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Haptics and vision in architecture: designing for more senses

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Abstract:

Architecture is experienced in a multisensory way. Moreover, human capacities to perceive architecture are highly diverse. Unfortunately the emphasis in designing and creating architecture lies in large measure on the visual representation. Other senses are hardly represented or even considered during the design process. Because of this, the resulting building does not always comply with the human needs. This paper reports on a research project that calls in the experience of people who are blind to restore the multisensory qualities in the built environment. These users/experts are more attentive to other senses. Their spatial experience relies mostly on the haptic sense, which appears to be the foundation for cognitive spatial representation. In this paper we point out the differences and similarities between visual and haptic perception related to architecture. This should allow to identify design parameters which create the opportunity for architects to take the haptic sense into account during the design process. In this way the paper hopes to point out the potential contribution of Design for All for improving the multisensory quality of the built environment.

1 Introduction

Although the built environment is experienced in a multisensory way, architecture evokes for most people visual associations.

These associations are stimulated by the visually marked Western society (Classen 1998; Bowring 2007) and the fact that architects, like other designers, tend to practise design mainly in a visual way (Cross 1982). Campbell (2007) wonders whether architecture results in a visual sport. Our cultural history gave rise to this visual predilection. The ancient Greeks already adored the eye as the primary sense and this adoration led to what is called the field of optics, studying light and vision and used by the Romans too. In the Renaissance, this visual adoration revived and new insights contributed to the scientific rise of perspective. This development was very far-reaching for visual dominance as it stimulated working in a new virtual visual world (Herssens 2004); moreover, at that time, the arts favoured painting.

Western culture is dominated by ocularcentrism, the hegemony of the eye. The appearance of museums and zoos further elevated sight to the position of the pre-eminent sense (Bowring 2007). This visual dominance lives on to the twentieth century and peaks during Modernism (Frampton 2001). Visual dominance is striking and it disguises the importance of the other senses.

In view of this, our research aims to question the visual dominance in architecture, and, to find ways to restore the multisensory qualities in the built environment. After all we should not adapt ourselves to the environment; the environment should be adapted to us. This view fits in with the principles of Design for All (DfA)—also called Inclusive Design or Universal Design—a recent design paradigm aiming at handicap elimination in the environment so as to establish a more inclusive environment for everybody. Ultimately, our research hopes to contribute to the realization of this design paradigm.

Increasingly disability is viewed no longer as a (physical or mental) characteristic of the individual, but as resulting from the interaction between individual and unadapted (social or physical) environment (Devlieger et al. 2003). By consequence, designers, producers and constructors are responsible for handicap elimination in the built environment (Froyen 2002). To realize DfA we use insights from Design for Special Needs (DfSN), which focuses on adaptations for people with certain impairments.

Our research relies on the abilities of people who are congenitally blind because they are more attentive to other senses than sight (Warren 1978, Hollins 1989, Heller & Kennedy 1990, Froyen 2002). The age of five is critical with respect to loss of sight: "*If people keep their vision up to this age, they seem to retain some sort of visual memory (...)*" (Fjeldsenden 2000). Because spatial representation of people with visual impairments is so diverse, we work with one specific group: users/experts who are congenitally blind and have no residual vision, because they cannot rely on a visual reference system (Warren 1974). Moreover we focus on the haptic sense in the exploration of space. Although the insights are based on the expertise of people who are congenitally blind, some turn out to be relevant for all of us.

2 Objective and approach

In questioning architecture's visual dominance, this paper compares the visual perception of architecture to the haptic, the focus of our research. Just as vision is the psychological science of the optic input, haptics is the science of what is tangible (Kennedy & Juricevic 2003). The term "haptic" refers to touchable experiences and derives from the Greek word "hapthai", to lay hold of . When comparing the haptic and visual sense, caution is necessary in order to avoid generalising sensory perception (Heller 2003).

For this comparison, insights from literature are complemented with in-depth interviews with people who are congenitally blind. Interviews with 10 people with congenital blindness have been conducted and analysed (8 male and 2 female with an average age of 44 years). Each interview took place at the participant's home and started by an open discussion on living patterns based, recorded on a dictaphone. We asked the participant to give a guided tour throughout the residence, while filming their movements and asking to demonstrate how they orient themselves in the dwelling.

Spontaneously they started talking about (mis)fits in their environment. Afterwards we transcribed the interview and made a plan of the residence with annotations of (mis)fits and guiding lines. For each participant we filled in a filing card with the coordinates, personal data and medical information. This paper verifies findings from literature concerning the similarities and differences between visual and haptic perception of architecture with examples from the interviews.

After briefly discussing the importance of haptics in architecture, we zoom in on the haptic perception process through Révész's classification of principles (Section 3). We close by defining haptic design parameters as tools to obtain more haptic qualities in architecture (Section 4).

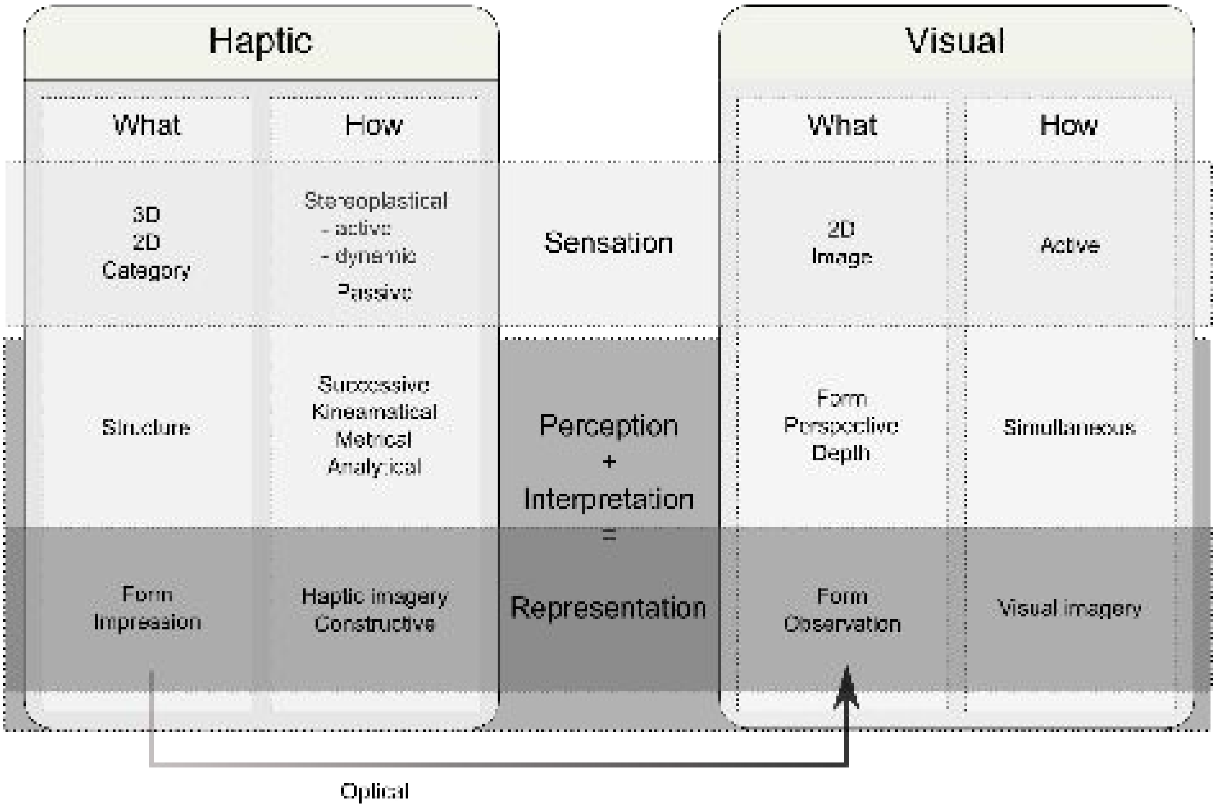
3 Feeling what architects see

3.1 Haptic experiences in architecture

Imagine your environment without ever having felt the texture of wood, the temperature of steel, the sharpness of a corner, the verticality of a wall, or without ever having moved on a ramp. Space is determined by haptic sensations, as subscribed by architect and critic Juhani Pallasmaa (2005): *"The mental experience of the city is more a haptic constellation than a sequence of visual images; impressions of sight are embedded in the continuum of the more unconscious haptic experience. Even as the eye touches and the gaze strokes distant outlines and contours, our vision feels the hardness, texture, weight and temperature of surfaces. Without the collaboration of touch the eye would be unable to decipher space and depth, and we could not mold the mosaic of sensory impressions into a coherent continuum. The sense of continuity unites isolated sensory fragments in the temporal continuity of the sense of the Self."*

This process from sensation to representation is a human way of perceiving and similar for vision and haptics. Nevertheless, in the perception process, the type of and way of gathering information differs between both.

In relation to the environment, the term "haptic" was first introduced by Révész (1950) and further investigated by Piaget and Inhelder (1956). Révész investigated the spatial perception of people who are blind and considered spatial experiences as the central problem of the psychology of the blind (Révész 1955). He defined the –in his view– key principles for haptic perception: the stereoplastical, the successive, kinematical, metrical, constructive, analytical and optical principle (Révész 1938). Using his principles as guiding line, we compare the different phases of spatial exploration in vision and haptics.



3.2 The sensation phase

What: characteristics of the stimuli?

During the sensation phase, the information on buildings and spaces received through our senses differs. Whereas visual sensation only relies on two-dimensional information, c.q. an image, haptic stimuli are three-dimensional in the first place, but can be felt as two- or three-dimensional dependent on the scale of the environment. For example, one interviewee refers to his piano as most important 3D reference point in the house. When moving through the house, he orients himself by referring to the piano, suggesting that in haptics furniture is as important as the building itself. Révész (1955) calls this the active-passive way of sensation or the stereoplastical principle; it is one of the most fundamental principles of haptics, because we live with an instinct to touch in our three-dimensional world.

Indeed the haptic system is a direct sense: haptic perception occurs in real time and real place. In both haptic and visual perception, the stimuli rely on material (texture, temperature, density) and space characteristics (form, place, orientation, length) (Hatwell 2003). Yet, the haptic system relies far more on material properties, and the nature of the features in both senses is different (Klatzky and Lederman 2003). What we look for architecturally is similar in both senses, but the emphasis on the stimuli and the stimuli themselves differ, which makes the representation different. Thus the way of extracting information in both is different too.

How: the process of sensation

Dependent on the field of study or scientific interpretation, haptics involve different ways of sensation. We can sensate the haptic actively (active touching), passively (tactile touch or being touched without any preceding action) or dynamically (touch by means of a tool). Some scientists define haptic touch as active and tactile touch as passive touch. Others make no difference and use tactile, touch and haptic as synonyms. Related to architecture we interpret haptics as an active and passive as well as dynamic way of perceiving. For example, we actively walk into our office and passively feel the warmth of the sun shining on our skin. Dynamically we feel the weight of the door through the door handle. This differs from visual sensation, which requires active visual participation; in real time we can always actively choose whether we want to see or not.

3.3 Perception and interpretation lead to representation

What do we perceive/represent?

Haptics and vision both use information based on context and past experiences (Klatzky & Lederman 1995), but the former makes us perceive in a *structural* manner: we explore things in an *analytical* way. An interviewee explains: *"(..) but yeah moreover a house is also, in a pure structural way, very practical for me. Euhm, sometimes more practical than an apartment. Yes, because in fact certainly in a house, a workman's house of about 4.5 to 5 metres large, you've got a fairly structured interior. You've got a little place at the front side, a place in the middle and in the back a little place. There are no doors here for the moment, and that is absolutely not necessary, otherwise it would be a very closed feeling, those have been there once, but we didn't remove them, they were already removed…(…)"*

Haptically we perceive every part separately (Révész 1955). This is reverse to the visual process: we start by seeing a whole, but do not see the structure immediately. We can find structure by analysing the whole. Révész compares this process to sketching. If you start drawing you first receive an overview, but during the sketch process you gain insight into the structure. This confirms that, for haptic perception, structure and materials are the most important aspects. Material characteristics are first perceived, while in vision (Klatzky & Lederman 2003) space characteristics as form, depth and the basic principles of perspective are ruling. For example, the estimation of corners is more accurate in visual perception than in haptics (Appelle 1971).

The differences between the haptic and visual puzzle of perception result in a difference of representing space: visual perception leads to form observation, whereas haptic representation provides a form impression. The process works reversely.

Révész distinguishes between three kinds of haptic spatial impressions or haptic imagery: *haptic space,* concerning the spatial experiences of haptics; *haptic spatial form,* standing for the representation of forms related to touch; and *haptic spatial objects*, covering the recognisability of haptics thanks to the recognition of things and materials. Those three impressions all support the haptic experience of space.

In haptic representation, form is discussable as it can be unrelated to its meaning. This is due to the fact that, related to form, visual information dominates haptic information (*Révész*: *the optical principle*). Yet a slight difference exists between the form of movements and the purely haptic forms. Movement and the successive-kinematic experience of space is still very difficult to observe visually. Purely haptic spatial forms even exist only for people who are congenitally blind. Moreover, research shows that the process of form perception for haptics as well as vision refers to the same dimensions of differentiation (Pick & Pick 1966) and pays attention to the same complexities (Brumaghin & Brown 1969; Owen & Brown 1970). For example, scale, symmetry and complexity are aspects people rely on when using vision as well as haptics to identify objects (Garbin & Bernstein 1984; Garbin 1990). Haptic spatial objects even work as haptic triggers, which can provide recognizable information.

For people who are blind or visually impaired, haptic triggers are considered as rewarding recognition points. Haptics in space are positively experienced when space is not that large so that one is still surrounded by haptic triggers, but not too small as movement is sill required to perceive haptically.

Interviewee:
"euhm but the largest advantage for me is that it is all very small in here and in fact you can move yourself very easily from one tactile point in the house to the other. Like this you'll never be on a place where you won't know where you are in the house. (...) "

Researcher: *"Do you feel yourself at ease in this house?"*
Interviewee: *"mmm yes but there wouldn't be much more (furniture) in this interior... otherwise you got such a closed feeling"*

Texture appears to be the most important information to identify objects through touch (Klatzky & Lederman 2003). We should not underestimate the role of pattern recognition (Klatzky et al.1985, Klatzky & Lederman 2003) and the ability of texture recognition (Hatwell 2003) in haptics. You have certainly experienced the night quest for the lavatory. Most of the time this movement happens in a dark environment, but still you are able to find the door handle or light switch. One interviewee describes it very poetically: *"For me good architecture exists in its imperfections"*. He refers to the traditional made architecture in which you feel the authenticity of its production. For example, a little twist in a wooden armrest can provide a good orientation point. The whole of haptic impression related to architecture largely relates to the first aspect: haptic space. It is the more fundamental cognitive space of interpretation or basic space from which pictorial (cognitive interpretation of taste, smell, sound and visual senses) and transperceptual spaces (refering to wayfinding) are metaphorically derived (Mark 1993).

Foto 1: Twist in a metal armrest. Although from a visual point of view one may prefer a straight line, this armrest is haptically marked as a good armrest due to the twist as orientation point.

Foto 2: An at first sight normal interior is in fact a supporting haptic space. Due to the concrete chair and flower box, the furniture of the house became as important as the house itself. The interviewee and his partner kept these remnants of the barn and now use them as orientation points.

How do we perceive/represent?

Haptic stimuli are experienced in a successive way by use of kinematics, the *kinematical principle* according to Révész. Space is haptically explored through movement and by means of a step-by-step process, analogous to solving a large puzzle, in which structure is the key aspect. One interviewee refers to his daily walk to the postbox. He explains it verbally and repeats his action in real time and place to show that he walks very sequentially in search for his daily mail applying his haptic sense: he opens the front door, follows the wall of the house which guides him to the hedgerow. Following the line of the hedge, he suddenly feels a change in the tactile pattern of the path. A grid serving the drainage of the drive indicates the way to the postbox. To go back inside, he just walks the same path in a reverse way. Characteristics and differentiations are perceived through movement. Lederman and Klatzky (1987) identified exploratory procedures as windows through which the haptic system can be perceived. For example, if we eliminate vision while exploring space, we first start moving through space and experience the environment through the floor and walls which lead us to the windows. *"Information from movement output thus plays an important, and probably crucial, role in tactual recognition"* (Millar 1994). We measure space with the help of our own body (Révész 1955: *metrical principle*) and our body gives us information about spatial as well as material properties (Hatwell 2003). Vision, on the other hand, can be considered as remote perception providing spatial information *simultaneously*. Visually we perceive the architectural puzzle as an image and notice the structure afterwards. Form overrides structure. This aspect contributes to the consideration of vision as the primordial sense for perceiving space as less time is needed to explore space visually. While visually we start with a holistic (Streri 2003) form to be analysed into a structure, haptically we perceive in a *constructive-analytical* way (Révész 1955) an impression of the structure which evolves into a whole. Due to this different way of gathering information, some scientists conclude that haptic representation is less sensitive to the laws of Gestalt. (Hatwell et al.1990, Lakatos & Marks 1999). In haptic representation the whole is only perceived as a unity by accident.

An interviewee refers to the usefulness of passages instead of a void, which gives him the feeling he is lost. The walls give structure to the space and a feeling of safety and comfort. Another interviewee refers to the structure he made with the help of little carpets in his living room. Details and structure are important in haptic perception and, of course, there must be a haptic stimulus in the first place, otherwise there is no haptic perception. We should not forget that we once learned to give meaning to our environment thanks to the interaction between visual and haptic sense (Piaget & Inhelder, 1956). Burton (1993) subscribes the importance of haptic (he uses the term tactile) perception in the exploration of the environment and the fact that this sensory source is universal in the animal world.

4. Towards haptic design parameters

Strikingly, the architectural concepts for visual and haptic representation tend to rest on similar categorisations of mental maps. In his book "The image of the city", Kevin Lynch (1960) analysed the city and its representation. Focussing on visual perception he divided the visual mental map into five categories of networks: paths, nodes, landmarks, districts and edges. Judging from the interviews with people who are congenitally blind, these categories even exist in the haptic mental map. For example, they make use of haptic landmarks in their orientation process.

This is an interesting point for architecture: if we want to implement haptic aspects into the design process, we can make use of recognizable architectural concepts. This offers a clue for translating haptic experiences in a useful architectural language.

However, because of the distinct characteristics of the haptic sense, haptic landmarks, edges, paths, nodes, districts will likely differ from the visual categories. For example, a large tower can be an excellent visual landmark in the city, but when walking sightless around the tower, you cannot feel the difference with a 2 storeys high building. This is illustrated by a funny story about blind men who gave two completely opposite answers to the question "What is an elephant?" after touching one. The one who touched only the animal's leg replied "It is a tree", while the one who touched only the animal's body replied "It's a wall" (Kusajima 1970).

In summary, the interpretation of what a landmark, node, path, district or edge may differ from visual experience. Moreover, the hierarchy which exists in the categories is not similar to that in the haptic categories. This interpretation is what we call a haptic design parameter. It is a description of a haptic design structure and its resulting environment-behaviour, which can be useful to implement in a design process. This haptic structure consists of a description in material, space and scale. The environment-behaviour defines the movement, experience and time. For example, a haptic path can be a route through your house, marked by the texture of the materials and subscribed by the form it makes. The fact that this route has the shape of a wave makes you feel free. It gives the impression of relaxed time. By this means the information in these haptic parameters relates to architectural concepts defined through haptic behaviours.

Discussion

This paper attempted to draw up the similarities and differences in perceiving architecture between the haptic and visual sense. It becomes clear that differences are due to the characteristics of the stimuli and the way they are sensed, which lead to a different manner of representation. Notable is the fact that we mark the same mental patterns in the haptic spatial representation as in the visual mental maps, although they sometimes are supported by a different way of perceiving.

In the future we want to identify haptic design parameters which can be introduced in the design process to realise architecture with more haptic qualities, or to check these qualities in an architectural design. For this purpose we will make use of the patterns which correspond in haptic and visual mental maps.

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