez 2015). Therefore, for the blind, the safest and most reliable way is to walk slowly in the environment to incur the least possible harms if possible obstacles arise (Zanganeh 2013).

6.6. Equilibrium Perception of Blind People

The sense of equilibrium depends on the sense of movement; however, what affects equilibrium is the human's conscious perception of the environment, performed by various senses (Irvani and Khodapanahi 2015). One of the problems that require the blind to practice for solving it is the lack of necessary equilibrium in movement, which can be easily resolved by exercise, concentration and care (Zanganeh 2013).

6.7. Direction-Finding and Routing Perception of Blind People

Finding directions is the proper way of finding routes in familiar and unfamiliar places. A white stick allows blind people to safely frequent and walk but does not help them understand where they are and where they head. Successful routing is when man knows where he is, knows his destination, recognizes the best path and goes through it and has the ability to return the path covered (Carpman and Grant 2002). Routing has two levels of direction-finding and movement, which are totally interdependent, as a blind who enjoys both aspects can safely can effectively and independently move through the environment (Etebari et al. 2001). A blind person needs to use the following five stages to practice direction-finding skills:

- Perception: denoting receiving information through senses
- Analyzing the perceived sensory information and classifying them
- Selecting sensory information that best meets direction-finding needs
- Planning: denoting actions that is most related to the current situation
- Implementing a series of planned actions related to the situation arisen (Etebari et al. 2001).

6.8. Subjective Perception of Blind People

The imaginations people have of their environment are a kind of subjective visualization that can be symbolic or associative images (Lang 2014). Cognitive maps are associated with individual experiences, along with such criteria as gender, age, culture, social and economic position, the duration and place of residence and occupation activities, as well as the type of urban commuting. Blind people were long thought to have no image of their surrounding world and incapable of creating subjective visualization; however, research has suggested that congenitally blind people are capable of subjective visualization and their underlying visualization mechanisms do not differ that much from those of the sighted people (Aleman et al. 2001). Meanwhile, since congenitally blind people lack the experience of vision, they find it more difficult to imagine their surrounding world, and what they visualize about the world comes from their perceptual and tactile senses and the images told by others (Noordzij, Zuldhoek, and Postma 2007). Despite the fact that congenitally blind people have never had visual perception, their brain activities are similar to those of sighted people and they have both have areas on their brain that help visualization. This lack of difference may arise from the fact that when moving, the sense of vision and other senses of hearing, smell, touch and movement are engaged (Thinus-Blanc and Gaunet 1997). In general, blind people have two imaginations of space, as illustrated by Figure 3, in their minds and use three subjective visualization methods of hearing, touch, and movement to perceive the environment:

- A neighboring space that involves their surrounding environment and has their real contacts occur there
- An action space that appears when moving and takes place based on muscular mobility and movement (Sharifi Daramadi 2000).

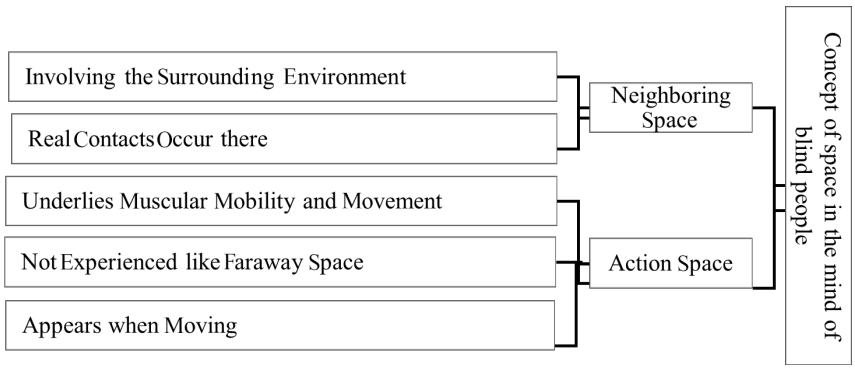

Fig. 3. Concept of Space in the Mind of Blind People
(Sharifi Daramadi 2000, 92)

6.8.1. Process of Auditory Subjective Visualization in Blind People

Auditory visualization is one of the pre-requisites to the successful movement of blind people in a physical environment (Freiberg and Freedman 1984). Visual and auditory subjective visualization are different and this difference comes from the perception process. Visual perception and visual subjective visualization occur simultaneously; however, auditory perception and visualization take place gradually (Sharifi Daramadi 2000). Research has shown that the auditory spatial visualization of blind people is greater than in sighted people (Voss et al. 2004). Detecting and recognizing the physical obstacles of the environment has been one of the skills that enable the blind to move through in the physical environment. This is also possible through acoustic reflection and the strengthening of auditory concentration and auditory subjective visualization. However, this does not make blind people as highly capable pedestrians; rather, it is regarded as a small means because it is distorted by the negative sounds of the environment such as traffic and rain sounds. Also, the effective use of this sense requires a very quiet movement in the environment, which requires the individual to constantly exercise auditory subjective visualization to properly react in the environment (Sharifi Daramadi 2000).

6.8.2. Process of Tactile Subjective Visualization in Blind People

Tactile subjective visualization helps the subjective visualization of blind people in two categories of combined touch and analytical touch:

Combined touch: It pertains to small objects that can be enclosed by the individual and helps create an image of that object in the mind using the touch sense.

Analytical touch: It refers to objects that cannot be visualized through combined touch. In this method, various parts of an object are touched and then separate parts are combined together through the mind and the individual tries to make a Gestalt image of which through analytical subjective visualization (Lowenfeld 1987).

Since tactile information is limited to close-range distances, it cannot be used in daily situations where no acoustic source is available. Usually, blind people use auditory kinetic signs under conditions that pertain to the body and the auditory space (Andreou and McCall 2010).

6.8.3. Process of Kinetic Subjective Visualization in Blind People

In kinetic visualization, the individual recalls movements in his mind, without doing any bodily activities. Research has demonstrated that blind people do not have much difference from sighted people when it comes to kinetic visualization (Mudler et al. 2007). In this visualization, some controlled imaginations in relation to the human's physique are created, which blind people are able to do like sighted people. For this, training kinetic visualization can facilitate this process. For example, when a blind person is asked to imagine his running and standing, this imagination is much easier than visualizing a summer house in his mind (Yousefi et al. 2009).

7. ANALYSIS OF RESULTS AND THEORETICAL IMPLICATIONS

The theoretical foundation of the study identified the sensory and subjective perception of blind people to determine the process of perceiving the environment by these people. Findings revealed that congenitally blind people use both non-visual external senses (hearing, smell, taste, touch, equilibrium, movement, temporal and spatial direction) and subjective perception and thinking mechanisms (memory, imagery and auditory subjective visualization, tactile subjective visualization and kinetic subjective visualization) to understand the environment. Concerning the sensory perception of total blind people in the process of environmental perception, the tangible information and characteristics of the environment is first perceived and classified by non-visual systems, and in the next stage, the information received from senses will be transported to the brain and analyzed through subjective perception. The subjective perception of total blind people includes auditory, tactile and kinetic subjective visualization, which are influenced by the individual physiological differences and social-cultural factors. Table 3 below gives various theories about the way the subjective and sensory perception of the blind and sighted people affect environmental perception.

Table 3. Methods of Perceiving Environmental Information by the Blind and Sighted People from the Perspective of Scholars

Theorists	Theory	Method of Perceiving Environmental Information	
		Sighted People	Blind People
Guilbert (1995)	Blind people are capable of visualizing peoples' personality traits through hearing their acoustic patterns. Blind peoples' auditory perception is gradually created. Blind people obtain environmental information through hearing and touch senses while sighted people take the information from vision and touch	Touch and Vision	Touch and Hearing
Coliss (1997)	Congenitally blind people use their hearing power to perceive the environment. They also replace the visual system with the auditory system.	Touch and Vision	Touch and Hearing
Lowenfeld (1987)	A congenitally blind child uses auditory subjective visualization to understand affective behavioral, physical and cognitive characteristics.	Touch and Vision	Auditory Subjective Visualization
Zimmer & Kitan (1983)	The subjective images of congenitally blind people are based on auditory abilities.	Touch and Vision	Auditory Subjective Visualization
Remsa & Robin (1994)	Sighted and blind people have different visualization. In cases where the stimuli are absolutely visual, it is in the benefit of the sighted, while if they are auditory, that benefits the blind people.	Vision	Auditory Visualization
Theory of Inefficiency	The lack of visual experience may lead to similar spatial abilities compared to sighted people, though with less efficiency.	Similar Spatial Abilities but Little Efficiency among Blind People	
Theory of Difference	The lack of visual experience reveals qualitative differences and similar reactions compared to sighted people	Qualitative Difference, Similar Reaction	

Theorists	Theory	Method of Perceiving Environmental Information	
		Sighted People	Blind People
Theory of Sensory Compensation	Congenitally blind people have stronger auditory, tactile, and olfactory senses	Vision	Hearing, Vision and Touch
Descartes' Theory quoted by Lando	Sighted and blind children have similar subjective visualization although with different sensory bases; hence, the tactile and auditory exploration of blind children can fill the visual exploration.	Similar Subjective Visualization but with Different Sensory Bases	
Empiricist Theory	There is a gross difference between spatial perception through vision, hearing and touch. Therefore, the results of the spatial visualization of blind children cannot be compared to those of sighted children.	Vision	Lack of Space Perception
Rationalist Theory	The perception of spatial concepts by total blind people is impossible, as spatial visualization is generally made through vision.	Vision	Impossible Space Perception
Sanden Theory	Vision is the dominant sense and the only sense capable of creating environmental experiences. Vision is key to enjoy direct environmental experiences an affordance.	Vision	Lack of Space Perception
Revez Theory (1935, 1950)	Three sensory systems (vision, touch and movement) provide different but independent spatial structures, which if accessed by the individual, the relationship between him and the objective experience of objects in space and a spatial state will be established.		Vision, Touch, Movement
Carlson Theory	Senses cannot be separately perceived; rather they are a combination of different sensory receptions (visual, auditory, skin, and internal stimulations). In congenitally blind people, the touch sense is the most important sense; however, they are capable of immediately perceiving objects in the space by combining their abilities For them, object imagination is a representation of perception and is divided into three major forms: perception in the form of subjective visualization experience; perception in the form of imaginations, and perception in the form of information		Touch and Immediate Perception through Subjective Visualization
Lowporet Theory (1997) Freiberg (1984) Millard (1982)	Visualization in sighted and blind children is different. The subjective visualization of sighted people is mainly based on the sense of vision, while it is based on the touch and hearing senses in blind people.	Vision	Tactile and Auditory
Kinetic Organization Theory	Blind people have their spatial experiences take place slowly due to their slow independent mobility		Spatial and Kinetic Experience
Oral or language-Based Subjective Visualization Theory	The subjective visualization of people who lost their eyesight before 5 is formed based on the sense of hearing, with language and speech affecting it.		Auditory and verbal
Thinking-based Subjective Visualization Theory	There are qualitative and quantitative differences with the subjective visualization of blind and sighted people. In the subjective visualization of blind people, thinking takes precedence over language.		Precedence of Thinking over Speech
Fundamental Subjective Visualization Theory	Auditory-speaking patterns are both objective and abstract. In objective auditory patterns, the past stimulated activity is aroused when sounds are heard in the human's nerve patterns. In abstract auditory patterns, stimulants are stored into visual or abstract patterns through hearing, and finally represent as subjective images or imagery.		Abstract and Objective Auditory Patterns

Theorists	Theory	Method of Perceiving Environmental Information	
		Sighted People	Blind People
Auditory Subjective Visualization Theory	Congenitally blind people have greater abilities of subjective visualization, which increase with the increase of age and may make up for the visual limitations. The less people vision and the more they move toward total blindness, auditory visualization will be greater than the tactile visualization.		Auditory Subjective Visualization
Lando et al. Theory	There is no difference between blind and sighted people in terms of space perception and the spatial visualization of objects.	There is no Difference in Terms of Space Perception and Spatial Visualization.	

The last stage of environmental perception process is cognition. In this stage, the blind's mind uses environmental data, subjective visualization, and past experiences and memories to understand the environment, which would facilitate a certain behavior in the environment. Figure 4 below illustrates the conceptual model of the environmental perception process by total blind people.

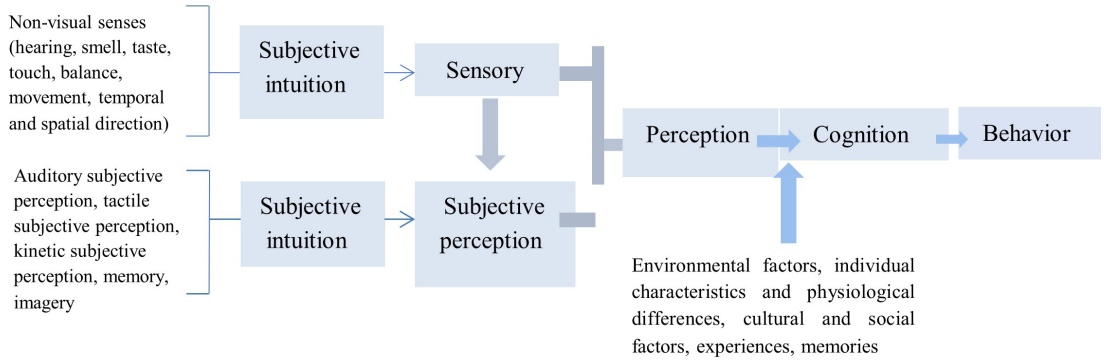

Fig. 4. Process of Environmental Perception by Total Blind People

8. CONCLUSION AND RECOMMENDED SOLUTIONS

As stated, perceiving the physical environment requires attention to the process of environmental perception by all people, especially blind people. Environmental perception is a purposeful process by which man receives necessary information from the environment based on his needs. This ability is not similar in all people as they have differences. Total blind people work differently from sighted people in order to perceive the space they are in and the space they want to go, and this is due to their quantitative and qualitative perceptual tools. Meanwhile, the blind people's information of the environment is based on their non-visual sensory perception and subjective visualization-based mental intuition. Blind people, especially congenitally blind and total blind people, perceive their surrounding world based on realities that are tangible to them. Since they have no visual sense, they use their non-visual senses for perceiving the environment and focus on these senses to perceive the environment. These people use the information acquired from sensory organs (hearing, smell, touch, and other perceivable information such as heat, wind direction, sound, humidity, etc.) and subjective perception (auditory, tactile and kinetic visualization) to perceive the environment. Of course, not all people are the same and their perception depends on many cultural, social factors, individual, affective and cognitive states, environmental factors, as well as individual experiences and memories. Thus, it is imperative that physical environmental planning and design utilize auditory, tactile, olfactory and thermal changes to increase the quality of environmental perception. This will, by itself, increase the active presence of blind people in public spaces and create equal chances, thus providing them with easy, safe and independent access to the physical environment.

This study aimed to identify perceptual characteristics of non-visual senses and their effective functional relationship on the formation of environmental perception among blind people. Also, the role of subjective perception, which is the feedback of tactile, auditory and kinetic visualization by these people, was analyzed. Findings revealed that there are some quantitative and qualitative differences with the subjective visualization of blind and sighted people.

Blind people are capable of immediately perceiving objects in the space, due to their ability in combining sensations. A clear image of the environment enables them to move there. Blind people do not have much difference from sighted people in kinetic visualization in relation with the physical image. Blind people use tactile information to perceive information in their neighboring spaces and also use auditory visualization with the help of acoustic reflection and auditory concentration to perceive faraway situations. Thus, it is imperative that physical environmental planning and design utilize auditory, tactile, olfactory and thermal changes to increase the quality of environmental perception. This will, by itself, increase the active presence of blind people in public spaces and create equal chances, together with easy, safe and independent access to the physical environment.

Since various activities in the environment can determine the extent to which an individual can perceive the environment, creating a safe and accessible environment and facilitating the sensory perception of blind people can help expedite their presence in the environment. Also, environmental readability can help perceive situations and find directions. Table 4 below gives a set of goals, strategies, solutions and recommended executive policies on urban design and planning for facilitating the blind peoples' process of environmental perception.

Table 4. Goals, Strategies, Solutions and Recommended Executive Policies on Urban Design and Planning for Facilitating the Blind Peoples' Process of Environmental Perception

Goals	Strategies	Solutions	Recommended Executive Policies
Creating a Safe and Accessible Environment	Feasibility of Easy Movement in the Environment	Removing Physical and Traffic Obstacles	Creating a consecutive chain without obstacles in the environment with the goal of helping spatial perception
Creating a Safe Environment	- The Possibility of Accessibility and Displacement - The Possibility of Presence in the Environment	- Using Human Scales - Increasing the Quality of Environmental Comfort - Sociability and Companionship of the Environment	- Creating intimate and amicable spaces - Removing unused secondary spaces in the environment - Removing noise pollution and inconveniences - Creating positive sounds such as fountains, falls, etc., to hide negative sounds such as traffic - Creating diverse and continuous day and night uses
Facilitating the Sensory Perception of Blind People	Stimulating Various Non-Visual Senses to Help create Signs and Provide Necessary Information in the Environment	Using Light, Heat, Smell, Sound, Touch changes in the Urban Environment, and using Equipment and Materials	- Difference with the scale of space and its proportions - Changing the type of ground materials - Changing the type of passageways' walls to spread heat on the traffic path - Using acoustic signals for positioning and direction finding - Changing light to shadow, heat to coldness, sound to stillness, and the flows of different smells related to urban spaces
Facilitating Visualization among Blind People	- Readability - Perceiving the Situation -Easy Direction-Finding	-Avoiding Non-Necessary Complexity	- Using order and proximity of space forms to simple geometric forms Continuity of the path

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CONFLICT OF INTEREST

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