EXPERIENCING SPACE WITHOUT VISION

A THESIS
SUBMITTED TO THE DEPARTMENT OF
INTERIOR ARCHITECTURE AND ENVIRONMENTAL DESIGN
AND THE INSTITUTE OF FINE ARTS
OF BILKENT UNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF FINE ARTS

By
Naz A. G. Z. Evyapan
May, 1997

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I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Fine Arts.

Assist. Prof. Dr. Halime Demirkan (Principal Advisor)

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ABSTRACT

EXPERIENCING SPACE WITHOUT VISION

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M.F.A. in
Interior Architecture and Environmental Design
Supervisor: Assist. Prof. Dr. Halime Demirkan
May, 1997

In this study, the human body without vision, and its relation with the surrounding space, is examined. Towards this end, firstly space and the human body are briefly discussed. The sense modalities apart from vision, and the development of spatial cognition for the blind and visually impaired are examined. The environmental factors that contribute in the understanding of the surrounding built environment, and the assistive devices for this population are briefly covered. These issues stress the importance of stimulating thus, training the human body without vision to establish body and spatial awareness, and to learn to gather information from the surrounding architectural environment to be able to perform a task. To illustrate this fact, an experiment was conducted among blind and visually impaired children from the Göreneller Primary School in Ankara. The study consists of testing a game played with an educative toy and its effects on the tactual learning performance of the children.

Keywords: Blind and Visually Impaired, Spatial Cognition, Educative Toys, Architectural Information Gathering, Built Environment.

ÖZET

GÖRME DUYUSU OLMADAN MEKANI ALGILAMA VE YAŞAMA

Naz A.G.Z. Evyapan

İç Mimarlık ve Çevre Tasarımı Bölümü

Yüksek Lisans

Danışman: Yrd. Doç. Dr. Halime Demirkan

Mayıs, 1997

Bu çalışmada, görme duyusu olmayan insan bedeninin onu çevreleyen mekanla olan ilişkisi incelenmektedir. Bunun için, öncelikle mekan ve beden kısaca tek tek ele alınmıştır. Ardından, görme dışındaki duyular, ve mekan algılamasını geliştirme konuları incelenmiştir. Kör ve görme engelli kişilerin yapılanmış çevreleri anlamalarına yardımcı olan faktörler, mimari mekanlara ilişkin bilgi edinme metodları, ve kullanılan kişisel araçlar ele alınmıştır. Böylece, görmeyen bir kişiye mekan ve beden bilincini verebilmede bedeni uyarmanın, dolayısıyla eğitmenin önemi vurgulanmaktadır. Bu konuyu incelemek için, Göreneller İlkokulundaki görme engelli öğrenciler arasında ampirik bir araştırma yapılmıştır. Bu araştırma, geliştirilen eğitim amaçlı oyun ve oyuncakların, çocukların dokunma duyularını geliştirmelerine olan katkısını sınamaya yöneliktir.

Anahtar Kelimeler: Kör ve Görme Engelli, Mekan Algılaması, Eğitim Amaçlı Oyuncaklar, Mimari Mekanlara İlişkin Bilgi Edinme, Yapılanmış Çevre.

ACKNOWLEDGEMENTS

This thesis would not have been completed without the guidance and support of my supervisor, Asist. Prof. Dr. Halime Demirkan. I heartily thank her for her patience, and her confidence in me.

I would also like to thank Prof. Dr. Umur Talaslı from METU, for his valuable criticism in the design process of the toy that has been developed for the case study.

The case study I have conducted also was very enjoyable. I would like to thank the managers of Göreneller Primary School and the dear little children who showed great interest in my work.

Finally, I would like to thank my research assistant friends in Bilkent; we all have enjoyed working on our thesis in an atmosphere of friendship and mutual support.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

Blindness is a word that frightens many, and the blind are often pitied for their 'misfortune'. People with sight cannot be blamed for such an attitude, as they can see how difficult it is for the blind to cope with the environment, the difficult conditions in which they try to perform any task, or the hardships encountered in finding a job.

But, blind people just do not see, and that is their only incapability. The rest of the difficulty is caused by the sighted people who design and build the environment exclusively for sighted people, and who shape the social attitudes against persons with disability.

The Royal National Institute for the Blind (1996) in Great Britain, estimates that there are at least 42 million people on earth who are blind; and many more who are partially sighted. Over 50% of this population is over 75 years of age, and only 8% are born with impaired vision. Some of the blind or visually impaired population have multiple disabilities. Approximately 1 in every 15 to 20 thousand children have severe visual impairments (RNIB, 1996). In Turkey, over 700,000 persons are considered to be blind or visually impaired.

Blindness does not mean complete darkness. The causes of blindness is not within the context of this thesis, but the degrees of blindness should be described. Legally, blindness is measured by using a chart, visual acuity is recorded as the distance the chart can be read, over the distance a normally sighted person can read the same line of that chart (RNIB, 1996). Those who are considered as legally blind have a visual acuity of 20/200 or less, or a field of vision less than 20 degrees. Persons who have a visual acuity over 10/200 do not have difficulty for independent movement and generally have blurred vision caused by aging, or diseases of the eye.

Persons with **travel vision** have a visual acuity of between 5-10 over 200. They have enough sight to move around independently. Persons with **motion perception** have a visual acuity of 3-5/200. Movement can be seen, yet a still object is difficult to perceive. Persons with **light perception** have a visual acuity of less than 3/100. Bright light can be distinguished, but movement cannot. Persons with **tunnel vision** have a field of vision of 20 degrees or less. Persons with **total blindness** cannot see light. The total blind is a small percentage among the general blind population (RNIB, 1996).

Altı Nokta Körler Derneği, in Turkey, registers blindness in three categories; b1- are totally blind, b2- are those who can perceive light and see up to a distance of 2 meters, and b3- are persons who can perceive motion and see up to a distance of 6 meters. In this thesis, this population consisting of all three categories is referred to as the blind, the visually impaired, or using both terms.

This thesis firstly aims to understand what the built environment/space is, and how the human body reacts, in relation to it. When the human body, a perfect machine with all its sense modalities which gather information from its surrounding environment, loses one of these sense modalities, it offers others to compensate, or at least to contribute in information gathering, in order to survive.

The first part of the thesis examines the body without vision and its relation with the surrounding space. The sense modalities of the human body that contribute in information gathering are discussed. The importance of stimulation and free exploration for the blind and visually impaired persons, and their contribution in spatial awareness and independent mobility is stressed. The perceptual learning theories, spatial cognition and representation systems of the blind and visually impaired persons, are briefly covered. Finally, how the built environment communicates with the blind or visually impaired persons is explained; the methods used for spatial information gathering, and informational cues offered to these persons for orientation and wayfinding, are discussed.

The second part of the thesis consists of an experiment made among blind and visually impaired children; a game has been designed and the accompanying toys are produced toward assessing the children's performance on learning to develop their tactual sense modality. The study was conducted among 30 students from the Göreneller Primary School. To measure the effects of the game and accompanying toys on the performance of the children, a pre-test and a post-test was carried out. The reason for conducting a study on an educative toy, is to examine and find out the importance of play as a means of training and practice for the blind and visually impaired children, for using the built environment as a source of information and communication.

The overall aim of the thesis is to be able to understand the aspects of a built environment that can constitute problems for the blind and visually impaired, and to discuss the manner in which spatial communication can be provided between the built environment and this population.

2. SPACE

In this chapter, the following questions are briefly discussed: what is space, how can space be studied, what forms a space, and how can spaces be related to each other in an architectural context. While accomplishing this, one should not limit the body using the space with only the body without vision; space will be considered in the manner it is experienced by the human body in general.

2.1. The Personality of Space

Jules (1974) considers space basically as a volume, in which neutral space forms the inside static volume with its center of gravity centered on itself. Conway and Roenisch (1994) explain this volume as enclosed by floors, walls, ceilings or roofs, but they do not mean that space is only the inside of these boundaries. Space is also the outside, or the transitional space, flowing between the inside and the outside. Planes such as walls, define or subdivide spaces and affect the way one experiences them with their location or material.

Consequently, this volume which is called space has to be in interaction with other volumes to be able to form an environment. Jules (1974) describes the first step of manipulation on this volume, as creating links with the surrounding environment. This is done with openings, such as doors and windows, on the planes. This space can now be considered as a place where a function can take place. The location, size, shape and number of openings play a role upon the personality of the place, by enhancing or diminishing the relationship with the environment.

2.1.1. Spatial Elements

For those who can see, Passini (1984) cites the hierarchical order of spatial elements as volumes, planes and lines. One first perceives the volume as a whole, containing the activity, then perceives the plane separating the activities and consequently, the line directing the user, either inward or outward, to these. The line contains the significant end points and boundary. The intersection of these lines opens or closes spaces, and thus identify the 'content'.

Intersecting lines, planes and volumes form angles. These angles imply closure with different nuances. Expanding parallel walls give directions to the user of the space. Openings on the planes and lines formed by these planes play upon one's sense of closure according to their location.

The space also has another aspect which plays role in the sensing of it, which is dimension. Dimension of spaces is due to their size, and their form.

2.1.2. Dimensions of Spaces

As Prak (1968) has stated, the size of spaces is due mainly to their height. Conway and Roenisch (1994) believe that the size of a space will depend on the number of people that are assumed to use that space. With this statement the authors bring into the minds other issues such as, scale and proportion. Scale is a term used to discuss the size of a space relative to the size of something else. Proportion, which is a mathematical relationship of length, width and height of spaces, is used to obtain harmonious relations. It is an important notion for architects who manipulate spaces to obtain functional and psychologically appealing environments for the human body. Le Corbusier, for example, used the human body as a basis for proportions and combined it with the golden section, to obtain the most humane results in a built environment (1973).

According to Prak (1968), the form of spaces is due to the proportion, size, angularity, regularity, plasticity and isolation of these spaces. Proportion is classification of forms according to their relations of length to width and width to height. Size is their classification by height, angularity is the degree to which spatial elements intersect, regularity is their possession of one or more planes of symmetry, and plasticity is due to their physical properties. Isolation, he continues, is the degree to which a space is open towards adjacent spaces. The form of space determined by the stated characteristics plays an important role in the way one perceives the spaces and influences the manner in which activities take place (Prak, 1968).

2.1.3. Relationships of Spaces

''Relationships between spaces, or what one may in a sense call architectural form, will necessitate an ordering so that the general user will comprehend the order of significance in which perceptual stimuli are received and understood'' (Jules, 1974: 41). Conway and Roenisch (1994) state that the relationships of spaces are very much influenced by the circulation route of the activities that take place in, or the method of construction and desired appearances of the built environment.

In other words, the architectural composition of spaces and forms are held together in certain manners and, principles are chosen according to the function and aesthetic considerations of a building. These constitute the grammar of the composition. Jules (1974) gives examples of possible relationships of forms in an architectural composition; one element may be inside the other, one penetrating the other, the elements can be adjacent or separated. Here comes into the scene, the concept of dominance.

If a total composition has a center of gravity, or a major axis, it will dominate. If there is a change in level, the upward direction is more significant. Larger elements are dominant over smaller ones. These effects must be considered to form compositions that orient the user in spaces and help understand their relationship.

Jules (1974) cites the manners in which architectural compositions are constituted as using an axis, patterns or sequences. Using an axis, Jules (1974) states, will create a dynamic sense of direction along the axis. A hierarchy can be based on the dynamic qualities on the axis. Orientation off axis is more dynamic than on axis. An axis motivates, and the dynamism discomforts a person. This discomfort stimulates one until he finds what he is looking for. Equilibrium has to be disturbed on this axis. The more an object is out of equilibrium, the more strongly it is sensed.

The architectural composition of spaces and forms is held together also by patterns and sequences. Jules (1974) defines a pattern as combinations of repetitive elements, and sequences as linear perception of elements having characteristics that relate them, as well as, ones that amplify their differences.

According to Jules' (1974) definition, a sequence is composed of places and transitions differentiated from each other by contrasts and related to each other by similarities. Contrast and similarity between elements are based on the relationships of scale, mass, static versus dynamic qualities, color, light, texture, continuation or discontinuity, pattern, cultural significance, open versus closed, public versus private, exterior versus interior, and proximity.

Patterns have some basic Gestalt configurations which include similarity, symmetry, use of grids, center-oriented or dispersing radial patterns, interlocking and resting forms. The simplest form of patterns is the rectangular grid. It has flexibility, while other forms separated into grids will be quite rigid, and appropriate to some situational needs.

Two dissimilar patterns can intersect or overlap. Perception of the compositions may alternate where each pattern may express a different meaning. Jules (1974) claims that these will bring forth the hierarchies of significance that the visitor will choose among which to travel through and complete a task in a building.

Considering these examples, while an architectural organization is being planned, some architectural principles have to be kept in mind to provide an understandable built environment to the user. These lead to organizations where a preference for one type of perception takes place over another. Prak (1968) states these as:

1. **Proximity** - objects close to each other on the retinal image tend to be seen as a group.

2. **Repetition** - inclination to perceive equalities even where they do not exist.

3. **Simplest and largest figure** - perception of the simplest and the largest forms possible.

4. **Continuity and closure** - lines tend to run on beyond their end points, planes beyond their edges.

2.1.4. Complexity of Spatial Organizations

An efficient composition of spaces in a built environment will communicate its layout. The grammar of the layout can be easily understandable when the building is of small size, but as the built environment involves more and more spaces and the size becomes larger, this grammar may not be as evident. To communicate to the user, more sources of information may be necessary, and the means to communicate this information might just as well augment the amount of stimulation.

Arthur and Passini (1992) define a complex environment as an environment with a lot of stimulation where information selection becomes difficult. This does not necessarily mean overload, the environment contains more information than one can process, anyway. ''Overload occurs when stimulation interferes with purposeful information processing'' (Arthur and Passini, 1992: 32).

The built environment has to be safe and has to function efficiently. An efficient environment is very much related to wayfinding and spatial orientation. Passini (1984) has made an ample amount of research on orientation and wayfinding. He states that disorientation has been a problem as the built environment has grown in size and complexity, and that it provokes stress and frustration due to the fear of getting lost.

To define a spatially complex environment, Passini (1984) associates this term with unpredictability, the unknown, the mysterious. He describes such an environment as labyrinthine. The resemblance is even more evident at the building scale, as no overall view is offered when a person walks along a corridor, or as it is not possible to see what is happening on the other side of the wall. Labyrinths in disguise exist in many built environments. Passini (1984) gives examples of labyrinthine layouts such as; small rooms surrounded by other rooms each with individual access, leading to a complicated corridor system, routes ending in cul-de-sacs, parallel passages of open angles, or considerable distances to be walked to destinations.

To overcome the problem of complexity, Passini (1984) does not suggest a simplistic functionalism that leads to uninspiring monotonous environments. A certain level of spatial complexity, he argues, and the unknown awakes curiosity and the desire to explore as long as this complexity in the layout is interesting, stimulating and orderly.

Our perception and understanding of the environment always involves a simplification of it. Bloomer and Moore (1977) have observed that individuals tend to simplify patterns toward horizontal and vertical rather than distorted organizations, toward symmetry rather than asymmetry, and toward basic geometric groups rather than random or less precise ones. For example, the square is shown to be the most memorable and neutral form, because of its orientation and regularity. This is the case in visual experience.

Jules (1974) explains this statement pointing out that good configuration provided with regular, symmetric, simple, uniform layouts of space close to each other and showing uniform direction, cause minimum possible amount of stress for the user. Prak (1968) suggests that complex buildings can be broken down into a set of sub-spaces which can be related in various ways. These can be by their position, location, connection, similarity, or by their significant and dominant aspects. This helps the user to simplify the layout and represent it in a way easier to remember.

2.2. The Meaning of Space

All that has been discussed above, were the physical aspects of spaces and spatial layouts. They included short descriptions of what is perceived as a space, and actually were the properties of conceptual and physical spaces.

A conceptual space is a product of the Gestalt laws of perception; it is the space one sees. Prak (1968) defines it as a product of our mental make-up obeying the Gestalt laws of perception. Gestalt laws, he explains, prefer simple Cartesian coordinates, probably due to the humans' physical symmetry. The position of the eyes and the way one moves provide with discriminating one's behind-before, right-left, below-above.

On the other hand, a physical space is independent of psychology; it can be described in terms of Euclidean geometry (Prak, 1968). Its structure is also determined by gravity.

Another notion we should discuss, is behavioral space. It is the space affected by one's own movements, whose structure is also determined by gravity. A behavior one performs is due to the activities taking place in a space, and the function of that space.

A conceptual space to which meaning is given, may be considered as a place, as it now has its own identity. Passini (1984) explains that the meaning of a space can be of a functional nature, of a socio-symbolic nature, or may be derived from a person's sensory experience of a place. Meaning, he continues, together with the physical and spatial characteristics, constitutes the formation of an image of the environment.

Hillier and Hanson (1984) in their book 'The Social Logic of Space', state the following: ''The design of an artefact has a logic to it. There first are functional objectives - materials or elements are assembled into a form. The second dimension for them is that of style. Modifications of shape can give the designed artefact a significance over and above its practical uses,belonging to the realm of cultural identity or meaning''(1).

Architecture is the organization of spaces into a perceptual whole, a composition. The composition which is a part of some larger context, also is the context in which the space has meaning. The control of the context is in this composition. The architect manipulates form, location, color and mass of an object from which one derives meaning and expectations (Jules, 1974). One has cultural and contextual expectations of the environment. These may simply be standard door sizes, or ceiling heights. As the context varies, expectations may vary.

For those who can see, spatial enclosure permits certain inferences about the inside (Passini, 1984). One can guess its content or function. The exterior configuration can serve to structure the inside, at least to imagine blocks of spaces and functions in two or three dimensions, although in general the internal organization principle of a particular layout is left unknown.

Ideally, each function should have its own architectural expression. It is to build an environment where variations are not form, but are position that is important, just like describing the choreography of a trip.

2.3. Buildings as an Organization of Spaces

Buildings, in such a context, create and order empty volumes of spaces into a pattern (Hillier and Hanson, 1984). Buildings are transformations of spaces through objects. The ordering of spaces in buildings is about the ordering of relations between people. These systems of spatial relations, embody social purposes.

Human spatial organization is the working out of common behavioral principles through a hierarchy of different levels. By moving around a built environment, large or small, one builds up knowledge of exterior relations until one has a picture of some kind of structure (Hillier and Hanson, 1984). But spaces inside a boundary have a different property; they are not continuous but are a series of separate events. A boundary can be defined as a form of control.

Relations between interiors are also conceptually experienced. Human spatial organization has a certain internal logic (Hillier and Hanson, 1984). This is responsible of the knowability of the space. As it has the property of knowability, space can operate as a language, as one of the means by which a society is constituted and understood by its members. Although abstract in nature, descriptions used by the members of a society, are summaries of the principles of a spatial pattern. They are a means to communicate information about the space.

The stronger and more complex the structure of a built environment, the more lonely will be the user, relying on his or her past experiences and knowledge of the buildings based on similar spatial organizations. ''A building is therefore a domain of knowledge in the sense that it is a certain spatial ordering of categories, and a domain of control in the sense that it is a certain ordering of boundaries ''(Hillier and Hanson, 1984: 146).

In an interview with the Journal of Philosophy and Applied Arts (1995) on experiencing architecture, Bernard Tschumi says that architecture cannot be static; the collision of spaces and events is always plural, and always dynamic. ''Spaces are qualified by actions just as actions are qualified by spaces, they exist independently, yet, they affect one another as they intersect. Architecture is not about the conditions of design, but is about the design of conditions that will dislocate the most traditional and regressive aspects of a society. Simultaneously, architecture will reorganize these elements in the most liberating way, so that one's experience becomes the experience of events organized and strategised through architecture'' (82).

Every building identifies at least one 'inhabitant'. Hillier and Hanson (1984) define the inhabitant as a person with special access to and control of the category of spaces created by the boundary. Every building also potentially has an outset of visitors who are persons who may enter the building temporarily and have not control over it. So, if not a permanent occupant of the building, the inhabitant is the user of it.

2.4. The Humanness of Spaces

The question of ''What do we mean by space when our subject is 'body'?'' should be discussed relevant to the subject of the thesis.

In this context the space is considered within the built environments, which are bordered and defined by architectural features. This is the space that is built to 'contain' the human body, so that it can perform activities. The elements of this space are considered such that, they are in harmony with the capacities of the human body. The body can stand up, reach at, manipulate, or do other activities. It is not disturbed with obstacles. It can travel through levels over steps of appropriate height, it can pass through openings without having to bend, or it can observe activities in other spaces maintaining its standing position, because elements covering this space are built according to the human scale.

'Human scale' does not only comprise the built environment being appropriate to the physical realities of the body. It is also concerned with the feelings it evokes in humans. One can feel comfortable in a built environment or not, very much depending on one's past experiences. The built environment may invite persons in, or repel them; it may especially be considered for the use of one person, or it may be built to meet the needs of a crowd.

Greene (1976) describes human scale as metaphor of the body projected into the environment. The human sense of vertical, human centering, human balance, human gesture are signs of humanness in a building. Human scale reflects the individual existential being, it can also evoke participatory emotions.

3. THE BODY IN SPACE

An environment must be perceived to be understood. The designer of the environment must understand and appreciate how these perceptions occur and how they are interpreted. In this chapter, how different modes of perception occur within the human bodies and how the human body develops different forms of coding will be briefly discussed.

3.1. Perceiving with the Body

An important part of the environment consists of matter in the solid state. Gibson (1983) points out that the solid environment is a physical support for behavior. Since it is rigid, unlike the viscous or liquid environment, it permits the body to stand up and walk upon legs, and to find his way from one place to another. Rigidity gives geometric permanence to places and constancy of shape and size to things. It therefore supports not only the upright stance but also locomotion, orientation and manipulation.

To understand the surrounding environment, one has to be able to gather information about it. For this, one perceives the environment by seeing, hearing, smelling, touching, and even tasting. The human body is the only means to understand the space that surrounds it. It is quite common for some people, particularly for those with physical disabilities, to feel trapped in their own body.

These modes of perception, then, are the means to break through, as long as they can be activated. A challenge in this case for a body is, to awaken these modes of perception to be able to gain maximum information and thus, control over the space one is in.

3.1.1. Sensing and Stimulation

The human body senses. As Gibson (1983) defines, the verb 'sense' means firstly, to detect something, and secondly, to have a sensation. The senses of an individual only work when they are stimulated, and the environment of the individuals is the source of all stimulation. Stimulation can be imposed or obtained. The easily measured variables of stimulus energy, the intensity of light, sound, odor and touch for instance, vary from place to place and from time to time, as the individual goes about his environment.

Gibson (1983) states that the living body is stimulated also by itself. Its internal organs provide stimulation, and so do the movements of its extremities and sense organs or feelers, and the locomotion movements of its whole body through space. The higher animals have evolved both mobile and adjustable sense organs. They can modify the stimulus input in two ways: by moving the organs of the body that are called 'motor' and by moving those that are called 'sensory'. The hand for example is both motor and sensory.

The observer seeks for stimuli. He explores the available fields of light, sound, odor and contact, selecting what is relevant and extracting information. Even with an imposed stimulus, the observer begins to modify it after the first moment. He turns away or moves toward; he sniffs at it. The passive detection of a present stimulus gives way to active perception. Active perception thus, entails not only stimulation from the environment but also stimulation from the attentive actions and reactions of the observer (Gibson, 1983).

The five perceptual systems overlap one another, they are not altogether independent of each other. They often focus on the same information; the same information can be picked up by a combination of perceptual systems working together as well as by one perceptual system working alone. The eyes, ears, nose, mouth and skin can orient, explore and investigate (Gibson, 1983).

3.1.2. The Senses

Gibson (1983) characterizes the senses as active detecting systems constantly seeking out information from the environment. In his work, he focuses on the types of environmental information the body deals with, and lists the senses as the visual system, the auditory system, the taste-smell system, the basic-orienting system and the haptic system.

According to Jules (1974), the dominant senses are sight and the internal sense of balance that occur in the semi-circular canals in the ears. The sense of balance gives humans a constant set of axis forming a basic horizontal and vertical orientation from which the humans sense their relationship with the earth. The third, he cites, is the sense of touch. Touch adds meanings and associations to objects in the environment, and is considered as the most important means to gather information in cases where there is no vision.

Besides the sense of touch, Barber and Lederman (1988) state the additional non-visual information as auditory, haptic, olfactory and thermal information. Even though these senses offer a fewer number of differentiated views of the perspective transformation than vision does, still such information can be used to perceptually update knowledge of location when there is no vision.

The following section briefly discusses how visual residue can be benefited from. The non-visual information receiving senses will be discussed in more detail in the coming sections.

3.1.2.1. Visual Stimulation for the Blind and Visually Impaired

Studies indicate that young children up to the age 10, have the capacity to strengthen the underlying neurological processes that are responsible for vision. Axons and dendrites in the retina can gain increased physiological response, and the brain processes can restructure themselves to take over the cells that were not originally meant to be vision cells. Therefore, as Gellhaus and Olson (1993) suggest, providing a visually stimulating and educationally enthusiastic environment is the responsibility of designers, to neurologically stimulate and strengthen the vision cells of blind and visually impaired young children.

In an educational environment, color can be used to help prevent the adverse effects of sensory deprivation, promote mood enhancement, and serve as a means for cueing and coding. According to the theory of visual functioning, pastels of primary colors such as pink, powder blue or light aqua, are less distinguishable from each other than are brighter hues of the primary colors. Similarly, deeper shades of the primary color family, such as dark green or navy blue, are also difficult to distinguish. Thus, as the difference in color saturation increases between two visual objects, the easier it may be to differentiate them visually (Gellhaus and Olson, 1993).

The more intense a color's brightness, the more the retina is stimulated. Glare must also be taken into consideration; as a generalization, the brighter the object, the more visible it is.

Contrast is another important aspect. The first major type of contrast is luminance contrast, as an example bold black letters on a white background will be easy to distinguish. Luminance contrast is dependent on the difference in the brightness of two objects. The second type is the relation of light and dark. It is produced by the amount of light reflected off from different areas of similar surfaces. The enhancement of contrast in the environment can allow sensory impaired individuals to perform more self-help skills.

3.1.2.2. Hearing and Smelling as Sources of Information

Arthur and Passini (1992) state that hearing can be the primary mode of perception for the blind. One does not have to move one's head position to hear, so sounds can be excellent informing cues. Here, it should be stressed that objects in the environment are silent; they become audible through direct contact or through the reflection of sounds.

Hearing is an important external information source for spatial coding, within personal space. Regardless of the severity of the visual handicap, Passini, Dupré and Langlois (1986) note that audition cues are used to varying degrees to identify door openings, the general nature of the space, and others. Yet, since screening for sounds is impossible, sounds may cause pollution. As Gibson (1983) remarks, noise absorbs informative sounds, so the soundscape of the built environment is also a consideration, if auditory perception is to be relied upon by the users.

In addition to these, Greene (1976) points out the importance of the sense of smell, although only of marginal value, as it indicates important reference points to some people. The taste-smell system cannot be overlooked. One often remembers an environment saying 'The place was cold and damp, smelling of mildew.' These are very much in relation with the materials used in the construction and finishes, and the effects of the climate surrounding the environment. They provoke feelings of comfort, disturbance, and such similar sentiments.

3.1.2.3. The Haptic Sense and the Sense of Touch

''The sensibility of the individual to the world adjacent to a human or animal by the use of his body is called the haptic system'' (Gibson, 1983: 97). The haptic system operates when a person feels things with his body or its extremities. One feels an object relative to the body and the body relative to an object. Gibson (1983) explains that the haptic system includes the whole body, most of its parts and all of its surface. Millar (1994) adds that touch receptors are all over the skin, the most sensitive parts being at the fingertips and lips.

Active exploratory touch permits both the grasping of an object and an understanding of its meaning. The hand can feel, handle, push, press, rub, and many of the properties of an object can thus be detected in the absence of vision. These properties are geometrical variables like shape, dimension, proportion, slope, edge, curve or protuberance; surface variables like texture, or roughness-smoothness; and, material variables like heaviness, mass or rigidity-plasticity (Gibson, 1983). The relative temperature is also detected.

Passive skin detects the source of the stimulation whenever this external source is specified in a proximal mechanical event. The pushes, punches, and scrapes of the environment come from different objects that need to be dealt with in particular ways. These are mechanical encounters at the skin, but each is more or less specific to the confronted object and it is these specifications that are the information which is looked for. The passive skin can also be stimulated by placing an object on it. The amount of pressure, skin deformation is a source of information.

Texture, on the other hand, is learnt through rubbing the finger or skin on the object, that is, with active stimulation. The mechanical friction results with lateral vibration of the skin. Effortfull touch will also provide information such as rigidity, elasticity, viscosity, or softness of a thing. A non-spatial input from the muscles and tendons give way to another perception of the material substance of the object; this information coming from muscular effort is the weight of the object.

For the blind and visually impaired persons, the sense of touch is also associated with the white cane, which can be seen as an extension of the user's arm. It is used to follow a footpath, to identify obstacles, etc. (Passini, Dupré, and Langlois, 1988). When a blind person touches something with a cane, he feels it at the end of the cane, not in the hand. Information from the mechanical disturbance at the end of the cane is obtained by the hand as a perceptual organ, including information about the length and direction of the cane. (Gibson, 1983).

The cane is also used to obtain echoes, which is called echo-location, an orientation method for the blind and visually impaired (Boehm, 1986). Tapping the cane provides the user with information felt as sound waves in return. According to the echoes, the user orients and locates him/herself, knowing whether he/she is facing a wall, an obstacle projecting from the wall, or whether there is an opening ahead. Echolocation can also be produced by human-made sounds such as hand-clapping, or foot-stamping. To produce an adequate echo, the sounds have to be short, sharp and distinct (Boehm, 1986). The 'obstacle sense' of the blind which is felt on the face, is actually haptic and auditory echo detection.

Tactile and haptic exploration also result in the perception of temperature. The perception of temperature can be subdivided into two systems, one with cutaneous contact and one without. The first registers the relative temperature of a touching surface and the second registers the relative temperature of the medium, usually air. The first is part of the haptic system, the second is part of the body's temperature-regulating system (Gibson, 1983).

The perception of warmth and coolness is not exact, since it is subject to illusion. The reason is that the stimulus information does not always correspond to the thermometer reading. An object of metal at the temperature of the surface of the skin will feel cool, whereas an object of cork at the same temperature will not, because metal conducts heat away from the skin faster than cork does. Moreover, the perception of the warmth or coolness of an object depends on the temperature of the skin touching it; a surface of neutral temperature will feel warm to a cool finger, but cool to a warm finger.

Finally, it should be noted that as Millar (1994) points out haptic items are coded less efficiently, and memory for haptic standards fade more quickly. Millar (1994) compares tactual and haptic coding; tactual coding requires consideration, as patterns identical in touch are easy to match and remember. But instructing blind and visually impaired children to mentally imagine feeling tactual shapes does not improve their recognition, and it cannot be relied upon.

3.1.2.4. Basic-Orientation and Movement Sensitivity

Basic-orientation refers to our postural sense of up and down, which, because of its dependence on gravity, establishes our knowledge of the ground plane (Millar, 1994). The upright body posture depends on the head relative to the trunk, the trunk relative to the legs, and thus the whole system relative to the ground (Gibson, 1983). This system functions together with the vestibular orientation of the head relative to gravity.

Visual information has a very important role in obtaining the posture and balance of infants. Being congenitally blind does not prevent children from sitting, standing or reaching for objects; but the natural appearance of such activities and postural balance is delayed compared to that in sighted infants (Axelrod, 1959. Norris *et al.*, 1957. Fraisberg and Fraisberg, 1977; all cited in Millar, 1994). The body posture of congenitally totally blind children is also often poor later on.

Balance in human locomotion depends on stable head posture with regard to the body and on gaze relative to fixed landmarks in external space (Millar, 1994). Stable orienting of the head depends on a stable body posture supported by the legs, and the orienting of the nose, ears and eyes depend in turn, on the stability of the head. There is another supplementary effect on muscular tonus and equilibrium coming from the gravity receptors of the inner ear. Equilibrium, provides an awareness of the vertical and horizontal axes of the world, the gravitational frame of reference, and an awareness of the frame of the body which has its own axes of reference: head to foot, right to left, front to back.

Locomotion obviously depends on postural equilibrium; in order to walk, one must stand. The locomotion of the body through its environment can be analyzed into displacements and turns. The vestibular apparatus provides information about both linear and rotary components of physical movement.

The word kinesthesis means sensitivity to motion. During active locomotion, the body controls the distance of its displacement and the amount of its turning. During passive locomotion, it perceives the distance and the turn. Kinesthesis is the pickup of movement. There are many kinds of movement that need to be registered. There is articular kinesthesis for the body framework, vestibular kinesthesis for the movements of the skull, and cutaneous kinesthesis for movement of the skin relative to the field of view.

Movement sensitivity does not depend only on the action of the individual. The eyes, for example, also register the movements of the head, forward, backward, or rotary, by way of the motions of ambient light. The ears register the sounds of locomotion and of vocalization. The skin registers manipulation.

The body can detect an angular movement as small as a fraction of one degree. Both the posture and the change of posture of the joint can be registered. The angular position of every bone of the body, out to the extremities is precisely articulated with the body frame, and thus affixed to the direction of gravity. The sensitivity of the joints to their angles is of crucial importance.

The body experiences space through frames relating the body with the space. Self-referent frames are centered on the person's body. For the congenitally totally blind, spatial reference is centered on the body which is the haptic space. External frames are based on information from the environment. Object locations within display can be related to each other and viewed in relation to the surrounding external frame.

When the body is stationary, the body-centered frames are useful. The body mid-line which is also the gravitational vertical axis, together with head and eye positions provide invariant proprioceptive information about body orientation and its relation to the limbs.

An extremity can be oriented to both the frame of the body and the framework of space, even in the absence of vision. Cutaneous touch gains importance, the layout of environmental surfaces in contact with the members of the body and the disposition of the members of the body go together. In this way a sitting man might feel the shape of the chair, as well as the shape of his body in the chair.

3.2. Meanings and Associations due to the Senses

During perception, remembrance of the past experiences may be stimulated by some cue, visual or not, of an object or feature (Greene, 1976). The particular experiences that are recalled by a perceptual cue are different from what is perceived, yet because of some similarity with the object, it is these particular experiences that are remembered.

Greene (1976) states that in order to be meaningful, sense cues must be embedded in a context that one can recognize from the stored experience. A cue is what one is focusing on, while the context is what influences the interpretation of a cue.

Experience ➔ memory ➔ imagination ➔ reconstruction

Arthur Koestler says the following; ''The sensory input is screened, dismantled, reassembled, analyzed, interpreted and stored along a variety of channels belonging to different hierarchies with different criteria of relevance. We instinctively respond to the color, degree of transparency, mass and tactile characteristics of materials. Through this response we judge the tectonic or structural character of a building. Our stored experiences of stresses and strengths along with our experiences of scale provide criteria by which we unconsciously measure physical phenomena'' (cited in Greene, 1976: 3).

3.3. Developing Forms of Coding

People with vision organize space in terms of external spatial coordinates. Vision facilitates spatial understanding (Millar, 1994). Infants discriminate the shape, size, depth and distance of objects by vision from birth (Gibson, 1983). Millar (1994) too, states that spatial relations are detected from birth. In time, infants get better at detecting higher-order invariant spatial relations. Perceptual learning depends on differentiation of distinctive features in the environment.

Visually directed reaching begins from the age of 4 and 5 months. According to Piaget's theory (cited in Millar, 1994), sense modalities initially function separately. Logic is at first, absent. Logical concepts of objects and space are achieved in a series of invariant, sequential, biologically limited stages.

Action schemata are achieved throughout the first 18 months of a baby's life; object concept develops. Objects exist independently for the child even if they are not in view, through invisible displacements in space and time.

Piaget and Inhelder theorized in 1967 that a child develops the concept of space in stages that follow each other from the sensorimotor to the operational or representational (cited in Birns, 1986). Perception takes place when stimulus is present; imagery takes place in its absence. Conceptual space develops because it requires the representations of objects (Birns, 1986). They continue explaining that the child is able to represent three major spatial relationships, which are defined in topological, projective and Euclidean spaces.

Topological space involves spatial relations that remain constant whatever changes there may be in size, shape, proximity or order of figures. Then the child makes transition to Projective and Euclidean Space where objects and forms are viewed in relation to the observer and to each other. **Projective space** includes concepts of rotation and perspective where the child projects how objects will appear from another viewpoint. **Euclidean space** deals with geometric elements such as measurements, proportion and transformation.

Some results indicate that even congenitally blind children, 2.5 years old, seem to understand Euclidean properties of spatial layouts (Landau, 1981, cited in Passini *et al.*, 1988). Yet, a study by Simpkins and Siegel (1979, cited in Birns, 1986) indicates that, blind children have difficulty in making the transition to projective space. Reasoning that require spatial orientation and imagery is found to be difficult for blind children (Stephens, 1977 cited in Birns, 1986).

Although studies adapted by Piaget and Inhelder suggest a strong positive relationship between the amount of vision and performance on spatial tasks, certain authors argue that spatial imagery need not depend on visual experience and that congenitally totally blind subjects scan mental images much as sighted persons do (Kerr, 1983 cited in Passini *et al.*, 1988).

3.4. Spatial Coding without Vision

The knowledge of the world is, mostly acquired through vision. Information gathered through vision dominates one's beliefs so much that one does not have any doubt on the truth of this information. One should be questioning how true one's knowledge about the world is, and how complete it is. There are so many sources of information that are ignored, and knowledge that is incomplete. Since one sees, one does not know how to concentrate on the other modes of perception.

It is surprising for many people when a blind person points to where a window or door is located. Also it is surprising when a blind person recognizes someone without the person speaking. One cannot understand how they find their way easily to the kitchen or bathroom. It is commonly believed that the blind have special gifts such as the sixth sense enabling them to take the right bus or prepare a meal without any trace of destruction in the kitchen. But these accomplishments require only attention, common sense and experience. It is the environment they are surrounded with, from which they gather the clues to complete these tasks, just as we do.

Although vision is important, it is not the only sense modality that can provide spatial information. The reason for the difficulty the congenitally blind encounter is that, they have differences in perceptual information. Visual deprivation retards the construction of mental rotation-reorganization.

Different senses have different contributions at different levels. Multiple inputs are useful when perception from one of the sources is difficult, or clarity is reduced and in conditions of uncertainty. Blind and visually impaired children are trained to attend to perceptual cues in as many modalities as possible. Schaegel (1953, cited in Millar, 1994) found in his study that blind and visually impaired adolescents reported images of sound, feel, smell, and temperature, etc. Then they use these forms of coding to sustain temporary memory. Modes of coding differ, depending on what information is needed for given tasks. In blind conditions reliable information comes mainly from proprioceptive sources, and spatial coding tends to depend on body-centered reference.

Millar (1994) has observed that persons who can use their residual vision rely mainly on vision during locomotion, as long as there are essentially stable light levels. Those who have progressively lost their vision, find that they are better able to cope without residue, because total blindness facilitates concentration and the development of the other senses (Passini, *et al.*, 1986).

As blind children cannot converge vision with body information, vision can be substituted by hearing. Millar (1994) proposes that hearing and movement relation should be encouraged for the blind to learn to use the body-centered reference cues. Hearing is an important complementary reference information, although localization by hearing can be less accurate. People can use self-produced echo-location as a guiding cue. This can be done by hand-clapping, tapping with foot or cane, or prosthetic devices that disseminate sound waves.

Sounds alone do not provide information about the relation between external planes. So, this knowledge and current updating cues should be supplemented. This can be done by using proprioceptive and body-centered information. In blind conditions, body-centered and movement information are more reliable than external cues when subject is stationary. Body-centered spatial reference and memory for kinesthetic cues are egocentric. As an example, position of feet gives cues of the direction one is facing and when one turns around 180^0 left-right is reversed, so one has to update his knowledge of the space.

Memory for movement sequences and cognitive skills also make contribution for updating information and building up notion. It should be noted that recall of blind movements deteriorate without repetition (Millar, 1994). Haptics compared to vision, is poorer at perceiving and representing the space, whether small raised 2-D displays or large spaces through which the observer walks (Millar, 1994).

4. STIMULATING THE BODY WITHOUT VISION TOWARD GATHERING SPATIAL INFORMATION

How a body with no vision uses the sense modalities in perceiving, thus gathering information from the environment will be covered in this chapter. The importance of stimulation, and the effects it has in gaining body and spatial awareness are discussed. Establishing body and spatial awareness have important contributions in gaining independent mobility and in developing spatial concepts.

4.1. Stimulation of Congenitally Blind Children with Play

Parsons (1986), who does research on the effects of play on young blind children, describes play as a means of learning effectiveness of tools for an end, and exploration of the environment, cognitive development, acquisition of competence, practicing and perfecting skills, social interaction, learning, rehearsal, therapy for reducing anxiety and tension for past unpleasant experiences.

A visual impairment can affect a child's pattern of play. A blind child will be more focused on his or her body, rather than its relation in space, or spending a lot of time observing and holding a toy with no aim. The child will be more apt to play alone and passive, but not in thoughts. Blind children are more ready to slip into fantasy in their thoughts and play, as this is for them a means to compensate the experience of being appreciated and admired that they cannot live through in their real environment. Because of this sensitive situation, Parsons (1986) suggests that expression and exploration must be taught with interaction and verbal communication, starting from very early ages.

Studies show that gross motor development is usually retarded in blind infants, and manual and locomotor development is delayed. Motor skills should be taught to encourage the child's reaching and grasping behavior (Palazesi, 1986). Ear-hand coordination is established in the last quarter of the first year in life. So for blind children the mobility and locomotive sequence is initiated only after this coordination is achieved.

As blind and visually impaired children develop spatial awareness, O'Donnell and Livingston (1991) have observed that for their feeling of security, they are more comfortable among well-defined boundaries which define districts and continuous links among these districts. Having this in mind, Joffee (1988) suggests rich structured home environments as means of reinforcing spatial awareness. Also for the development of conceptual awareness, sensory-play experiences like using different textures, sounds, sights on walls, on the floor, on the ceiling, corners, turning points, in cribs and playpens, etç. are suggestions for families of blind infants.

Play environments should provide certain context and properties for play. They should be continually available, non-evaluative, and providing feedback. Toy equipment for congenitally blind children can be; brightly colored, tactually interesting, sound-making toys, climbing equipment, riding toys, large and soft areas for small children who enjoy the feeling of self abandonment (Schneekloth, 1989).

Interesting and stimulating environments ease the dependency of children and encourage them. For visually impaired children, intensive environmental stimulation should be provided to address all senses. A designer then, must not avoid complexity; complexity provided with textures, color, sound, and extra pieces to explore gives more opportunities and also makes a child perform complex motor skills (O'Donnell and Livingston, 1991).

Davidson and Simmons (1984) state that, in creating an environment for blind children, it must not be forgotten that the children are developing continually within a specific environment unique to each child; and it should be kept in mind that they are not passive recipients. O'Donnell and Livingston (1991) here point out that such environments cannot replace the need for social interaction. These children must be encouraged to communicate with their social environment, and make friends from among their peers.

4.2. Stimulation toward Gaining Mobility

According to Chin (1988), concepts of spatial movement must be specifically taught to blind and visually impaired children through expressive body movements, and are most meaningful when experienced through physical and tactile activity.

Mobility is an important issue to blind and visually impaired persons; to be able to move freely is a prerequisite to their personal and professional independence, in short to their full social integration (Passini, *et al.* 1986).

Orientation and mobility intervention is introduced to blind individuals who are physically and psychologically prepared to gain independent traveling skills. Intervention can be by using various mobility devices instead of the cane to compensate for the lack of motor coordination. A question that is discussed among various researchers is whether such adapted mobility devices should be introduced to a child at a very early age. Such devices that are used with blind preschool children can be push toys, handle and wheel cane, T-bumper, etc. Such toys would encourage them towards a sense of safety and independence. Such encouragement is delayed most generally by parents. Fear, overprotection, lack of stimulation and lack of motivation are causes that discourage children from being mobile.

Lack of visual feedback, and lack of imitation are also problems. Lack of visual input of assurance in space and walking cues retard blind infants from being mobile. Palazesi (1986) states that such children can equally keep up the same rate of development, with assistance in orientating themselves to the environment.

So, beginning mobility training at preschool level encourages the greater use of this sense in exploring the world. Palazesi (1986) points out that intervention in later ages will be difficult. For older visually impaired students, movement programs like physical education, yoga, kinesthetic, creative dance, etc. are offered to improve awareness of gravity, body image, spatial awareness, control of body and self, improvement of posture, self-confidence, balance and stamina, efficient mobility, and independent travel.

Palazesi (1986) describes movement sessions for such aims as stretching, bending, twisting, swinging, sliding, jumping, turning, reaching. Animal imagery, targeting qualities in environment like weight, and expressive dancing are also sessions used in many rehabilitation programs.

4.3. Stimulation toward Establishing a Body-Image in relation to the Space

To travel efficiently, the individual needs proper spatial and body awareness. Walking, posture, body control and body management are all parts of orientation and mobility, and hence movement. However, visually impaired children have a greater need for assistance in developing body and spatial awareness, since they cannot imitate through seeing what others do and must have a safe environment in order to experience free action (Chin, 1988).

4.3.1. The Importance of Establishing a Body-Image

Palazesi (1986) brings arguments of researchers indicating that a well-developed body image is an essential basis for learning to structure external space. This covers the forms of representation which are referred as body-centered or self-referent coding, and also, applies to movement coding.

It is necessary to know where one's limbs are in relation to each other and to the head and trunk of the body. Body-centered frames also help in coding the location of external objects that touch a part of the body. Knowing how body planes relate to external planes are important contributions to body and spatial awareness (Millar, 1994).

Spatial awareness is required for effective and efficient motor behavior, because it includes accuracy in locating objects in space and in positioning the body parts to make contact with objects in space. For blind and visually impaired children to move skillfully and efficiently, they must understand their own bodies and the relationship of their body parts. Chin (1988) states that by understanding the fact that the human body is symmetrical, children are able to arrange their body movements so that one side is a mirror image of the other, with regard to copying movements, or movements can be done on one side of the body. By learning the differences between symmetrical and asymmetrical movements, blind children are able to grasp the concept of laterality. It is assumed that in general the congenitally totally blind child at school age is aware of the potential identity of angles of his or her outstretched body parts.

To stress the importance of this subject, Millar (1994) states the results of a research: Cratty and Sams found among blind children having a mean age of 10, inability of making accurate left to right judgements. The test's name is The Body Image of Blind Children Test (ages 5-15 years), (1968). Also children had wrong and missing notions of their body, causing lack of body perception in relation to the environment and movement inability. The test aimed at determining new techniques for improving body image and spatial directions for new educational programs for blind and visually impaired children.

So, Joffee (1988) points that starting from very young ages, blind babies should be made aware of their body parts. Prone positioning for very young blind babies help them to develop trunk strength and rotation, correcting the position of babies' heads, pairing this positioning with auditory cues, tying bells on babies' ankles and wrists while they play alone, vision-stimulation cues, tactual cues and praise are encouraged to be made, for mothers and caregivers.

4.3.2. The Body-Image Theory and the Body Boundary

''The body is the source of a personal world which generates the way meanings are attributed, by which one experiences the whole world'' (Bloomer and Moore; 1977: 43). The action and judgements of an individual may be impaired by a damaged or distorted body boundary.

One unconsciously locates one's body inside a 3-D boundary. The body boundary may be modified by clothing, or by weapons or artifacts like an automobile that connects directly with the body and is subject to body-reflex actions. Everyone has a psychic image of their own body. Bloomer and Moore (1977) believe that persons with a psychologically strong body boundary are more individuated and more capable of vividly experiencing the environment than weak-barrier persons. The authors further stress the importance of the sense of orientation, believing it is the essential instinct that urges one to stand up independently in space.

Up/down is the most basic orientation. It begins with the heroic struggle of a child to stand up and walk, and the desire to grow up. Front is the orientation toward mobility. It is imagined to signify strength and virtue, whereas back has private and earthy implications.

Right and left also acquire meanings derived from experiences of body strength and control. The right side of the body is generally stronger, and thus it has been associated with power, dexterity, rationality and self-assertion.

Bloomer and Moore (1977) define the body-image theory as; ''all experiences in life, in particular experiences of movement and settlement in 3-D space, dependent on the unique form of the ever-present body''(37). Body image in this context means a knowledge of the parts of the body, how the parts are related spatially to each other and to the wider environment. In order to aid the development of spatial cognition, instruction for the blind child should concentrate on alternative methods for improving large-scale space understanding instead of concentrating only on close-to-body skills. A most important factor in building up spatial knowledge is direct experience of the space.

4.4. Improving Spatial Understanding for the Congenitally Blind Child

Congenitally blind children need assistance in developing spatial concepts. Training, verbal instructions, and demonstration are useful and necessary for the child to learn, repeat and memorize a space (Liberti, 1987).

Free exploration has much contribution in establishing a blind child's knowledge of space. Active exploring begins with a child learning to reach to sound which is around 11 months of age (Davidson and Simmons, 1984). Listening to the sounds that occur when someone else is doing something will provoke a child's curiosity. So, by providing situations for the child which are incomplete or missing, the child is encouraged to ask for, to talk about and to explore for the missing.

The environment can be mediated to create, improve, or facilitate a connection between a child and some aspects of his/her environment by providing access, stimulating or guiding exploration and encouraging interpretation (Davidson and Simmons, 1984). If a child knows the space and is familiar, he or she feels safe. Feeling of safety encourages further exploration to find out new aspects. Interpretations occur between the blind child and his social environment, and experiences are exchanged (Davidson and Simmons, 1984).

Suggestions to help a blind child beginning to explore residential spaces may be placing a favorite toy or landmark to identify a room, entering end exiting rooms with child in same routes through houses to initiate the development of spatial orientation skills (Joffee, 1988).

4.5. Prerequisites to Independent Movement in Space

An independently mobile blind child should know advance information about what lies ahead, to avoid obstacles. The child should be taught how to obtain information from as many fixed sources as possible in the external environment, to orient himself to a fixed location and to update cues for moving around.

As Millar (1994) states, sounds, smells, changes in temperature, air flow, changes in the terrain underfoot in terms of material and gradients etc. are all orientation cues. The blind child should learn to dominate the sense modalities which help perceiving such spatial cues.

Apart from such external cues, Millar (1994) points the importance of the blind child being aware of his/her body position and its relation to external space. The young child must know that he/she should turn his/her head and also feet to the aimed points. Another important aspect is the child's knowledge and ability to use the relation between different reference frames. Blind children are taught in mobility training

- Right angle body turns,
- Right angle turns in external 3-D contexts (wall to floor),
- Right angled hand movements,
- Right angles in 2-D objects and shapes.

Using the cane means independent travel for the blind and visually impaired. As a prerequisite to cane instruction, the student must be in a clear awareness of all major body parts involved in cane travel as well as pre-cane skills such as the sighted guide technique, protective arm techniques, squaring off, taking a line of direction, and room familiarization. The student should be encouraged to improve sound localization skills, identify a variety of sound sources and effectively use clues and cues in the environment to facilitate orientation (Wier, 1988).

The student should have the ability to demonstrate a consistent use of positional concepts such as left and right, parallel and perpendicular, compass directions, 1/4, 1/2, 3/4, full, 90°, 180°, 270° and 360° turns, beside, behind, below, in front, upon, between, over, under. The concept of time and distance that is traveled during outings should be able to be estimated. The student must learn the environment, be familiar with intersections, and recognize traffic patterns (Wier, 1988).

With these notions and abilities established, the cane can be introduced to a student who wishes to be mobile in space in an independent manner. The cane is considered to be an extended sense of touch and therefore safety, and a symbol to others that the user is blind. However, before introducing the cane to a blind traveler, the following should be considered (Wier, 1988):

- need and physical development
- degree of visual impairment
- travel environment
- awareness of body parts
- pre-cane skills
- sensory development
- concept development and
- emotional readiness

The need and the physical ability of the person to use the cane are important. The future cane user must have the gross motor control and physical coordination necessary to grip the handle, to move the tip in a consistent arc motion, and to remain in step (Wier, 1988).

Being a cane user does not mean that the traveler will no longer be able to travel without a cane. Certain cases of vision loss may require the use of cane only during the evening; however during daylight hours, the cane may not be necessary. Likewise, an individual may feel comfortable without a cane in a familiar setting, but will need to use it in an unfamiliar territory.

4.6. Orientation and Mobility for the Blind and Visually Impaired

Orientation and mobility programs are training programs for blind individuals which provide self-awareness, spatial awareness and independent traveling skills. Orientation and Mobility (O&M) services were founded on methods and strategies for teaching that were developed to meet the needs of soldiers who were blinded during World War II (Joffee and Rikhye, 1991).

Joffee and Rikhye (1991) explain that mobility education is required to overcome the fears of, secure the safety of, and teach techniques that enable the blind and visually impaired to travel as independently as possible.

O&M skills are structured for easy access and safe movement. Easy access pathways are those that allow for simple and unobstructed routes of travel through the environment. They are established by the thoughtful placement of classroom or household furniture, shelving, and activity centers. Access for safe movement means that travel paths are free of clutter, unprotected drop-offs, and obstacles. So Joffee and Rikhye (1991) suggest that once the environment is satisfactorily structured, furniture and other points of reference must remain in place.

In O&M training programs, concrete object cues located in space are used. There are two purposes for this: **a)** motivation for movement, and **b)** identification of landmarks and destinations. For example, a roll of toilet paper or a diaper would indicate the rest room. Such concrete cues, affixed to door jambs and other landmarks, inform students about points of orientation and indicate when a destination is reached (Joffee and Rikhye, 1991).

In training programs, students are positioned to move using the sighted-guide technique, trailing, direction-taking procedures, and long cane techniques. They are trained on the environmental structure, and functional communication systems (Joffee and Rikyhe, 1991). Also, devices such as the electronic travel devices, including the Polaron, Mowat Sensor, or Russell Pathsounder, are introduced to students to be used as a secondary travel tool for students using wheelchairs and orthopedic devices.

Developing physical skills will not be enough for independent travel. Geruschat and De l'Aune (1989) explain that the skills required to perform safe travel have been measured as two separate areas: the mental aspects known as orientation and the physical effort or behavioral performance of mobility travel. The aim of training programs is to increase the ability to use landmarks thus understanding spatial relationships.

4.7. Exploring Where an Object is

''Since blind children have difficulties conceptualizing boundaries and since there is no visual field to restrict them, the space which can be utilized is as large as their imaginations'' (Emes, 1978 cited in Chin, 1988: 188). It is important for a blind child to become familiar with spatial concepts to develop freedom of movement and the ability to move with confidence. Chin (1988) states the importance of a child to be free to explore and experiment within the environment.

Exploration of high, medium, and low areas in a given space is a must. Movement occurs not only in a straight line, but in zigzags, curved lines, and free-form travel. By making either small movements or large movements, the child will learn to use a comparably sized space.

Blind children do not have the visual cues to coordinate with their proprioceptive cues. They locate objects primarily by their movements toward them. Thus, they may be tied to a representation of a space that is based on sequential proprioceptive components. Such a representation would allow them to go easily to where they wanted, but would not give them an overall perception of the layout of the space itself.
For the blind user, an environmental layout is a mystery, that has to be solved up to a certain point, that is, until the user can travel safely and complete the necessary tasks. So the blind user explores the environment to understand how he or she can make use of it.

Before starting exploration, a person has to have prior knowledge like where to start and stop, and basic knowledge of forms and functions. In the exploration process, there are goals that have to be established. Hill and his colleagues (1993) state the basic purpose as; finding out what there is to use it for, then what is needed to be learnt for future use, and to travel through space. Secondly, they claim, a clear starting point (landmark) is established to start exploration and to maintain orientation. Thirdly, the exploration process continues with applying an appropriate systematic search pattern to locate in the most efficient way, the objects and features of the space. Fourthly, an appropriate mobility technique is used for safety during movement. Fifthly, a systematic search strategy is selected and used to facilitate the development of important object-to-object relationships that contribute to safe and easy travel in the space in the future.

Mettler (1987) describes the usually implemented search patterns to locate objects as follows:

1. For the immediate surrounding, moving hands and arms in various patterns, this involves haptic and kinesthetic input.
2. To extend the immediate surrounding, using a cane as an extension, swinging the cane in 180° arcs.
3. Walking independently and systematically in space. This can be walking the perimeter of the area which is the perimeter search method, or, the gridline method where the area is crossed to and fro within the perimeter.

Once an object is located, connections or links of objects can be developed. The object is chosen as the anchor and straight lines are made to other objects. The area can be walked back and forth between two objects, or between an object and the perimeter. A pattern can be imagined to follow in space and approximate the locations of the objects.

A study by Hill and his colleagues (1993) aimed at determining the strategies used by blind persons when they enter an unfamiliar area, and explore. To determine what strategies were effective, the adults were videotaped and those who were more skillful and those who were not as comfortable were compared. The results of this study show that, the worst performers tried to use the less efficient perimeter strategy, employing a self-to-object type of strategy by wandering in space until they hit into something.

The best performers in exploration and location of target objects, used the strategies linking objects to other things. The best performers were reported to first use the perimeter strategy to understand the borders of the space, and to locate an object near the borders as a landmark. Their strategies included depth as well as width.

The results of the study suggest that the combination of a perimeter pattern and a grid-like search pattern of exploration is more effective for the estimation of relative distances, and a reference-point strategy is more favorable for the relocation of objects.

The effectiveness of strategies for learning depends on the time the explorers have had with vision, their intelligence, performance of short term memory, and the orientation and mobility instructions they have had (Fletcher, 1981 cited in Hill *et al.* 1993).During Orientation and Mobility instructions, specialists guide students through novel spaces, pointing out the features and relationships of important objects in the layout. Verbal instructions and orientation aids such as tactile maps and models are used. The students are instructed on how to explore and learn novel environments systematically and independently.

4.8. Exploring What an Object is

When an object is located and active exploration begins, it is moved, shaken, hit, pinched. Depending on the differences between features of the shape, identification is provided from information of pressure, temperature and texture that the object offers.

In the recognition process, stimulating the senses with the characteristics of the object is necessary. Stimulation for the explorer may be passive or active. When stimulation is passive, there is more acuity. To illustrate her statement, Millar (1994) gives the Optacon as an example. The Optacon is an electronic reading device which scans print letters and transforms them into impulses perceived by the finger. The finger is passive, the impulses are dynamic. In such cases, stimulus change is needed, otherwise sensation is lost. Passive stimulation is static and unvarying and gets lost after some time.

On the other hand, active stimulation requires active body parts. Active touch involves the receptors in the joint, the tendons and the skeletomuscular system. It is possible when an object can be grasped, and detected by touch.

For large three dimensional objects that cannot be grasped by hands, tactual acuity is less important. To detect the material of the object, touch, pressure, and heat are the main means of information. To understand its shape, movements and body-centered reference gain importance; such information is gathered from joints and stretch muscles, and also from gravitation. It should be noted that such exploration only provides information of the objects; background cues are less obvious in touch. It will not be easy to relate objects with their background.

Millar (1994) claims the fact that shapes can be recognized by touch as well as by vision can be misleading. Haptic information differs with the size and depth of objects. Miniature representations that do not feel like the real objects will not convey any information on them. The exploratory movements which enable the blind child to recognize full-size chairs and tables are quite different from these needed in exploring small toy chairs. This requires assisted learning, demonstrating the function, similarities in shape, etc. Millar (1994) suggests toy scenes to be used to teach relative sizes and uses of objects that are out of normal reach or full tactual exploration.

Very small objects, or features like raised figures or dots in combination with symbols and varying texture, are usually detected with the active exploration forefinger of the preferred hand. These require special training on how to explore (Millar, 1994). Very small complex contours are difficult to recognize. That is, raising visual print letters, even in capital, has not been successful.

The Moon Alphabet was an attempt of providing the blind, letters and figures to read in raise. It was developed in the mid 19th century, and is simple embossed derivations of upper-case letters. Having had revisions, the letters of the alphabet are mainly over half a centimeter in height and width. It is pre-cuing for those who know print letters. It requires slow reading and results in bulky books (Millar, 1994).

The Braille alphabet is commonly used from the time it was developed in the late 19th century. The alphabet consists of a system of six dots, in which the density of the dots provide texture differences. It requires exploration by one finger. Those who have poor tactile acquity and no opportunity of repetition, have difficulties in recognizing the shapes and thus in learning Braille. Enlarged Braille embosses cannot be suggested to overcome the difficulties, as one finger will no longer be enough to explore (Millar, 1994).

This chapter was concluded with discussions on methods of gathering spatial information from large and close spaces. The following chapter covers the ways the gathered information is interpreted to make use of, in developing spatial understanding.

5. DEVELOPING SPATIAL CONCEPTS WITH NO VISION

Knowing the nature and dimension of a space is very important, if one is to learn to organize oneself in relation to it. Several factors influence how spatial knowledge is acquired and represented during one's travel through space (Tellevik, 1992). Human beings have different sense modalities through which information from the empirical world is obtained. Mettler (1987) points out that the majority of people have access to visual information that predominates over information gained through other senses; consequently, the dominant model of the world is primarily vision-based. Then one should ask the following question: ''Is the sighted way of picturing the world, the way the world really is'' (Mettler, 1987: 477)?

Even though one's senses do not provide one with a complete access to the world as it really is, one does manage to build from the provided information a consistent model of the world. One's ability to order and make use of that information in reason and experience is highly developed (Mettler, 1987).

People with visual impairment come to know the environment in different ways comparing to the fully-abled. In the following sections, the perceptual learning theories are briefly explained to understand how learning through the senses occur, and the development of spatial cognition of the blind are discussed.

5.1. Theories of Perceptual Learning

Dodds and Davis (1989) cite and summarize the theories of perceptual learning as follows:

1. **Differentiation theory:** This model is offered by Gibson (1969). Differentiation refers to an increasing sensitivity to the variety of stimulus variables during the course of learning. Differentiation proceeds by the mechanisms of abstraction, filtering and peripheral mechanisms.

Abstraction: Abstraction is said to occur when an invariant relationship is discovered over a number of different objects or events. For example, in the case of the mobility of persons with low vision, invariant relationships (such as textural elements that specify surfaces) that specify the environment to a fully functional visual system may no longer be perceptible. In such a case, the visual system may be able to extract other invariants that are present in the masses of tone, which may act as cues to aspects of the scene that cannot be directly seen but that have been previously seen.

Filtering: Filtering involves the ignoring of irrelevant information, such as randomly occurring changes that are noise rather than signals. Selective attention is operating.

Peripheral Attentional Mechanisms: Gibson (1969, cited in Dodds and Davis, 1989) considers abstraction and filtering to be under the control of central mechanisms of attention. However, an active visual system produces observable behavior, including fixating, tracking, scanning, and head turning. These peripheral attentional mechanisms are guided by the goal of the perceptual tasks at hand and hence are determined partly by the subject and partly by the array of stimuli. So, although visual activity can be directed by conscious planning, it can also be captured by features of the array of stimuli that are relevant to the task at hand.

Gibson's view of perceptual learning consists of the differentiation of global perception of the stimulation into a more articulated one. She believes that perceptual learning takes place without any rewards or feedback, and that repetition of the same task is sufficient for changes in perception to take place. Her theory is a cognitive one.

2. **Schema Theory:** The two key elements of the schema theory are the roles of expectation and memory, and, in common with Gibson's view, the role of experience is emphasized so that schemas are built up and refined through repeated encounters with the environment.

The match or mismatch between the perceptual activity and its expected consequences causes the schema to be modified, and this modification alters the perceptual activity itself. Expectations direct attention so that perceptual activity becomes automatically adapted to environmental circumstances.

The spatial cognitive abilities of the blind have always been a subject of research for the fully-abled. Kitchin (1997) briefly summarizes the three main theories developed after such a discussion:

1. **Deficiency Theory:** This theory states that congenitally blind individuals are unable to develop a general spatial understanding, because they have never experienced the perceptual processes necessary to understand two or three-

dimensional arrangements, scale changes and concepts such as hierarchy, pattern and continuity.

2. **Inefficiency Theory:** This theory states that people with visual impairments can understand and mentally process spatial concepts, but because information is based upon auditory and haptic cues this knowledge and comprehension is inferior to that based on vision.

3. **Difference Theory:** This theory states that visually impaired individuals possess the same abilities to process and understand spatial concepts, and that any differences in quantitative or qualitative terms can be explained by intervening variables such as access to information, experience and stress.

It is a fact that congenitally totally blind people have difficulties in understanding and processing spatial concepts, and that non-visual information may be less efficient than visual information, but it cannot be considered that blind people do not understand spatial relations at all. As it will be mentioned in the following sections, by using strategies suitable to the spatial task to be performed, blind people can perform just as well as sighted people.

5.2. Representational Strategies

To be able to use a space, a traveler must be able to mentally represent this space. Thus, the traveler can make use of strategies to accomplish his/her travel. Among people with full vision, two different wayfinding strategies are distinguishable. The first is of a linear order. Their representation of space is composed of such decision plans and the relevant reference points. They imagine a walk through the setting. Their representation is egocentric, sequential and temporal '(Passini *et al.*, 1986). The second is spatial. Their representation is no longer linked to their movement through space. The wayfinder can easily choose alternate routes (Passini *et al.* 1986).

Young children up to the age of seven, organize space only in a linear-sequential fashion (Hart & Moore, 1973, cited in Passini, 1984). The first contact with an unknown place results generally in a linear-sequential map. Some arrive quicker at a spatial organization while others remain linear-sequential.

Although it is considered that the visually handicapped and the congenitally blind who rely on proximal information could only operate on a linear basis, Rosencranz & Suslick (1976), Aiello (1981), Fletcher (1981) and ,Hollyfield (1981) have argued that the blind person is capable of a visual representation (cited in Passini *et al.*, 1986).

A study by Bigelow (1991) investigated whether blind children's pattern of development of spatial knowledge of their home environments is similar to or different from sighted children during early school years. Blind and visually impaired children were asked to point at certain locations from where they were positioned. Most of the mistakes the children made, involved pointing to the routes they would take to get to the location requested: that is, they pointed to doorways and stairways rather than to the Euclidean direction of the requested locations (Bigelow, 1991). The children especially made mistakes when they were asked to point to locations in their houses on a different floor from where they were.

The blind and visually impaired children's performance suggests that their spatial knowledge was based on routes between places rather than on a Euclidean understanding of locations in their homes and close surroundings (Bigelow, 1991). Their performance suggests that the location of places on a horizontal plane is easier than the location of places that also differ on a vertical plane. Yet, as Piaget (1954, cited in Bigelow, 1991) predicted, all children have difficulty coordinating changes in two dimensions at once.

Bigelow (1991) discusses that the problem for totally blind children may not be the coordination of changes in more than one dimension, but understanding the layout of the space itself; that is, they may not conceptualize the location of the requested place in relation to their current position independent of their knowledge of how they get to it.

Previous research on cognitive mapping has indicated that knowledge of routes, whether based on proprioceptive or visual information, is an early form of spatial knowledge. A more mature spatial knowledge is layout knowledge in which Euclidean distances and directions between locations, even locations that are out of sight, are known. The lack of vision may make the transition from one form of spatial knowledge to the other more difficult (Bigelow, 1991), but not impossible.

Passini (1984) has found in a previous research that to understand the spatial organization of a setting is the single most important factor for creating a spatial representation. Once blind travelers are aware of how a setting is organized, they will also be able to choose between alternative routes.

They therefore behave as if they had a spatial representation at the macroscale (Passini *et al.*, 1986).

Piaget & Inhelder (1956) state that behavior in space and representation of space are in fact very different and they make the distinction between 'practical' space -the capacity to act in space- and, 'conceptual' space -the capacity to represent space-; ''The capacity to act and move intelligently through space may well occur before, and in the absence of, the capacity to represent that space'' (Spencer *et al.*, 1989 cited in Kitchin, 1994: 6).

By the age of five, blind children understand that people with sight have a different way of perceiving things, and that this is another way of internal cognition independent of them that operates differently (Bigelow, 1992). By the end of preschool years, they generally develop an early cognitive understanding of perspective. Yet, they still are confused about under which conditions their sighted peers see objects, when it comes to the orientation of the observer. To show objects to others, they face the person and touch or point at the objects, even if they are between the objects and the other person.

As for their understanding of perspective, younger children may believe their tactual experience is same as the visual experience of a sighted person: If the object is available in hands, it is easily seen by a person. Perspective is not taken into account. The orientation of an object affects its visibility. This understanding can be developed faster by training, of course primarily it should be cognitively acquired (Bigelow, 1992).

5.3. Representation Systems in Lack of Vision

Strong concentration and short-term memory are important for visually impaired people because they lack the means available to sighted people, to check and refresh their memories by referring to visual materials (Kainthola and Singh, 1992). Evidence from studies support the superiority of visually impaired people's ability to concentrate because of their greater attention to the environment.

Blind people do not perceive spatial relationships simultaneously since these relationships are formulated on the basis of different data. Therefore, spatial orientation must be understood in relation to tactile and auditory properties of the space (Rogow, 1974 cited in Kainthola and Singh, 1992). Unlike sighted persons, visually impaired persons relate each separate tactile impression to the next and mentally hold the impressions together to form a percept (Kool, 1981 cited in Kainthola and Singh, 1992). They acquire knowledge of the spatial relations among objects through tactile, proprioceptive, or auditory modes. Although they sometimes get information about spatial layouts from the verbal descriptions of others and less frequently from tactile maps, when moving through space, they must rely primarily on mentally updating the spatial relationships between themselves and the environment (Bigelow, 1991).

Each human being has a number of different ways of representing experiences of the world, but our minds can only 'think' in terms of what we have perceived. Thus, a congenitally totally blind person who has never 'seen', may misperceive the environment. People experience the world differently, because they develop their own representational model or map of the world through the senses (Williams and Jacobson, 1989). They tend to develop or value one representational system to a greater degree, and they display how they are thinking in indirect ways.

Persons with a kinesthetic primary representational system will prefer feeling to process information, and will rely on feeling when remembering or thinking. Adventitiously blind persons may use a visual primary representation system when traveling in a familiar environment, but that may result in uneasy situations when traveling in novel environments.

Auditory primary representation system travelers most probably **a)** travel at a moderately fast pace, **b)** utilize cane tapping to attend to echoes, **c)** establish fewer physical landmarks, **d)** rely more on the location of echoes and auditory cues to find their destinations (Williams and Jacobson, 1989).

Kinesthetic primary representation system travelers may **a)** travel at a slower pace, **b)** prefer continuous physical cane or foot contact with the sidewalk or shoreline, **c)** establish a significantly higher number of physical landmarks, and **d)** use trailing to locate destinations (Williams and Jacobson, 1989).

5.4. Spatial Knowledge and Spatial Cognition

Spatial knowledge as described by Spencer and the colleagues (1992) is; ''Knowledge which facilitates mobility, knowing the location of resources, of places for safety, security and sociability, knowing the routes for efficient travel and when necessary, for escape''(192). The knowledge of space is important in determining attitudes toward, and decision making about the behavior within places (Kitchin, 1994). It leads to the cognition of the space which provides the user with the ability of representing the space.

Spatial cognition is defined as ''the knowledge and internal or cognitive representation of the structure, entities, and relations of space; in other words, the internalized reflection and reconstruction of space in thought'' (Hart and Moore, 1973 cited in Kitchin, 1994: 1). Spatial cognition leads to cognitive mapping, and this is essential in wayfinding and orientation.

5.4.1. Cognitive Mapping

The ability to plan and execute movement in a familiar environment requires that one possess a cognitive map of that environment in addition to the stimulus information directly available to the sensory systems (Kitchin, 1994). A cognitive map is a mental construct which we use to understand and know the environment (Kaplan, 1973a cited in Kitchin, 1994). The term assumes that people store information about their environment which they then use to make spatial decisions. ''It is a mental device and store which helps to simplify, code and order the complex world of human interaction with the environment'' (Walmsley, *et al.*, 1990 cited in Kitchin, 1994: 2). Cognitive maps represent the organization of the physical environment in a simpler form. They contain distortions: open angles are transformed into rectangles or multiples, curved lines are straightened, spatial configurations are simplified to basic geometric forms (Passini, 1984).

Cognitive maps may be developed and represented as information on the path or route including important points and direction turns along route, or as information describing the' spatial relations among locations. Cognitive mapping involves knowing the spatial relations among objects or landmarks and one's position in space in relation to the relevant objects or landmarks (Bigelow, 1991). Environmental information extracted from a cognitive map allows a person to develop decision plans in accordance to routes chosen. In order to be of maximum use, cognitive maps must represent a spatial ensemble in a continuous fashion. Frequently, images do not exist as an integrated whole but as disparate, unrelated elements or partial maps. Spatial correspondence summarizes the environmental characteristics that facilitate the development of comprehensive cognitive maps reflecting the continuity of space (Passini, 1984: 127).

Memory of spatial layouts and routes is related to the activities performed in space and the goal of the spatial experience. The systematic pattern of travel is helpful in remembering spatial relations, whereas random movement is less efficient (Fletcher, 1981 cited in Hill *et al.,* 1993). An active exploration by walking and driving tends to produce more detailed and structured maps than passive exploration (Appleyard, 1970 cited in Passini, 1984).

Cadwaller (1976, cited in Kitchin, 1994) suggests that cognitive maps affect at least three types of decisions:

1. The decision to stay or go.
2. The decision of where to go.
3. The decision of which route to take.

Garling *et al.* (1985, cited in Kitchin, 1994) add:

4. The decision of how to get there.

One of a cognitive map's function then, is to rehearse spatial behavior in the mind so that when one is actually traveling, one can act with a degree of assurance that he would otherwise not have (Tuan, 1975 cited in Kitchin, 1994).

Golledge and Timmermans (1990, cited in Kitchin, 1994) have reported that cognitive maps are in effect a series of knowledge structures which consist of different levels of detail and integration. These knowledge structures develop with age and education, thus increasing the information held. By combining different knowledge structures and information using cognitive processes relating to perception, storage, retrieval and reorganization that interact with memory structures, a cognitive map is formed for specific tasks (Golledge *et al.*, 1985, cited in Kitchin, 1994). By this is meant that there is not only one cognitive map in memory but rather we construct them for specific events (Siegel and Cousins, 1985, cited in Kitchin, 1994). In this respect cognitive maps are dynamic. They are not independent of time and space.

5.4.2. Wayfinding

Learning new routes and experiencing new settings often lead to tension, anxiety and feelings of insecurity. Yet, even if wayfinding can be stressing, blind people do take walks just for pleasure (Passini *et al.* 1986). Wayfinding refers to the person's ability, both cognitive and behavioral, to reach destinations. It is considered in terms of spatial problem solving (Passini *et al.*, 1986).

Wayfinding requires active involvement in the environment, skills in problem solving, and exploration to acquire new information each time an area is traveled (Passini, 1984). Wayfinding skills will be necessary for a traveler for recreational, resolute (like in office buildings) and emergency needs.

Passini (1984, 172) analyses wayfinding tasks in a building as;

1. from entrance/exit to destination zone,
2. from one destination zone to another destination zone,
3. within destination zone.

The information needs of the visually impaired wayfinder are determined by two factors (Passini *et al.*, 1988):

1. the decision-making and decision-execution process necessary to prepare and to make a journey (as Passini (1984) states, each decision contains an action and an image component), and
2. the perceptual and spatio-cognitive abilities in processing relevant environmental information.

Wayfinding in an unfamiliar setting requires information for planning the decision and further information to execute the decisions. In a familiar setting, people execute recorded plans. However, without meaningful environmental information, wayfinders -blind or sighted- have no other options than to rely on chance to plan and find their destination: a most inefficient and, for the blind, hazardous strategy (Passini *et al.*, 1988).

The wayfinding studies of Passini and the colleagues (1988) show that the visually impaired group uses significantly more information than the sighted control group to make the same journey. In order to maintain a wayfinding direction, totally blind travelers will rely on the cane if they have no dog guide, and will use any rectilinear feature in the environment, such as the edge of a footpath, a wall or a fence. Sometimes they can follow the movement of other people or if they are in an exterior environment, even of motor traffic (Passini *et al.*, 1986). During their journey, the visually impaired travelers make many errors until they get familiar with an environment. The errors are generally made in situations where no relevant information exists or in situations where many units of information are accessible but not distinctive (Passini *et al.*, 1986).

Almost every blind person develops his/her own way to travel. These step-by-step decisions fitting together into meaningful travel plans can be logical or temporal organizations (Passini, 1984). After an active involvement, travelers become more efficient in recalling the logical and temporal order of decisions.

Some travelers rely on directions, some emphasize the importance of the sun in their urban travels, others refer to the street system or to some major reference points and paths which organize the city space. Some count their steps and posts etc. as they walk to certain destinations. Others use temporal references. After walking for a certain time, they look out for relevant cues indicating destination (Passini *et al.*, 1986).

In buildings, some people prefer obtaining information from sign systems (linearly obtained information), others try to understand the spatial properties of the setting and their position within it (spatially organized information) (Passini, 1984).

People have the ability to mentally simulate wayfinding. It is possible to imagine the completion of a wayfinding task during which decision plans are elaborated and executed. ''We have expectancy image from the decision and a mental representation of the setting (cognitive map) as a matching counterpart'' (Passini, 1984: 73).

The same simulation procedure may be used to estimate the time needed to reach a destination. Time estimates are linked to behavioral episodes or activities. In estimating the time it takes to go somewhere, we perform a simulation of plan execution. This feeling for time is linked to experiencing movement in space (Passini, 1984).

5.4.3. Orientation

Orientation is an awareness of present position in space, destination and movement through space (McLinden, 1981 cited in Palazesi, 1986). ''Sense of orientation is the sense of direction which is an ability to maintain a direction independently of one's location in space and independently of cues originating from the environment ''(Passini, 1984: 28). Also, spatial orientation refers to the process by which a person knows where he/she is relative to something else (Garling and Golldege, 1989 cited in Kitchin, 1994).

Instead of relying on a spatial representation of the physical environment to situate oneself, a person may rely on a plan of action or a strategy to go somewhere. These two static and dynamic aspects of spatial orientation are complementary. Without them, the sensation of being lost or disoriented occurs (Passini, 1984). Spatial orientation could therefore be described as a person's ability to mentally determine his position within a representation of the environment made possible by cognitive maps. Spatial orientation is equated with knowing where one is, and having an adequate cognitive map (Passini, 1984).

The ability to maintain orientation within the spatial environment varies widely between individuals. One possible explanation for these differences is that individuals focus on different types of information about the environment as they engage in wayfinding. As stressed previously, environmental cognition researchers have distinguished between two types of environmental knowledge: configurational knowledge, or understanding of the spatial relationships among locations, and knowledge of places and the routes that connect them (Hart and Moore, 1973; Siegel and White, 1975; Evans, 1980; Russell and Ward, 1982; Golledge, 1987 cited in McLinden, 1988). Configurational knowledge allows the navigator to localize places that are not perceptually available, which may then serve as reference points in determining one's position in the environment (Garling *et al.*, 1986 cited in McLinden, 1988).

Then, blind or sighted, travelers determine strategies for themselves which they use in their orientation and thus wayfinding in a built environment. Route and orientation strategies are strategies for wayfinding which use different information and modes of representation.

The route strategy focuses on information about a route to be followed, such as instructions about where to turn left or right. The outdoor orientation strategy makes use of global reference points, such as compass directions or the position of the sun in the sky, in order to maintain orientation within the environment (McLinden, 1988). Global reference systems thus appear to play an important role in strategies of outdoor wayfinding, and also in cognitive maps of large-scale outdoor environments. It is less clear whether global reference systems play a similar role in indoor settings (McLinden, 1988); yet, maintaining orientation by focusing on directional cues is a strategy of wayfinding in indoor as well as outdoor settings, and is distinct from the strategies of attending to building configuration or relying on route information in a building.

It can be considered that individuals do not rely on only one type of wayfinding strategy, but rather switch between strategies depending on the context. An individual who typically uses an orientation strategy, for example, might prefer to use a route strategy in an environment rich in route information and landmark distinctiveness. Likewise, an individual who usually relies on a route strategy might switch to an orientation strategy when route information is lacking. It is possible that people engaged in wayfinding also switch strategies as they gain familiarity with a particular environment (McLinden, 1988).

This chapter is concluded with discussions on how persons with blindness and visual impairment represent space and the strategies they use to develop their familiarity in a space. The following chapter will discuss the technical difficulties they encounter in the built interior environment which is unfamiliar to them, and how these difficulties can be reduced to provide comfort in their travel and ease in reaching a destination.

6. COPING WITH SPACE FOR THE BLIND AND VISUALLY IMPAIRED

Blind people encounter technical difficulties in negotiating the physical environment. Certain tasks in an architectural environment can be particularly difficult for the blind wayfinder. Simple examples can be named as maintaining a given walking direction, finding architectural features, traversing open spaces, and coping with stairs (Passini *et al.*, 1988). The most difficult places experienced by the visually handicapped population are vast places, both indoor and outdoor: shopping complexes, department stores, hotel lobbies, train and bus stations, airports and parking lots, etc. The open non-urban environment is also considered to be difficult. The blind population relies mostly on distinct auditory reference points in wayfinding.

One major difficulty encountered in these environments is that such reference points are often missing or difficult to perceive due to sound-absorbing materials (e.g. carpets, acoustic tiles) or due to a high level of background noises (Passini *et al.*, 1986). A second major difficulty affecting the blind persons in vast spaces is as Passini and his colleagues (1986) note, the difficulty in the perception and understanding of complex spatial layouts. The researches state that small, carefully thought-out design interventions can have a major effect on the mobility of visually impaired users and may even enhance wayfinding for the population in general.

6.1. Environmental Information

''Environmental information describes events and objects and sets them in a time and space frame'' (Passini, 1984: 60).

Environmental information is;

1. obtained through direct sensory contact with a setting,
2. evoked from past experience,
3. obtained by inference which is combining sense and memory.

As Passini (1984) notes, a person's memory and knowledge of the setting, of similar settings, and of past experience are also sources of spatial information. Sensory information also involves memory, as, information once went through the process of being directly perceived. At a given moment, memory information can be obtained without or independent of sensory inputs from the setting (Passini, 1984).

Information extracted from space and architecture is used for decision making, decision execution and interpretation of environmental situations. This information is also incorporated into an overall cognitive map that allows the person to locate the place he is in with regard to the space (Passini, 1984). As Passini (1984) describes, environmental information includes a descriptive, a location and a temporal content.

The **descriptive content** gives an identity, helps to separate and differentiate, renders recognizable. Classifications and equivalencies are made. Some characteristics stand out, some are ignored. Similarity or generality is considered.

The **location content** gives response to the question 'where'. This leads to two basic responses, one using a process description, and the other a state description of location. The process description indicates location by what one has to do, to get there. The state description indicates location within some reference system. This reference system should be shared to be of use, and may not necessarily tell how to get to a location.

The **temporal content** is fundamental in coordinating activities. Variables related to a person's condition like health and age, intervene in time estimates (Fraser, 1975, cited in Passini: 58). Temporal estimates are essentially of two types: past oriented which measure the length of an episode that has occurred, and future oriented which estimate the time it will take to accomplish something or get somewhere.

Time and distance (space) are closely related notions important in interpreting environmental information. They are often used interchangeably to describe and measure each other. Motivation, especially like liking and disliking, influences the perception of time, as does the density of significant events (Lynch, 1972, cited in Passini, 1984: 58). Closer to the present, an episode of the past will be perceived as longer in time (Passini, 1984).

Studies show that people are not accurate also in estimating routes in metric units. Even when distances are compared in non metric terms, distortions occur. Routes appear generally longer if they contain many intersections, barriers or features like curves, reference points and so on (Sadalla & Staplin, 1980; Byrne, 1979; Canter, 1977 cited in Passini, 1984).

Large spaces are often mapped by regrouping spatial elements into distinct areas. If two elements are situated within the same area, the distance will tend to be assessed as being shorter than if the elements are in distinct areas (Rapoport, 1977, cited in Passini, 1984).

Maps and descriptions are also important in making estimations of distance and time, thus in planning activities. Millar (1994) points out that distortions in distance estimates occur mainly in the absence of a definitive spatial frame by means of which the start and the end of the intervening space can be specified. She continues stating that illusions may also happen from social and individual factors, like attractiveness of the goal of the travel, the value attached to it, elements on the way, crowdedness, activities, etc. Fatigue, durations, force of movements, she explains, will influence distance estimations.

Most places cannot be comprehended from one perspective only. Passini (1984) states that comprehension and representation in the form of a cognitive map or an overall image require the organization of bits and pieces of environmental information gathered at various points over an extended period of time. To organize or structure a cognitive map, not everything seen and heard is used, but a selection process takes place through which a certain type of information becomes more important and generally relied upon. Perception is strongly affected by what a person knows and what he wants to know.

6.2. Architectural Factors

The architectural factors that are to be considered as sources of information in this section are, the spatial layout of the built environment, architectural features and finishes, and furniture and interior elements.

6.2.1. Spatial Layout of the Built Environment

''Effective mobility includes the ability to travel safely, comfortably, gracefully and independently'' (Foulke, 1982 cited in Spencer *et al.*, 1992: 192). In familiar areas, this travel may happen among established, familiar routes. In unfamiliar areas, the traveler may use general expectations for the layout of types of place, reading the regular environmental grammar (Kay, 1974 cited in Spencer *et al.*, 1992).

Information from space has to be gathered and interpreted for efficient mobility. Architecture and spatial configuration of a building generate wayfinding problems for people to solve, but Passini (1984) discusses that, they are also a wayfinding support system. Certain places lend themselves better to extracting and comprehending relevant information - this quality is the legibility factor. Strongly articulated, clearly organized spaces do help the sighted user and would also improve the blind user's perception and cognition of a setting (Passini *et al.*, 1986). This also helps in easily representing a place mentally, which is its imageability.

Forming space according to function, conceptualizing and organizing space, informing the user of the building is what an architect and designer is concerned with. Spatial organization is the principle by which an order among various inside spaces and architectural elements is established. The continuity among inside spaces is called spatial correspondence. It affects the image continuity of spaces within a setting and among settings. Continuity is due to the circulation in a building. Circulation is the major organization force of a layout, it is the basic structure that links and organizes spaces (Arthur and Passini, 1992).

Briefly, Arthur and Passini (1992) summarize the basic points in planning the layout of the building as;

1. identifying the spatial units of the setting and their identity. For this, the units have to be distinct. This can be achieved by the form and volume of the space that defines architectural and decorative elements and by the use of finishes, light, color, and graphics. Activities and atmosphere created by people's behavior will also create distinctiveness, although temporary in nature.
2. grouping the units into destination zones. For this, equivalence comes into consideration. Units having features in common are grouped. Function can also be an equivalent feature.
3. linking the spaces and destination zones into a designed ensemble. This is provided by the circulation system in the building. ''Circulation is space, therefore architecture'' (Arthur and Passini, 1992: 139). The circulation system itself can have a form which can enhance the setting and give a special character. It can be communicated through the form and volume of the building.

Spatial articulation of the circulation system coupled with the expression of destination zones will create distinctiveness, giving landmark quality to those architectural elements. Types of circulation can be linear, composite, centralized, or scatter point, grid or hierarchical networks in nature. The wayfinders rarely see the overall form of paths. The more systematized a pattern, the easier it will be to keep in mind. If not, the

Gestalt has to be constructed mentally to give a meaning to the form, to make it easy to remember.

Architectural wayfinding communication can be provided through the location and features of entrances and exits, and elements of horizontal and vertical circulation (paths, corridors, stairs, escalators, elevators, etc.). The legibility of such key elements is important in clearly understanding the spatial organization.

Proper articulation indicates the direction of movement, facilitates the understanding of the circulation system, indicates the importance of the destination and whether there is access to it. In a built interior environment, to go from the entrance to the appropriate path is the first step. Using multiple means to communicate the same information can guarantee its reaching the users of all groups. For this, besides visual information, auditory, tactile and kinesthetic means could be used as well (Arthur and Passini, 1992).

Lack of landmarks will be a problem to the blind wayfinder. This problem, generally encountered in large spaces, is due to the spatial uniformity. A suggestion will be in this case, apart from providing spatial information as reference cues, is to remember complex buildings with subzones (Arthur and Passini, 1992).

6.2.2. Architectural Features and Finishes

Totally blind people tend to rely on small-scale reference points such as posts, fences, walls, stairs, trees, interior plants, etc. Most identifiable objects and architectural features can serve as reference points. To be meaningful they have to communicate some specific identifiable features (Passini *et al.*, 1988).

The presence of architectural features, including stairs, and other elements of information can facilitate the movements of the blind and visually impaired, by providing consistency in the design and placement of these elements (Passini *et al.*, 1988). This is necessary for the traveler in order to know 'what to look for' and 'where to look for'.

Architectural features and finishes are sources precuing and warning users about what the area is containing. In buildings frequently used by the blind, safety barriers or swinging doors are located in front of stairs and changes of level which open only toward the traveler. Shore lines and trails which can be traced by the cane, are placed to define walking paths.

The cane is also used during the travel to detect texture and to provide echoes from tapping. Providing texture and finishes of different material that can also be felt with shoes, has been a corrective suggestion. But different textures defining different walkways to different destinations in buildings have not been found efficient, causing excessive information. Yet, in many training programs, visually impaired children are trained barefoot and then with shoes to gain sensitivity to texture detected by walk (Liberti, 1987).

A product named 'pathfinder tiles' has been made with this consideration. Mettler (1987) describes these tiles as made of various tactile materials such as synthetic rubber, vinyl, concrete or ceramic clay, and claims that they are considered by some, to be the best way of providing surface information. They come in two forms; 1 cm. high dots, intended to serve as warnings, and 1 cm. high bars, to guide travelers in a straight line such as when making street crossings.

A traveler relying on tactile warnings to any considerable extent has to reflect upon what any particular one is intended to indicate, and divert his or her attention from other nonvisual sources of information. Explaining these, Mettler (1987) believes that tactile warnings would not be reliable, because only to a small fraction of environments have these standards been applied. Even when subject to them, it would be unwise for a traveler to infer anything from the absence of a tactile warning in any given situation. Dependence on tactile warnings thus, causes losing control and responsibility for self-directed action according to one's own experience in favor of the judgement of others (Mettler, 1987).

It has also been suggested that the bar form be used to guide blind people through public facilities. A traveler relying on the bar form is encouraged to travel from point to point assuming that this path will not lead to any danger or inconvenience. Again the traveler encountering bar tiles must still determine what path they form. As with warning tiles, encountering bar tiles still requires the traveler to engage in further information-gathering to decipher what the tiles signify (Mettler, 1987).

It must also be kept in mind that some of the cane users tap their cane during a travel and cannot perceive clearly the texture on the ground. This is done to gather information from the echoes the strikes produce, and orient oneself accordingly.

This points out that resiliency is highly detectable and distinguishable comparing to texture, as it can manifest itself both aurally and tactually. In many circumstances, the sound and feeling of the cane striking a hard or rubberized surface will echo and so advise the traveler of an overhang. Where the floor is carpeted or when for whatever other reason no echo can be heard, low-hanging obstacles create problems (Mettler, 1987). Care must be taken to eliminate or hide such obstacles, or inform of their presence.

Yet, as Greene (1976) describes, texture is a way of communication in architecture. The symbolic quality of a textural stimulus can be more important than the actual characteristics of a surface. It may provoke coordination of the sensory properties of materials with the meanings and associations that may be peculiar to the user's experience. It can also be used for contrasting environments for varied activities.

Mettler (1987) suggests to use warning textures for the indication of hazardous areas in buildings. These can be at uncurbed intersections, stairs, and on doors to hazardous areas on the door handle, knob, pull or other opening hardware. Besides being warnings, all such precautions are nevertheless, important sources of information.

6.2.3. Furniture and Interior Elements

Interior elements such as furniture can also contribute in orientation, wayfinding and gathering spatial information such as the function of a spatial unit. Furniture layout belonging to a space should be carefully considered, as the environment a blind person encounters also includes furniture. Furniture are not stable, they can be moved in space. Moving them may cause annoying situations for the blind user, because many travelers rely on their arrangements and has expectations of locating them in their familiar setting in a space. It could be suggested to keep them in place as certain references that can be detected easily. Consistency in the placement of objects throughout the built environment is an important factor in the development of spatial relationships. A suggestion from Long (1995) is to align furniture with doors leading into or out of a room, to serve as a useful guide for establishing a line of travel to locate a door.

Apart from furniture, the information referred to by the visually impaired travelers include handrails, doorframes, ashtrays, garbage cans, floor finishings, and sources of noise, echo, odors, and heat, etc.. The visually impaired travelers often make inference when detecting such information. Ashtrays fixed on walls, for example, can be associated with a nearby elevator having in mind that smoking is forbidden inside elevators (Passini *et al.*, 1988). Liberti (1987) suggests keeping objects and informative obstacles near the wall to help following the surrounding environments, as well as being additional supports and sources of spatial information.

The architectural elements and objects which can be perceived as obstacles and potential sources of accidents can be listed as stairs without railings, benches, half-open doors in corridors, objects which project into space but which are not perceptible with the cane on the ground, stair overheads, public telephones fixed on walls, objects lying on the ground such as toys and bicycles (Passini *et al.*, 1986).

Along the way and movements of travel and exploration of the blind, all corrections should be made known to the blind user, and the improvements should not be vulnerable to vandalism.

6.3. Additional Wayfinding Aids

A very important consideration is to find a means to communicate to the blind user how places function and how they are spatially organized. This may be done by tactile maps, verbal descriptions at information centers, and technical interactive devices which guide the blind travelers or allow them to ask questions about the setting (Passini *et al.*, 1986).

6.3.1. Understandability Provided through Signage

The traveler not only receives, but looks for information (Passini, 1984) and he should know what to look for. The blind traveler has a reduced field of search in space. Instead of having to guess for placement, he should be able to focus on particular architectural elements, such as columns, panels, kiosks, openings, etc. expecting them to communicate relevant information.

Using signs is one way of communicating information. Passini (1984) classifies these signs as directional, identification and reassurance, and states that they can be verbal, pictorial or symbolic in nature;

> **Directional signs** give a process description of the location and are part of a decision plan.
> **Identification signs** state a description of the location.
> **Reassurance signs** confirm that the traveler is still on the right road.

Problems may arise such as difficulties in obtaining information in finding the sign in a setting or the message on the sign and in understanding the meaning of the message. For differentiation and identification of signs in a public area with information overload, rendering is necessary. Passini (1984) suggests that signs can simply be recognized by form and position. Different groups of signs can be differentiated by an appropriate graphic identity. Their discovery can be facilitated by giving consideration on their placement.

As information should not be dense, form standardization can be suggested for grouping signs. The user should not have to read through lists of names or signs, or study unstructured information on signs and maps. The perceptual processes are not the same when reading a text and when scanning an environment. To whom the message is addressed, what the content is should be understandable. An additional meaning a person attributes to a sign or its message can also be a problem (Passini, 1984).

Mettler (1987) discusses that modifications such as tactile control indicators on elevators, raised or indented characters and symbols on elevator panels, and color contrasts between characters and symbols and their backgrounds can be suggested to apply in signage, considering visually impaired users. The researcher also points out that information display such as tactile and auditory maps, talking elevators, talking signs and prerecorded instructions for a variety of other information purposes, are being used more frequently in large buildings where it can be difficult to contact other persons to ask for information.

Reassurance, repetition, consistency, and continuity should be provided in presenting information (Passini, 1984). Consistency in the conception and the design of wayfinding support systems and consistency in the placement of wayfinding information provide easier perception and allow the user to cope with information overloads. For example, if the blind people know that door signs are done in relief print and are always placed at the right of a door at shoulder height, they will be able to use this information efficiently. As Passini and his colleagues (1986) point out, this fact applies to any user.

6.3.2. Maps and Verbal Instructions

Unfortunately blind people have little or no access to distant cues which would allow them to read how the environment is spatially organized (Passini *et al.*, 1988). They do not see the form and exterior volume of a building, they do not see the end of a long corridor or the large open plaza which informs the sighted user about the spatial organization.

It would be most useful to use tactile maps or small models and verbal descriptions to help them in understanding what they should expect to encounter during their travel in the particular space (Passini *et al.*, 1988).

''Maps are shapes and lines indicating location, distances and directions organized in terms of Euclidean coordinates of vertical and horizontal reference frames'' (Passini, 1984: 136).

As Passini (1984) explains, wayfinding maps provide information leading to the identification of a route that links a destination to the viewer's point of origin and to the development of a corresponding decision plan; they provide information leading to a spatial comprehension of a place. He continues stating that they also reassure a person 'about a decision plan and confirm the person's cognitive representation.

Especially considering the blind users who are unfamiliar with the building, setting or place, Passini (1984) indicates that it will be useful to introduce them with a stand provided with a tactile map of the building they have entered. This will provide information on the layout of the building they are about to use. It is known that the blind can successfully navigate an environment after being provided only tactile spatial layout information in the form of a raised-line map (Bentzen, 1972 cited in Easton & Bentzen, 1987). Such maps can be used at intersecting points in the building, at the same time indicating the position of the reader as he uses the map with a 'you are here' sign. So, their location and accessibility is a consideration.

Tactile perception is sequential, impressions are built up from details. It may sound difficult for blind persons to understand a three dimensional space from a two dimensional representation, but even blind children can understand maps, and can construct maps from partial information. Earlier sight and residual vision will be an advantage to develop such an understanding, but congenitally blind persons can easily learn to use maps, as maps are symbolic representations of spaces presented in the order they have been constructed (Millar, 1994).

As cues on tactile maps have to be much larger, clutter will have to be prevented. This can be with the use of differently scaled maps, the use of overlays, and of different height for the raised symbols. Yet, maps do not have to be of scale, neither do they have to be exact representations; actually maps which indicate the borders of spaces are not of much help for blind users. Blind users prefer route configurations presented by continuous lines, also indicating alternative directions and important points of reference they can use to reassure themselves during their travel.

When one compares route presentations given by verbal instructions and map presentations, map presentations give best results, for they are easier to learn. Of course experience gained through repetition is very effective in the ease of understanding a map. ''With repetition, time gets shorter, landmarks become more apparent'' (Millar, 1994: 169).

There may be dissociations between verbal and spatial descriptions, because of the complexity of verbal construction, or not knowing the meaning, or keeping in mind words like left-right (Millar, 1994). In giving verbal instructions, Millar (1994) suggests that appropriate verbal symbols and linguistic structures should be used, as verbal commentaries may not always convey the same information for everyone; as, according to their meanings, words belong to semantic domains.

All travelers, whether visually impaired or not, are faced with the necessity of remembering verbally presented directions. The blind can transform verbal route directions to a spatial form in order to remember them and, they can successfully use mental imagery as a form of thought (Easton and Bentzen, 1987).

6.3.3. Electronic Guides and Devices

The difficulty of maintaining a given walking direction and traversing open spaces could be reduced by providing the blind wayfinder with some other forms of directional guidance. Many electronic guides and orientation devices are being produced, tested, and even used today. Most of these guides are based on auditory signals emitted by sources placed at regular intervals in circulation areas, generally placed on ceiling tracks, which are received by travelers who wish, with the help of receivers that they carry personally. In areas where background noise is not a concern, musical pathways are installed on the ceiling for the blind travelers to follow to their destination.

In important facilities like metro or train stations, it is now possible to use an electronic guidance laid in the floor which gives messages to the blind through a small portable speaker (Preiser, 1985 cited in Passini *et al.*, 1986). Such guides also produce flashes of light to be used by visually impaired persons who can receive light. The same guidance device is also adapted into interior complex environments, it can be built into the floor or laid under a covering surface. This system allows verbal messages to be given at key points of the setting.

The reason for such products to be developed was actually to facilitate wayfinding of impaired and old persons to evacuate buildings in cases of emergency. Especially in cases of fire where smoke prevents vision, such devices serve all persons.

Another system that is being developed is a following device that senses persons who wear a special emitter. Persons who wish to use the help of the device can get into verbal contact by phones placed at certain locations or can hear the directions of the instructors through speakers placed at regular intervals.

Among many modifications that are made to provide accessibility to blind travelers, are audible indicators above doors in mass-transit vehicles, sonar devices warning the approach to stairs, or to objects projecting into space. These proposed measures, however, offer nothing that is not already available through the cane technique. Spaces between different elements, entrance ways, and changes in level are the kinds of environmental features that cane technique is intended to detect (Mettler, 1987). Although they may provide assistive help in gaining time and independence of the help of others, it has been noted that such devices can also be sources of excessive information that the blind traveler may not prefer to use.

A simple way to solve such problems will be to provide audible information for the user of a complex building. Telephones linked to information desks or audible maps which provide the travelers with verbal descriptions of the building characteristics, where they are located, and where certain facilities are in relation to their position, would be cheaper to install and useful to all user groups in the building.

Apart from such systems that are applied at building scale, personal guiding devices are also being produced. These are portable pieces of electronics that detect the presence of nearby obstacles and warn the user by a nonvisual display (Heyes, 1984). These devices called electronic travel aids, emit laser beams or high-frequency auditory waves that are reflected from nearby objects. The reflections are converted into auditory or tactile signals that the user is trained to interpret (Blasch, *et al.* 1989).

One of the most frequently used device is the Sonicguide. The Sonicguide consists of an emitter and two receivers of ultrasound waves. The device generates a continuous emission of ultrasound; every time the ultrasonic wave encounters an object, an echo is sent back. This echo is then converted to a stereo audible sound, coded for the distance and direction, texture, shape, and spatial location of the objects (Sampaio, 1987). Using the device requires training in being able to learn what the sound represents in spatial coding. The Sonicguide is worn in a fixed position on the forehead, so the orientation of the ultrasonic beam depends on head movements (Passini *et al.*, 1986). The Sonicguide or such ultrasonic echolocation devices cannot detect holes in the ground, so they are suggested to be used as secondary aids accompanying a cane or dog (Heyes, 1984).

Throughout this chapter is discussed how the built environment provides communication systems to its users, and what kind of assistive devices can be suggested in extra for independent travel. Persons with vision have advantage in locating and obtaining any kind of information that is offered, but persons with no vision have to look for them and know how to interpret them to be able to make use of them. Knowing how to deal with the built environment and how to make use of it as a source of information, requires training for the blind and visually impaired. This training should be carried out starting from very young ages, and the best way is gaining experience through play.

7. TRAINING ENVIRONMENTAL INFORMATION GATHERING THROUGH PLAY

This chapter discusses the importance of play for blind and visually impaired children in stimulating the senses, gaining independent mobility, and interpreting environmental characteristics. Following the discussion, an experiment assessing the effects of an educative toy designed by the author, on learning to focus on the tactile qualities of an environment, is presented.

7.1. The Importance of Play and Toys for Rehabilitation

Playing is a means for children to discover, understand, imitate, thus learn the world (Zoels, 1996). Play can be used to compensate disabilities and to motivate handicapped children. It will help them break through their isolation and passivity, focus and concentrate, establish their body-awareness and thus prevent their repetitive movements and aggressive behavior (Teunissenvanmanen, 1996).

Play, for all handicapped children should be a source of stimulation. It should help the children to establish a dialogue between the surrounding realities. It should help them understand their capabilities, what the environment can offer them, and encourage the children for further experiences.

Through play, the children develop further skills that will help them to cope with the future life. The importance of games for social interaction, development of motor and intellectual skills and as a source of stimulation for a sensorily deprived, and in particular blind child, has been stressed before, in Chapter 4, section 4.1.

Blind and visually impaired children are very much willing to communicate and enjoy showing off their skills they have developed to compensate their lack of vision. Play also helps them develop notions of scale, depth, width, dimensions, space and time, and establish their body-image. Through play, they learn the physical qualities of an environment, and psychological aspects of social life. Play can be for them, the rehearsal of understanding and using communication systems provided by the environment.

Today, everything is produced to the pleasure of the eye. Objects and amongst them toys, lose their creativity (Zoels, 1996). Parents, educators and designers should not forget the other senses; toys should stimulate all senses and should be suitable to the cognitive, perceptual and movement capacities and interests of the visually impaired child. This can be provided through interesting, attractive play materials which produce direct reaction with their physical qualities. This can be auditory or tactile feedback, responding in movement, or producing visual effects when manipulated (Rottmann and Punge, 1996).

Parents and educators must be guided in selecting toys for their disabled child's development. Educative toys used for rehabilitation of handicapped children do not have to be expensive toys specially designed for them (Zoels, 1996). It would also be wrong to believe that toys for normal children and for handicapped children should be separate. Toys should be for all children to share.

Any object or material that excites the child can be a play material. Toys should give way to imagination. They should not confuse and stress while trying to train. Rather, they should help children to concentrate on an activity and make the leisure time enjoyable and meaningful (Hildebrand-Nielshon, 1996).

Educative or rehabilitative toys can be made at home, by parents or teachers. For this, any kind of spare material (empty boxes, old cloths, sponge, bells, shoe laces, ropes, beans, spices of different smells,...) could be used. Such materials can be easily replaced and the playthings repaired, when they are damaged.

The play materials for the experiment were prepared with these considerations, and the play things were made at home. Care was taken not to use any material which can be harmful to the child.

7.2. The Sixteen Cubes Puzzle Game as a Source of Stimulation and the Hypothesis

The game designed and made for the experiment, involves play materials addressing to the child's auditory and tactile attention mechanisms. Bright colours are used also, to provide visual stimulation for visually impaired children who can slightly see. Another consideration was to make the child be in movement throughout the game, and use his/her body all round.

With the continuous interaction of the child and observer, the child is alert to the observer's voice which can come from any side. This is in order to localize the observer and the following cube to be given. The cubes are covered with materials of different tactile quality, with the aim of encouraging the child to concentrate on the tactile aspects of the environment.

The holes for the cubes to be thrown through are kept slightly wider than the face of the cubes so that the child uses his manual skills to place the cubes correctly through the square holes.

The hypothesis can be stated as follows:

> The tactile sense of blind and visually impaired children can be trained through play.

The puzzle game was prepared with the question in mind, how visually impaired and blind children use their tactile, kinesthetic and auditory senses, whether these senses can be trained with educative toys, and how concentration and focusing can contribute in the process of learning. The observer also believes that, being totally congenitally blind may be a reason for the child to be more concentrating and attentive; and also that, games that the children find fun will be more contributive in their education.

7.3. Description of the Game and Task

The Sixteen Cubes Puzzle Game for Children with Visual Impairment which is designed by the author, is a game composed of 16 cubes (Figure 1), and 4 stands into which these cubes are distributed (Figure 2). The stands are constructed of cardboard and are at a height of 70 cm., which is an appropriate height for children as young as 7-8 years of age (Pheasant, 1986). The stands are placed in front, behind and at each sides of the child. The color of the stands is white, to provide a light background. The stand surface is 40x26 cm. The surface is surrounded by a protective border to prevent objects placed on the stand from falling through accidental gestures.

Figure 1. The Sixteen Cubes

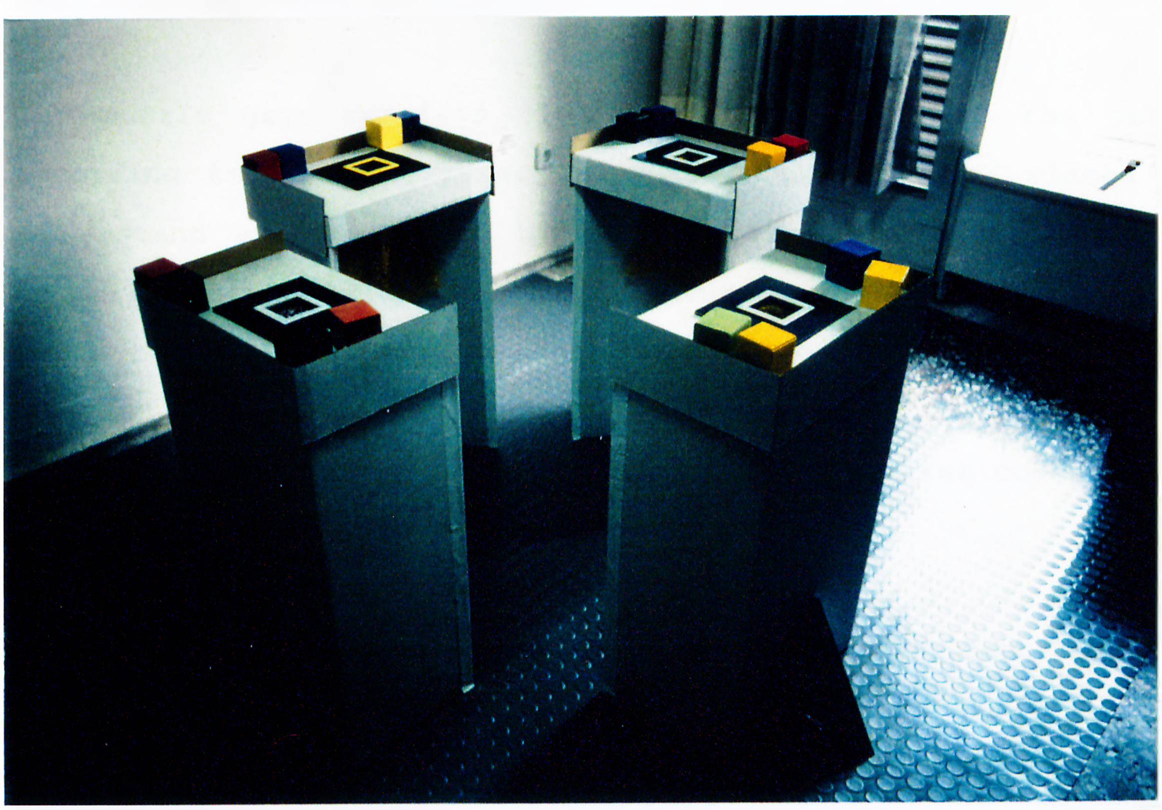

Figure 2. The Positioning of the Stands

The cubes of 5 cm. at each side are also made of cardboard but are covered with four different materials, which serve as cues for the children to group them into 4, with 4 cubes in each group. The texture providing materials used to cover the cubes are felt, corrugated cardboard, dense sponge and self-adhesive plastic sheets.

The cubes are filled with different materials that make noise when shaken, to provide some fun. The sound-making materials used in the cubes are; tea in the yellow cubes, rice and lentils in the red cubes, nails and nuts in the green cubes, and one bell in each blue cube. The cubes are of four bright colors, red, yellow, green and blue, as a source of visual stimulation for children who can slightly see.

Through the holes of 6x6 cm. on the surface of the stands, the cubes when thrown, fall into bags of meshwork from where they can be recollected.

The puzzle game consists of the task of grouping the cubes according to their texture. The four texture plates placed on each stand are keys that indicate to the child which texture group the stand belongs to. The texture plates are black, with white material framing the hole to provide contrast. Each cube is given to the child one by one, and the child is expected to orient himself to the side the sound of the observer comes from, to take the cube from the observer.

The puzzle game was tested with 30 children. Each child's performance in orienting himself to the sound to the observer, in grouping the cubes correctly and the time in which the game is completed, are registered. To measure the effect of the toy on learning, the experiment is repeated one week later.

7.4. Conduct of the Study

In this section, the composition of the participants, and how the experiment is conducted, are described. The results of the experiment are presented, and the conclusion is drawn.

7.4.1. The School of the Participants

In Turkey, a kindergarten for young blind children does not exist. The children who have participated in the experiment are chosen from among the primary school students of Göreneller (Seeing Hands) Primary School in Aydınlıkevler, Ankara. This school includes one of the two primary schools and three secondary schools in Ankara for the blind.

The school which was established in 1974, is supported by the Ministry of Education and also has its own foundation which accepts financial aid from the public. It is a boarding school and has 138 students, 19 of whom reside in town with their families.

Among the given basic courses, children have lessons for independent mobility, music, arts and crafts, modeling, and typing, and learn self-care skills. As there is no high school for the blind, the graduate students continue their education in ordinary high schools.

7.4.2. The Composition of the Participants

The test was conducted after the courses ended, so some of the students had left school. 30 students were chosen randomly among the students of ages 7 to 11 years. Among the 30 students, 16 are male, and 14 are female. The grade range is from 1 to 5. The year of training the children have had in this school is 1 to 5 years. The youngest child who participated is 7 years old, the oldest is 11 years old. The ages of 7 to 11 years is the period of Final Childhood and is considered as the Concrete Operational Stage where the child begins logical thinking and establishes his/her notions of time, space, amount, dimensions, equalities, etc. (Yavuzer, 1984). Although a child aged 11 is much more accomplished intellectually and emotionally compared to a child aged 7, this age range is considered acceptable for the conducted test.

A pre-test and a post-test is applied, with one week of interval.

The children are listed according to the order they were taken in. Their date of birth and grade are stated and their classification of visual impairment is noted. The classification of visual impairment is as follows: b1 for totally blind children; b2 for those who perceive light and can see up to a distance of 2 m. but for whom perceiving details such as grain and color is impossible; and b3 for visually impaired students who can see up to a distance of 6 m. and are able to follow moving objects and people with their eyes. The list of the participants are given in Table 1.

Table 1. List of the Participants

child	sex	age	grade	year	degree of blindness	s1	s2	t1 (min)	t2 (min)
1	m	10	2	3	b3	12	11	10	5
2	m	9	1	1	b3	16	15	7	3
3	m	10	2	2	b2	16	16	4	1
4	f	10	1	1	b2	14	16	5	2
5	f	8	1	1	b3	14	16	6	3.5
6	f	7	1	1	b1	14	16	6	3
7	m	11	1	1	b1	14	16	5	3
8	m	10	1	1	b3	11	16	13	2
9	m	8	1	1	b3	15	16	3	1.5
10	m	8	1	1	b3	15	16	4	2
11	f	9	2	3	b1	16	16	7	2
12	f	9	2	2	b1	16	16	2	1
13	m	10	2	2	b3	10	16	6	2.5
14	m	11	4	4	b3	11	15	4	2
15	f	10	2	2	b3	16	16	7	2
16	m	9	2	2	b1	15	16	4	2.5
17	m	11	2	3	b3	16	16	3	2.5
18	f	10	2	2	b3	14	16	4	2
19	f	10	3	3	b1	16	16	3	1.5
20	f	11	3	3	b1	16	16	3.5	2
21	m	10	3	3	b1	12	16	4	2
22	f	10	3	3	b1	16	16	2	1
23	f	10	3	3	b1	16	16	3	2
24	f	10	3	3	b1	16	16	2	1.5
25	m	11	4	4	b1	16	16	2.5	1.5
26	f	11	5	5	b1	15	16	2.5	2
27	m	11	4	4	b1	16	16	1.5	0.5
28	m	11	4	4	b1	15	16	3	1.5
29	m	11	4	3	b1	14	16	2	2
30	f	10	3	3	b3	15	16	3	1.5
						average **14.6**	average **15.76**	average **4.4**	average **2.05**

m: male
f: female
b1: totally blind
b2: light perception and vision up to a distance of 2 m.
b3: motion perception and vision up to a distance of 6 m.
s1: pre-test score
s2: post-test score
t1: pre-test duration
t2: post-test duration

7.4.3. Description of the Experiment

Each child was taken into the game area, which was a classroom, one by one. To start with, the participant was informed that this game was not testing their abilities, but that with their help, the performance of this game was being tested.

The child was positioned in the center of the stands, and was told that, placed on each side, front, back and two sides, there was a cardboard stand. He/she was informed that he/she did not have to take any steps towards the stands, and that to touch them, turning on the same spot and extending arms would be enough.

Then, with both hands, the child was asked to tactually explore the texture on each stand surface, one by one (Figure 3). The observer talked to the child during this, explaining the square holes on each surface. After being introduced one by one, some children continued tactile exploration, two texture pads at the same time (Figure 4), to understand their position in relation to each other. Some were at the same time speaking of their impressions of the textures, like 'this is cool and smooth' for the plastic pad, and 'this is soft and warm' for the sponge pad.

After being familiarized with the stands, the child was explained that he/she would be given 16 cubes one by one (Figure 5), and that he/she was expected to find the stand the cubes belonged to, according to their texture (Figure 6), touching each pad to match the cube. They were not told that there would be four groups of different textures with four cubes in each group.

Figure 3. The Participant Tactually Explores the Surfaces

Figure 4. The Participant Explores Two Texture Pads at the Same Time

Figure 5. The participant is given the cubes one by one

Figure 6. The participant finds the correct stand

The beginning time was registered as the first cube was presented. The first cube was the blue felt, and was given as the child was facing the felt stand. Most children recognized the similarity immediately, although a few had to think, especially comparing the felt and sponge texture pads.

The second cube was the green plastic cube, also given to the child as he was facing the felt stand. A problem encountered was that, some of the younger children attempted to throw it through the felt hole, because they were not yet familiar with the game, and because they thought they had to throw the cube they were given through the hole of the stand where the observer was standing. In that case, the task was marked 'incorrect', and the child was warned 'You are not checking the other texture pads on the other sides, that was incorrect'.

Some of the children expected assurance of the stand they matched; they were then told to have confidence in themselves, also that they were doing fine, and were asked not to wait for confirmation.

The following cubes were given to the child from different sides, so that the child had to orient him/herself to the side the voice of the observer came from. The child was asked to face the observer with positioning the feet and body correctly each time, and not just to extend an arm facing another side. Here, it should be noted that, totally blind children participating in the game were generally just extending their arms at first, but it should be reminded that turning totally to face a task makes it easier to use the body and to complete the task.

The order of the cubes and the sides they were given is noted on a schema, which is also used as an observation sheet. The observation sheet can be seen in the appendix section. The order was the same for all participants.

The final cube was given to the child by indicating that it was the last one. As the task was completed, the child was thanked for his/her participation, one of the stands were moved aside for him/her to step out of the area.

A total of 37 children participated in the pre-test; 3 were 12 years of age and were too old for the game, 1 had a sight near normal; 1 was comparatively retarded and could not complete the game. The other 2 children were sick and could not participate the post-test as they were sent home.

In the post-test, the location of the stands and the order the cubes were given were the same. The children were taken in the same order, one by one.

As a beginning, each child was reminded of the textures on the stands, touching them with both hands. One child refused to do this, having confidence in his memory, but as the cubes were presented, he had to go through the stands once again. As they were familiar with the game, they were asked to complete the task as quickly as possible, but all the same, being sure they were doing correctly.

This time there was no misunderstanding about the holes the cubes had to be thrown through. Most of the children made less mistakes. Two children made one more mistake each. All the children completed the game in a shorter time.

As the game was completed, the child was taken out again, thanked for the great help and time he/she had given, and was offered chocolates and sweets. They were asked whether they enjoyed the game or were bored. The girls in particular, seemed to have enjoyed the game. Most of the boys and girls helped the observer to collect the cubes from the meshwork bags and to reposition the stands for the next participant. They seemed to enjoy the sounds the cubes made. The most popular cube was the blue corrugated cube with the bell noise.

7.4.4. Evaluation of the Results

In the pre-test, the lowest score was obtained by one child which was 10 out of 16; in the post-test this child scored 16 out of 16. In the post-test, the lowest score was 11, obtained by a child who had scored 12 in his first trial.

In the pre-test, the slowest child took 13 minutes to complete the game, in the post-test that child completed the game in 2 minutes. In the post-test, the slowest child took 5 minutes to complete the game, that child had taken 10 minutes to complete in his pre-test.

The average score for the pre-test is 14.6, and the average time to complete the game is 4.4 minutes. The average score for the post-test is 15.76, and the average time is 2.05 minutes.

To interpret, the results of the children are listed once again according to the variables sex, age, degree of blindness, grade, and year in school, which can be seen in Table 2. For each group of variable, the number of students who performed above and under the average scores and times are listed.

Table 2. List of the Results

			s1		s2		t1 (min)		t2 (min)	
		total	below 14.6	above 14.6	below 15.76	above 15.76	below 4.4	above 4.4	below 2.05	above 2.05
vision	b1	16	4	12	0	16	13	3	13	3
	b2	2	1	1	0	2	1	1	2	0
	b3	12	6	6	3	9	6	6	7	5
sex	m	16	7	9	3	13	11	5	10	6
	f	14	4	10	0	14	9	5	12	2
age	g1: 7-8	4	2	2	0	4	2	2	2	2
	g2: 9-10	17	6	11	2	15	10	7	13	4
	g3: 11	9	2	7	1	8	8	1	7	2
grade	g1: 1-2	17	8	9	2	15	7	10	9	8
	g2: 3	7	1	6	0	7	7	0	7	0
	g3: 4-5	6	1	5	1	5	6	0	6	0
year in school	g1: 1-2	14	7	7	1	13	6	8	8	6
	g2: 3	11	3	8	1	10	9	2	9	2
	g3: 4-5	5	1	4	1	4	5	0	5	0

s1: pre-test score
s2: post-test score
t1: pre-test duration
t2: post-test duration
b1: totally blind
b2: light perception and vision up to a distance of 2 m.
b3: motion perception and vision up to a distance of 6 m.
m: male
f: female
g1: group 1
g2: group 2
g3: group 3

Although the sample size is too small and the number of subjects in each variable group is not enough to draw any conclusions which can be applied to the population of visually impaired children as a whole, the observer believes that some comments can be made on the learning performances of these children.

The Chi-Square test was conducted to find out if the pre-score (s1), post-score (s2) and the duration of the pre-test (t1) and the post-test (t2) each is independent of the stated variables; namely, degree of blindness, sex, age, grade and years in school. It is found that the post-test score is not independent of the degree of blindness (X^2_2= 5.00, α=0.10) and also, of sex (X^2_1= 2.92, α=0.10). When the durations were tested, it is found that pre and post-test durations are both not independent of the grade, respectively (X^2_2= 11.47, α= 0.05, X^2_2= 8.34, α= 0.05). In addition, the pre-test duration is not independent of the years in school (X^2_2= 7.21, α= 0.05).

1. Degree of Blindness

Among the b1 group, 16 out of 16 children (100.00 %), among the b2 group 2 out of 2 (100.00 %), and among the b3 group, 9 out of 12 (75.00 %) children performed above average score 2. Thirteen out of 16 children of the b1 group (81.25 %), 1 out of 2 among the b2 group (50.00 %), and 6 out of 12 among the b3 group (50.00 %) completed the task in a time below the average time 2.

From these, it can be stated that the totally blind children and severely visually impaired children were better comparing to group b3, in their performance, probably due to their better concentration and focusing only on the tactile and auditory cues of the play material. As these children have learnt to focus and use more their sense modalities apart from vision, they are more sensitive to tactile and auditory cues.

2. Sex

It can be seen from the results that, in the post-test, 13 out of 16 boys (81.25 %) and 14 out of 14 girls (100.00 %) have scored above average score 2. In the post-test, 10 out of 16 boys (62.50 %) and 12 out of 14 girls (85.00 %) have completed the task in a time below average time 2.

Although the close results are suggesting that sex does not play an important role in the learning performance of the children, it must be stressed that girls have obtained higher scores in less time in this game. This suggests that the toy had aspects that attracted the girls in particular. This can be explained with the cultural values the children are raised in.

3. Age

In the post-test, 4 out of 4 children of age group 1 (100.00 %), 15 out of 17 children from age group 2 (88.23 %), and 8 out of 9 children from age group 3 (88.88 %) have performed above average score 2. Two out of 4 children in age group 1 (50.00 %), 13 out of 17 in age group 2 (76.47 %), and 7 out of 9 in age group 3 (77.77 %) have performed under the average time 2.

Although the obtained results suggest that the younger children were slower in completing the task and better in their scores, the Chi-Square test shows that s1, s2, t1 and t2 are independent of age. Yet, it can be seen that the younger children were more attracted and more engaged in the game, due to its motivational factor.

4. Grade

From the grade group 1, 15 out of 17 (88.23 %), from the grade group 2, 7 out of 7 (100.00 %) and from the grade group 3, 5 out of 6 (83.33 %) children performed above the average score 2. From the high scores which are close to each other in each group, it can be seen that the grade the children are in, does not play any role in their performance of tactual discrimination and orientation to sound.

The Chi-Square test also states that s1 and s2 are independent of grade. Yet, t1 and t2 are not independent of the grade the children are in. The higher the grade of the children, the faster they completed the games in the pre and post tests.

5. Year of Training in School

Thirteen out of 14 children (92.85 %) in the year group 1, 10 out of 11 children (90.90 %) in the year group 2, and 4 out of 5 children (80 %) in the year group 3, have performed above average score 2. The close results suggest that the year of training has had no effects on the performance of the children. The Chi-Square test also states that s1 and s2 are independent of the year of training.

As for the time it took to complete the task, 8 out of 14 children from year group 1 (% 57.14), 9 out of 11 children from year group 2 (% 81.81), and 5 out of 5 from the year group 3 (% 100.00) have completed the task in less than the average time 2. Although these results of t2 can suggest that the children who have received longer training in schools completed the task faster, the Chi-Square test states that t1 is not independent of year in school but t2 is independent of year in school. This is not difficult to understand; as the children were at first not familiar with the game, the year of training had its effects on their performance. But as they were familiar with the game in the post-test, the year of training had no longer its effects.

7.4.5. Conclusion of the Case Study

From the obtained data, it can be stated that the degree of blindness, sex difference, grade, and year of education and training had their effects on the performance the children who took part in the game. The older children who have received longer education obtained higher scores in less time. The totally blind or severely visually impaired children also obtained higher scores. This shows that these children were faster and more accurate in tactile discrimination, orienting to sound and placing the cubes correctly due to their skills of manipulation.

A final statement may be to point out that, the scores in the post-test were higher than the pre-test, and the times to complete the task were much shorter. Then, this puzzle game and such toys addressing at different senses at the same time, can be useful in educative programs and can be used in rehabilitation for stimulation as they contribute in the learning process of the blind child. This also points out that the tactile sense of the blind and visually impaired children can be developed through play, as it was stated in the hypothesis. A suggestion will be to develop such educative toys and give more importance to play (apart from physical education lessons) in schools for handicapped children.

The observer also believes that the role of memory and spatial orientation is important in the obtained results. It has been observed that the children were very good in locating from mind the position of the stand the given cube belonged to, regardless of the side the cube was given to them.

Further research can be made on memory and orientation performances of the blind and visually impaired children; to investigate how these performances can be improved through play; and how children may use thus acquired skills, to locate themselves correctly in space.

8. CONCLUSION

Throughout the thesis, various topics have been discussed to better understand how the blind and visually impaired persons cope with their spatial surrounding and how this process can be improved or made easier. After a short discussion on space, and the human body in space, the human body without vision and the sense modalities that come forward in the absence of vision were briefly examined. The acquired information most of the time was very surprising and impressive. It helped to better understand many aspects of being blind and visually impaired, and provoked a feeling of admiration of the human body with all its complex mechanisms.

This study reminded once again of the other sense modalities, the importance of which is often neglected by people with sight. The blind and visually impaired persons are better able to use their remaining sense modalities; as they train themselves to compensate their lack of vision, they learn to improve their tactual, haptic and auditory sense modalities in particular.

As discussed, the blind and visually impaired persons can understand spatial relationships just as well as sighted persons. Although they cannot obtain cues such as distance, depth and perspective, as it is pointed out in the thesis, they are able to imagine spatial layouts and the relations of objects placed in a space, with the representation systems that they develop. This has to be provided by the information that the built environment offers them with its physical properties.

The environment is continuously stimulating the senses of the human body; the body selects certain stimuli and processes them into information that it uses to motivate itself to perform an activity. This study stresses the importance of stimulation and free exploration for the blind and visually impaired toward gaining spatial awareness. The thesis also evaluates how the built environment communicates, how the human body interacts with it, and under which conditions this communication would be improved, and made more understandable and easier to obtain.

The results of the evaluation point out that, a clear, understandable spatial layout, and standardized design considerations which become universal, such as similar arrangements of signage and informational architectural elements to be found everywhere in consistence, play important roles in helping to understand the layout and spatial properties of an arctitectural environment. Besides, prevention of obstacles, warning or elimination of changes of level and projecting elements, extra guiding rails and tactual cues placed for the blind and visually impaired are also of great value toward developing environmental awareness, and cautioning for safe conduct in even unfamiliar environments. In certain conditions, the body will be in need of assistive devices to interact with the built environment, such as a cane or electronic travel aids, to be an intermediary medium.

All these facts stress the importance of one thing; that is establishing a body image for the blind and visually impaired to negotiate with the space. An important means to prevent the delayed postural development often encountered in congenitally blind persons, to establish body-awareness and spatial awareness, to break through social isolation, and to learn to extract maximum use of the surrounding environment is, training; and in the thesis, it is pointed out that training can be at a very early age, through play.

Play excites all children, it demands their contribution, interaction and concentration, and trains through fun. It is the best way to motivate and activate children, whether impaired, or not. Play, in particular for blind and visually impaired children, encourages to explore, and thus gather information on their surrounding.

Play with educative and rehabilitative motives is a means for the child to rehearse future encounters with the physical and social environment, and introduces to the physical properties of the surrounding space, develops spatial awareness and also body awareness by challenging, thus improving the sense modalities, motor skills, and cognitive skills.

To conclude, in this thesis, learning the environment through play has been proposed for the visually impaired children for all the reasons cited above. The results of the conducted experiment support this proposition. Suggestions for further study have been proposed as the development of further play methods and equipment that stimulate the body in all senses and that contribute in establishing body and spatial awareness.

The thesis, thus, has stressed two points: that any environment has to be designed with aids of conveyance of its spatial structure to the blind and visually impaired; and that training of the blind and visually impaired children through play will help them in coping with the spatial environments they will encounter which hopefully will posses those means of conveyance. Then, the design and planning of spatial layouts and architectural features that provide a clear understanding of spaces for the blind and visually impaired population, and their responses to different physical qualities of a built environment as sources of information, require further study for future development; the means of providing accessibility of such sources of information to all user groups, and the application of suitable standards in all environments throughout the world, should be searched for.

It is essential that all people should be able to live in a comfortable environment, suitable for people of all bodily conditions. Although it sounds difficult to achieve, this ideal can be reached through patience, care and consideration on the part of those training the handicapped, and on the part of those responsible for the making of the environment. The designers of an environment have to understand the physical capabilities and incapabilities, experiences and feelings of the 'others'. The author hopes that, this thesis has been of interest to and will contribute in developing an understanding of the 'others'' point of view, for designers with vision.

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APPENDIX

TEXTURE RECOGNIZING PERFORMANCE SHEET

Name:

Year of Birth:

Sex:

	week1 felt 1	corr 2	plas 3	spon 4	week2 felt 1	corr 2	plas 3	spon 4
blue **felt**								
green **plastic**								
yellow **sponge**								
blue **plastic**								
green **sponge**								
blue **corrugated**								
green **felt**								
red **plastic**								
yellow **corrugated**								
red **sponge**								
yellow **felt**								
red **felt**								
yellow **plastic**								
green **corrugated**								
red **corrugated**								
blue **sponge**								

total time: total time:

ORIENTING TO SOUND PERFORMANCE SHEET

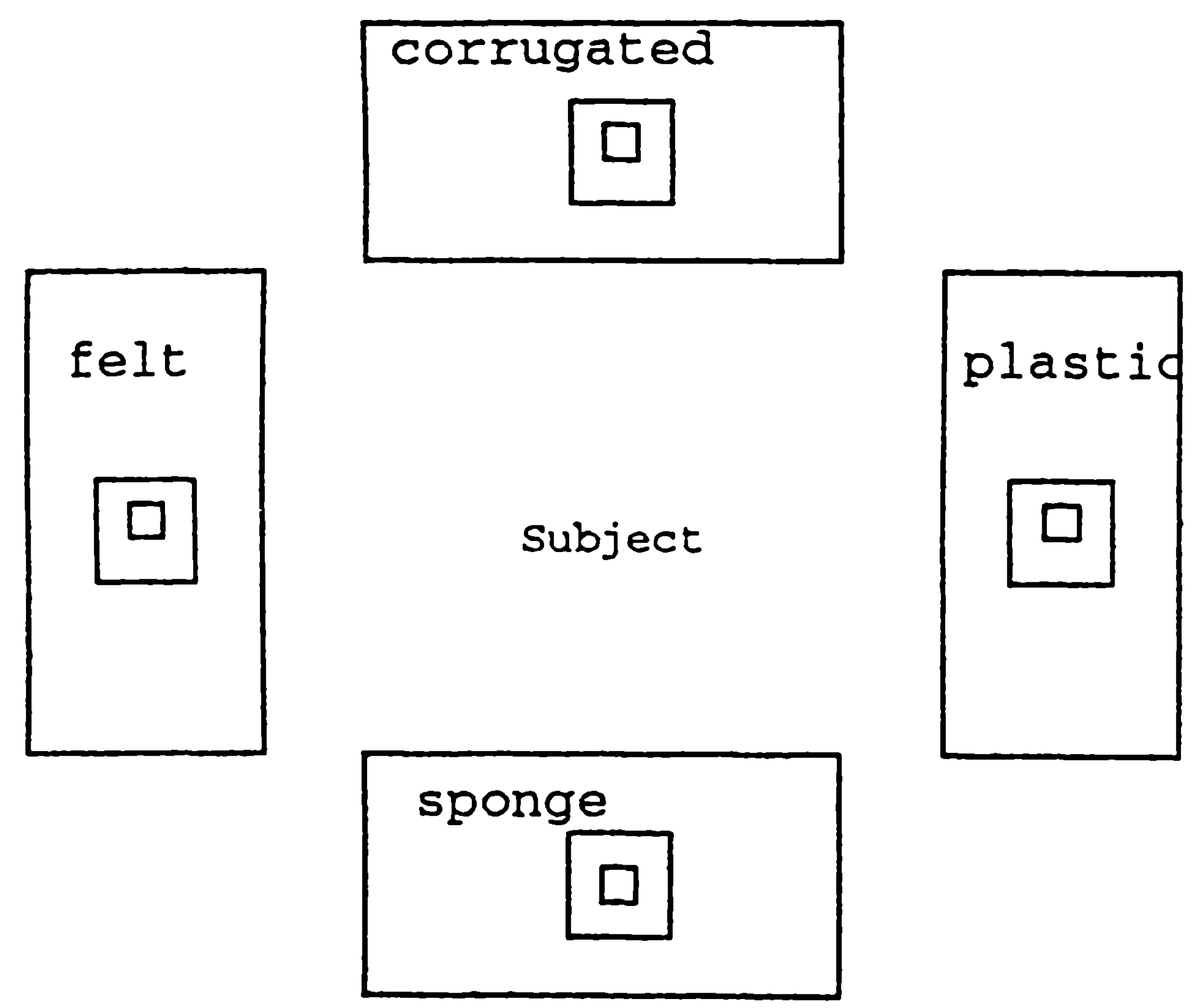
Name:

Year of Birth:

Sex:

	W1	W2	
5			green sponge
9			yellow corrugated
13			yellow plastic
16			blue sponge

		W1	W2
green felt	7		
red plastic	8		
red sponge	10		
green corrugated	14		



	W1	W2	
1			blue felt
2			green plastic
11			yellow felt
12			red felt

	W1	W2	
3			yellow sponge
4			blue plastic
6			blue corrugated
15			red corrugated