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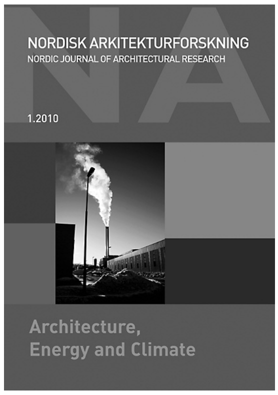

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NORDISK ARKITEKTURFORSKNING – NORDIC JOURNAL OF ARCHITECTURAL RESEARCH

Accessibility and sensory experiences: designing dwellings for the visually and hearing impaired

Camilla Ryhl

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Abstract:

This article introduces a new design concept; *sensory accessibility*. While acknowledging the importance of sensory design and experiences in architectural quality, as well as the importance of accommodating user needs in design, the concept combines three equally important factors; architecture, the senses and accessibility. Sensory accessibility accommodates aspects of a sensory disability and describes architectural design requirements needed to ensure access to sensory experiences and architectural quality of a given space.

In the context of architecture the word accessibility has become a design concept of its own. Accessibility is generally described as ensuring physical access to the built environment by accommodating physical disabilities. While the existing concept of accessibility ensures the physical access of everyone to a given space, sensory accessibility ensures the choice of everyone to stay and be able to participate and experience.

The research study described in this article was carried out at the Royal Danish Academy of Fine Arts, School of Architecture, the Housing Laboratory.

Keywords:

Sensory design, housing, visual impairment, hearing impairment, inclusive design, accessibility, universal design, acoustic quality

Background

The article presents the findings of a qualitative architectural research study on sensory impairments and accessibility. It is argued that a sensory impairment implies specific considerations related to the architecture of dwellings and that the concept of *sensory accessibility* is a decisive aspect of accessibility.

Contemporary architecture and architecture debate emphasise visual aspects of architecture, but although vision is the primary source of the conscious perception of sighted persons, every experience of architecture is multi-sensory. Every overwhelming, touching, breathtaking or emotional experience of architecture is always multi-sensory, and as such based on individual perceptions of different architectural features. When we sense space, form and context, we rely on vision, hearing and touch as well as our sense of balance and kinaesthetic (Pallasmaa 1996, Ryhl 2003).
Recognising the multi-sensory universality of architectural experiences, it is imperative to study the implications of a sensory impairment for the experience of space, usability and aesthetics of the basic architectural space which constitutes the dwelling.

Design of our physical environment is generally based on an ideal image of an average person and without particular consideration for the human diversity of physiological abilities. Consequently, the person who acquires an impairment as a result of a sudden trauma or the person who lives with a congenital impairment may be challenged by design in simple everyday activities such as orientation, communication or basic understanding and experiences of the space in which he finds himself. Statistic material of the number of persons living with an impairment, whether physical, cognitive or sensory, points to a general estimate in the Western world of approx. 17-18% for persons in the age group of 18-60 years (Bengtsson, 1997). Hence maybe the average person to consider in the design process is in reality the one connected to at least one impaired person if he is not impaired himself.
Living with a visual or hearing impairment is a condition that we will all encounter sooner or later in our lives. Dr J. Gill of the Royal National Institute of the Blind has presented statistic numbers for the European continent pointing to the large prevalence of sensory impairments, with 10% of the population being hearing impaired and 1% visually impaired (Gill, 1997). These numbers reflect Danish numbers (Ryhl, 2003). Whether we lose the ability to see or hear ourselves at some point, or a family member or friend does, the need for an accommodating environment will be evident in either case.
In the context of architecture, *accessibility* has become a design concept describing specific design features accommodating disabled users, and in particular physically disabled user. Accessibility related to sensory disabilities is generally limited to aspects of wayfinding and communication devices.

In the absence of vision, the visually impaired or blind persons depend in particular on their hearing and therefore their sensory awareness of auditory perceptions increases. In contrast, the sense of vision becomes primary for the hearing impaired or deaf persons. Common denominators are that both use their sense of touch, their kinaesthetic sense and their balance increasingly.
Studying the use of the senses in the experience of space with sensory impaired users provides information of specific design requirements needed to increase usability and architectural quality for this particular user group. But it also provides important understanding of the sensory outputs that we are all exposed to regardless of sensory disability, as the sensory experiences registered by the visually or hearing impaired are also registered by the non-impaired even if not consciously.

It is argued that a sensory impairment requires specific design consideration related to the architecture of dwellings and that these are basic features of architectural quality integrated in the early stages of any traditional design process. The necessary design considerations are impossible to add on easily in later stages of the construction process.
Furthermore the concept of *sensory accessibility* is introduced and it is argued that sensory accessibility is decisive to people living with a sensory impairment as is their access to architectural space and experiences and the life lived in dwellings.
While the existing concept of accessibility ensures physical access to a given space for everyone, sensory accessibility ensures everyone the choice to stay and hence participate and experience.

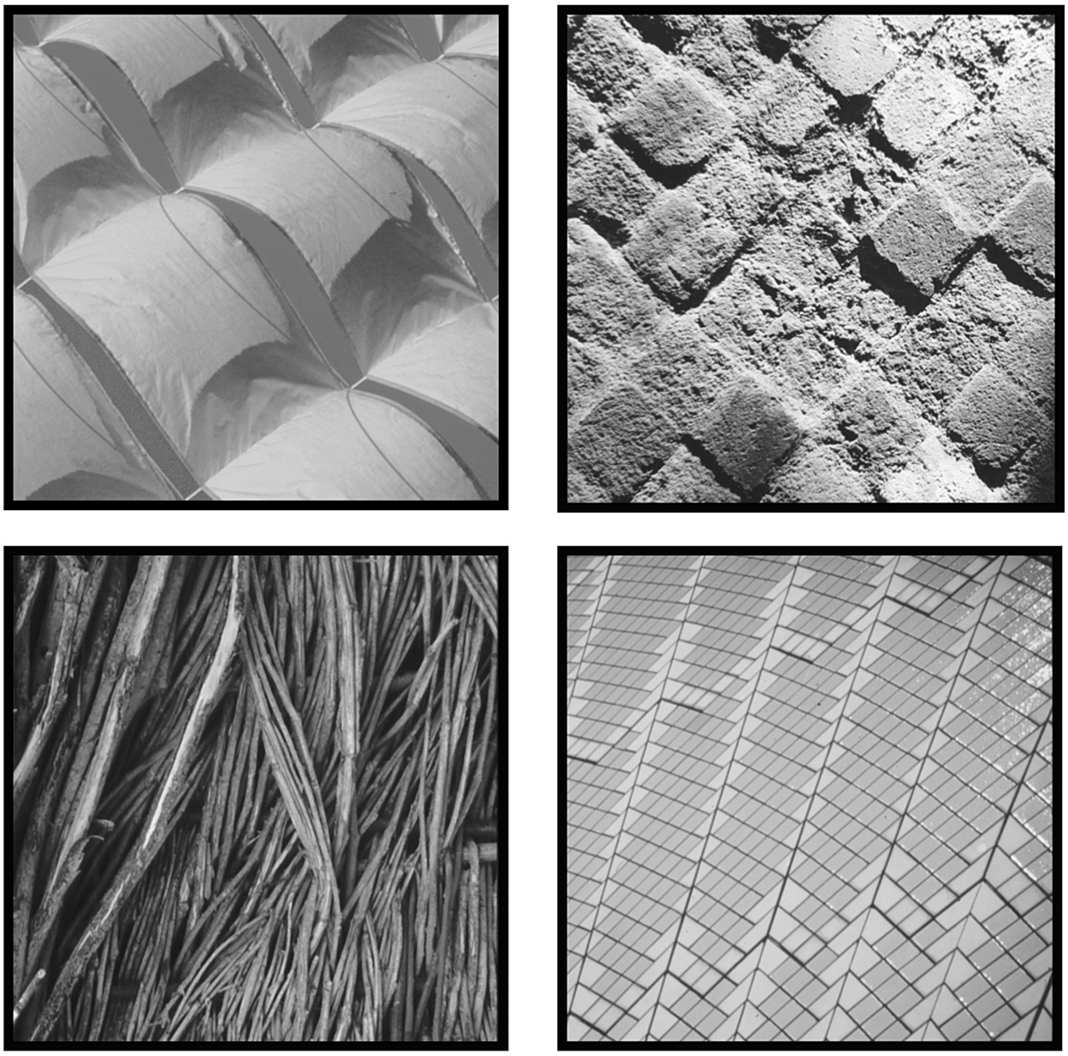


Fig. 1:
Details of architectural features

Context

Accessibility is generally described as the minimum level of design requirements needed to ensure physical access to the built environment for people living with a disability (Salmen, 2001), and as design concept it has replaced the use of barrier-free design as the latter became too stigmatising. Both barrier free design and accessibility are used to describe task performance (Danford & Steinfeld, 1999) and in particular to describe the process of physically moving from one point to another.

Iwarsson and Ståhl (2003) distinguish between accessibility to the physical environment, to information and to social activities and services, while at the same time recognising that the term accessibility is predominantly used to describe the extent to which a design meets the official legislative norms and guidelines. They also argue that the term accessibility is related to functioning functionality and that an accessible environment describes an environment in which an individual with any impairment can function independently. They argue that the term accessibility carries connotations of rehabilitation, civil rights issues and negative stigma, and suggest a more prevalent use of the term usability as an alternative, as this is not related to a specific user group but is related more to universal functioning than to disability. (Iwarsson & Ståhl, 2003). In their work Iwarsson and Ståhl emphasise accessibility as descriptive of physical accessibility and functionality of the built environment.

Universal design is a design concept that as an ideal vision rises above the differences between functionality and experiences as well as physical and sensory impairments, as it recognises human impairment as a universal condition which all human beings will experience during at one point in their life time. In its essence, it aims to go beyond merely breaking down physical barriers to include a re-definition of disablement as a condition shared by all and not just a minority group (Steinfeld, 2001) In theory accessibility is just the first step towards achieving Universal design and in reality focus within the Universal Design development is still limited to physical impairments and functionality in general (Ryhl, 2008)

To include disability considerations in housing design is not standard to the architectural design process. Others have pointed to the fact that accessibility features are add-on features to a core design and not an integrated part of the design. Imrie argues that designing according to standards that refer to the user as an ideally sized object reflects both an absence of human diversity in the user approach and the idealisation of human life lived as healthy and perfect (Imrie, 2006).
Still most disability-related research within the field of architecture is related to usability and physical impairments. Although research in regard to sensory impairments and design is normally limited to wayfinding and communication, it is argued here that there are specific design requirements to be considered when correlating the factors of sensory impairment and the experiences of architectural quality. In his influential pioneer work Lifchez argues that architectural access is a matter of more than basic physical access, as it is also a matter of accessing the sensory and less quantifiable qualities of a given space, which requires other considerations than those of merely physical ability and usability (Lifchez 1987). It is argued here that access to the sensory qualities of a space is as decisive to the sensory impaired users' overall experience of both architectural quality and usability of a given space as that of physical access.
The multi-sensory aspects of the architectural experience has been demonstrated in seminal works of architectural research (Eiler Rasmussen 1957, Holl, Pérez-Goméz & Pallasmaa 1994, Pallasmaa 1996) and the role of acoustics as paramount to the architectural experience (Rasmussen 1957, Pallasmaa 1996) is particularly interesting in the context of architecture, accessibility and sensory impairments (Ryhl, 2003).
Pallasmaa describes two essential elements of the architectural experience; the multi-sensory perceptions of form, space and scale, and the existential experience of being in the world and the societal context in which one exists. It is in the fusion and interaction of the sensory perceptions that we register and sense the world we exist in and, in spite of the visual bias in contemporary architecture all of our senses are mutually interdependent and perceptive. Through the multi-sensory perception of our physical environment we interact with our surroundings and social context.
In his phenomenological approach to the experience of architecture Pallasmaa elaborates on Gibson's 'five senses system' and demonstrates the individual and collective role of touch, vision, hearing, taste, balance, smell, muscles and limbs, as well as the importance of memory and emotions. Each sense is decisive for the experiences of architecture and based on our individual sensory ability we carry our experiences and memory within us, and it forms the basis of our perception and assessment of the world we encounter. As expressed by the anthropologist E.T. Hall "Man learns from what he sees, and what he learns influences what he sees." (Hall 1966)

Imrie demonstrates the well-documented role of the dwelling as an architectural reflection of ourselves and our self-image and how we expect it to serve as a place of rest, comfort, peace and personal privacy away from public life. Furthermore it is a space designed to nurture basic physiological needs, such as eating, sleeping, bathing and grooming which are all sensory experiences as well as physical (Imrie, 2006). Yet, as long as human diversity and sensory impairments are not included in design considerations, the standard dwelling will not offer a sensorily accommodating private space for retreat and peace. Instead the dwelling might enhance discomfort, unrest, stress and physical discomfort. (Ryhl, 2003)
In his phenomenological studies of the lifeworld of the blind Karlsson describes how blind persons, even in familiar spaces such as their own home, rely on cognitive chains of spatial recognition to a degree that has no equivalent for the sighted. Object and spatial recognition occurs in cognitive chains of *sense impression, knowledge* and *conclusion* and are repeated consistently by blind persons while moving through space (Karlsson, 1999). Hence the process requires intense mental presence and even if it is the blind person's own dwelling, it does not mean that it is easier to recognise it or that it is less tiring to establish awareness of one's spatial position or move around in it. For a blind person spatial perception and recognition of one's own dwelling cannot be compared with that of a sighted person.

In this theoretical framework a sensory impairment must reflect our experience of architecture, including the architecture of our own dwelling and our existence in the world. Therefore the study presented here aimed at answering the research question *Does a sensory impairment imply specific design considerations related to the architecture of housing?*

Method and Research Design

The data presented are the result of an empirical research project studying the implications of a sensory impairment for the architecture of dwellings.

Qualitative interviews and 1:1 tests with a group of sensory impaired participants formed the basis of the empirical studies.

Based on Pallasmaa's work on sensory systems, five sense categories were defined in the empirical study, and the sensory disabilities included were the two most prevalent; vision and hearing impairments. The two types of impairment were further divided into four categories; blind, low-vision, deaf, hard-of-hearing. A control group was added to the empirical study.

Important architectural features for the experience of architectural quality for the users in question were defined in a dialectic process of theoretical and empirical studies and in a reflective dialogue with the participants. Five core architectural features were defined; spatial proportions, openings (daylight, windows, doors, interior, exterior), connections (visual, acoustic and physical), acoustics (reverberation time) and complexity.

Impairment categories	sense categories	architectural features
blind	vision	spatial proportions
low vision	hearing	openings
deaf	touch	connections
hard of hearing	smell	acoustics
	kinaesthetic/ balance	complexity

Fig. 2:
Core concepts of the qualitative research study

Focus group interviews followed by a qualitative interview study were conducted with participants of the five test groups. The qualitative interviews discussed architectural features of importance for the experience of architectural quality for the users in question, and as a result five core architectural features were defined.

The interview was structured as open-ended qualitative individual interviews and the questions asked covered the interviewee's perception of different materials or spatial designs as well as which senses they would use in their spatial experience. An example of questions on the role of sound would be:

- What does sound in a space mean to you?
- Which one of your senses do you consider most affected by the sound in the space – and how?
- Does the type of sound affect your experience of the space?
- Do any other factors affect your experience of the sound in the space?

Based on the data collected in the interviews, the five architectural features were evaluated and discussed in a series of 1:1 qualitative tests in existing housing with the participant groups. In the interview survey 23 persons (14 women and 9 men) aged 21-67 years participated and 12 of them (8 women and 4 men) participated in the 1:1 tests.

The participants were organised in groups according to their self-identification as either blind or vision impaired and deaf or hearing impaired. Some of the hearing impaired participants had very little remaining hearing ability even with the use of assistive technology, but as they still relied on their remaining hearing as primary sense and self-identified as hearing impaired, they were included in this group. It was the same case for some of the visually impaired.

Five existing dwellings were included in the 1:1 tests. The space tested in each dwelling was the "living space", being kitchen/dining room or kitchen/living room. The five dwellings were situated in two different dwelling complexes designed by the Danish architects Vandkunsten; Dianas Have (1991-92) and Søhusene (1994-95). The same materials and construction principles as well as the

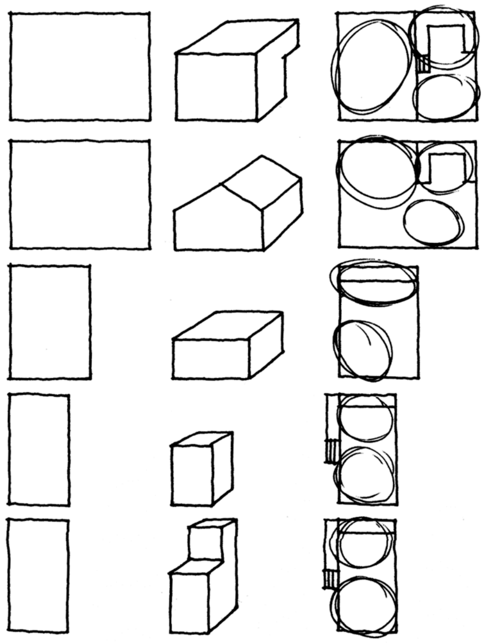


Fig. 3:
Comparing area, volume and function zones in the five test spaces

same basic plan and form were used in all five spaces tested. Each space would present a specific variation of the architectural features making it possible to compare the features.

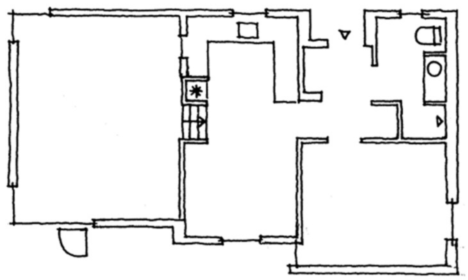
Architectural analysis of the five features of each of the five dwellings was performed prior to testing and reverberation time was measured by an acoustic engineer. Daylight was measured by the luminance factor throughout the day of the 1:1 tests.

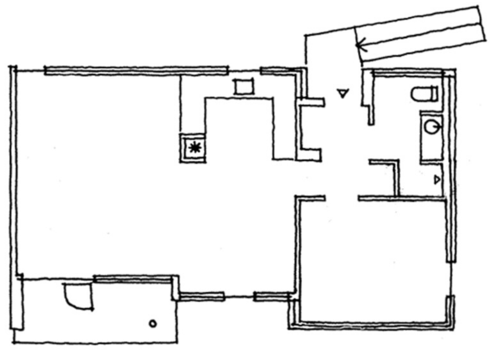
Each of the five participant groups spent 30-40 min in each space sensing and discussing the architecture of the space and the architectural features in question. Their responses were only guided by pre-defined questions in the few cases where some of the architectural features were not discussed spontaneously.
The 1:1 tests were recorded and the participants' evaluation and perception of the five features and the architectural quality of the tested spaces were then analysed in correlation with the interview and architectural analysis data.

Findings
The original research design included 1:1 tests conducted in the 1:1 lab test facilities. But based on the interview data, it was necessary to conduct the 1:1 tests in existing housing. The interviews indicated acoustics as a core architectural feature and it was decisive to ensure a realistic acoustic environment for the 1:1 tests. The results of the qualitative tests are presented here for each participant group individually as some findings may correlate, but many nuances differ.

Fig. 4:
One of the dwellings in the Søhusene complex included in the 1:1 tests

The blind
The sense of hearing and touch are primary senses to this group.
The interviews showed that spatial proportions are paramount for two reasons; acoustics and a point-of-reference. Proportions and acoustics were almost perceived as synonymous features because large spaces are by nature classified as having no acoustic quality. This experience was verified and emphasised by the 1:1 tests. Always being able to reach a point-of-reference is decisive to the sense of control, orientation and both physical and mental well-being. Hence large spaces were also by nature classified as having low architectural quality.
These interrelations of the features were demonstrated by comparing two rooms with identical floor size and layout, but with different ceiling heights (see Fig. 5). In the space with a 4 m levelled ceiling height and a 1.2 sec reverberation time, the blind participants expressed great discomfort. They felt unable to understand the room, they had no sense of direction





Space 1 – floor to ceiling corner windows, 4 m ceiling height, 4 steps between living and dining zones, reverberation time 1.2 seconds

Space 2 – horizontal windowpanes in both outer walls, sloped ceiling, no level differences, reverberation time 0.6 seconds

Fig. 5
Comparing two of the spaces used in the 1:1 tests. The two spaces are identical in floor plan, size and layout, but varied in some of the architectural features, e.g., spatial proportions, openings and acoustics.

or point-of-reference and the acoustics were evaluated as a barrier to communication, orientation as well as physical well-being. The acoustics were described as a source of insecurity and as the primary reason that none of the participants wanted to discover or experience other qualities of the space. The blind participants stood still in the middle of the room throughout the entire test and only moved to the door at the end when offered a guiding arm. In the other space with identical layout and size, but with a sloped lower ceiling and a reverberation time of 0.6 sec, the difference was instantly sensed by the participants and the overall experience was quite different. They moved around freely and calmly, finding a point-of-reference on their own, reading the room and discussing it's qualities with a strikingly different confidence. The space was classified as a positive architectural experience, with a positive correlation between the acoustics and the spatial proportions experienced. The spaces tested with a reverberation time of 0.7 sec or more were all disqualified by the blind participants regardless of other positive architectural features, and in most cases the acoustics were described as a physical discomfort.
The blind participants defined acoustics as decisive to the overall quality and usability of the space. This was consistent with the interviews and the 1:1 tests. Yet acoustics are not simply improved by lowering the reverberation time through acoustic adjustments as the reverberation time is used as a measure of spatial proportions. A grand room must sound grand; otherwise it is confusing and potentially dangerous.

Complexity was described in the interviews as very problematic, exemplified by features such as double-height ceilings and open vertical connections between floors. Sound travels differently and the acoustics alone complicate both orientation and communication. Moreover, the knowledge of the open connection to the upstairs floor was disturbing in the same way as a 3-step-level difference between spatial zones. Both situations were tested in 1:1 and the requirement was increased by the participants, who once again moved with more care and anxiety. The simple notion of stairs and the complexity of the home setting required constant awareness of the potential danger and resulted in mental and emotional fatigue and discomfort.

Openings were important due to the acoustic connections they provided. Large glass areas and the exposure factor were described as negative in the interviews but seemed to be without significance in the tests where the qualities of hearing sounds and activities from outside were emphasized as important. Also the physical comfort of daylight was noted. Filtered daylight was preferred to direct, as the latter causes pain in the eyes for some.

Low vision

Vision and hearing are equal primary senses to this user group, but individual visual ability varies.

The interviews showed that acoustics and daylight were the most important architectural features and decisive to the experience of architectural quality.
Testing in the space with 4m ceiling height and floor to ceiling corner windows (see Fig. 5, space 1) clearly demonstrated the significance of the remaining vision. Compared with the blind participants, the extra information they received through their remaining vision gave a slightly more nuanced experience of both the level differences and of the concentration of the window openings at the corners of the room. They described the daylight as too strong in the corners and too dark in the rest of the room. Like the blind participants they thought the room was too big with a reference point consistently too far away. Generally these participants registered more nuances than the blind, but the overall impression was very similar.

In the interviews the participants expressed a sense that acoustics and spatial proportions were inextricably linked and this notion was verified in the 1:1 tests.
The participants with low vision strongly criticised the acoustics in the space with a 1.2 sec reverberation time, yet still felt comfortable to move around and discover the room on their own using their remaining sense of vision. Their instant reaction was to praise the visual grandness of the spatial proportions as well as the daylight and openness of the design, but as soon as they began talking the reverberation time dominated their experiences. The space was subsequently perceived as being of low architectural quality due to the acoustics, although other architectural features were noted as positive. As in the case of the blind participants, the 1:1 demonstrated that the reverberation time must remain at 0.5-0.7 sec to be tolerable, and if it exceeded this level, the given space was assessed as useless to the visually impaired participants.
In the space identical to the latter (see Fig.5), except for a difference in ceiling height and a reverberation time of 0.6,sec the interrelation of acoustics and proportions was verified, as the acoustics were perceived as far better here and consequently the spatial proportions were assessed as positive. They felt instantly comfortable in the room, where they appreciated and registered the connection to the balcony with the green element in particular described as a quality. They also described the room as more coherent, because there was no level difference. This was considered a quality because, like for the blind participants, internal staircases were perceived as dangerous and unpleasant.
The significance of the remaining vision was strong, as daylight became an important source of both information and comfort. In one space the glass door to the balcony let in large amounts of daylight filtered through the tree outside. In the opposite corner of the room a small skylight was placed in the sloped ceiling. The participant with the most visual ability appreciated the large opening, the visual connection to nature and the sense of daylight flooding through the door. The participant with the least visual ability noted that the filtered light minimised sharp contrast and the room was subsequently evenly lit. This made the skylight a positive feature as the small field of contrast it created was useful to navigate by. The skylight became a source of physical comfort and ease.

Space 3 – floor to ceiling window/door in the corner, ceiling height of 2.4 m and 0.5 sec reverberation time

Space 5 – floor to ceiling corner window and door, two different ceiling heights; 6 m and 3 m, reverberation time is 0.7 sec.

Fig. 6:
Two of the five spaces tested.

One space tested had a 6 m high glass end wall bending around a corner (Fig. 6 space 5) while the other end of the room only had one small horizontal window between the kitchen counter and the cabinets. This contrast in daylight was perceived as a quality by the participant with the most visual ability, who described how she could use and enjoy the large amount of light all over the room. The participant with the least visual ability could only use the darker zone furthest back in the room, because the light in the other end of the room was too bright and blinding and required too much adaptation. He described the contrast as being the obstacle causing inaccessibility. It was obvious that walking towards the light and the stark contrasts on the floor enhanced insecurity and diminished his use of the already limited remaining vision.
The same room had a reverberation time of 0.7 sec, and the group perceived the acoustics as poor. Despite different perceptions of the daylight qualities in the room, there was strong consensus that the reverberation time was too uncomfortable to ignore. Once again it was the acoustics that determined the overall perceived quality of the space.

The deaf
Vision and touch are the primary senses for this group of participants.
Based on an increased visual sensitivity, the interviewees expressed a strong wish for very large spaces and large windows to ensure visual information of the activities that they could not hear. This preferably in combination with large openings and unobstructed visual connections to the exterior context.
The need for large spatial proportions and spatial openness was confirmed by the 1:1 tests which also demonstrated that openness was an indispensable element of the proportional demands. The tested spaces with large ceiling height were found unacceptable. They were described as large spaces, but at the same time they were also assessed as too small, claustrophobic and uncomfortable, because there were not enough window openings, clear visual connections to the outdoors or daylight. Large openings and large proportions were equally important and - very importantly - mutually interlinked. One feature without the other was not regarded as a quality.
The 1:1 tests demonstrated that to this group spatial proportions were not isolated from the other architectural features. In the interviews sloped ceilings were described as a negative feature perceived as both physically and mentally restricting, but the 1:1 tests revealed that spatial proportions

were inextricably linked to the other studied features. A simple classification of good or bad spatial proportions or ceiling type was not possible, as it seems that the spatial qualities are defined in the synergy of spatial proportions, window openings and visual connections in particular.
Increased visual sensitivity as compensation for impaired hearing was prevalent in deaf persons. This was particularly important as the sense of isolation and loneliness generally grows when one cannot hear the context one lives in. Deaf persons need to be visually confirmed about what they cannot register acoustically, in other words they need to see what they cannot hear.
The interviews pointed to several design requirements related to the increased visual sensitivity, which were all verified and further elaborated on in the 1:1 tests; size and placement of windows, daylight and visual noise.

The tests demonstrated that not only the size of the windows was important but that their positioning was equally important. In the interviews the wish for large window openings was emphasised without significant nuances, but the 1:1 tests demonstrated that the perceived quality of the window openings was more complex. The windows should preferably open up the space in all directions and in the 1:1 tests the space with a smaller but consistent horizontal window band along both outer walls and placed at eye level was preferred to the space that had very large floor to ceiling windows only at the corners.
Although the requirement in the interviews was specified only as large and plentiful window openings, the 1:1 tests showed that they must be placed at eye level and enhance the sense of a dissolved barrier between the given space and the exterior context. Furthermore the need for plenty of daylight, expressed in the interviews, was also affirmed as very important to the individual sense comfort and well-being, as well as the perceived architectural quality of the space.

The presence of visual noise, which is particularly confirmed in rooms with external staircases in front of the windows, disturbs the participants immensely and plays a significant role in their final assessment of the specific rooms as non-inhabitable. At the same time the priority of openness and daylight rather than minimal exposure was also confirmed. It was more important to have large window openings and views to the world outside than to avoid exposure. Moreover, it seemed that only an almost symbolic buffer zone was required to ensure a sense of privacy. In this aspect this group differed from most of the other participants. Visual noise was a complex phenomenon, which was demonstrated when e.g. the participants agreed that diversity in window proportions disturbed them visually and thus were very frustrating. Hence visual noise also comprised an aesthetic dimension.
Interior visual connections were important and an open and visually connected space enhanced communication and social activities for the deaf participants. The tested spaces that presented visual barriers within the room were assessed as very problematic and uncomfortable.
The importance of sensing activities and movements through vibrations in the surfaces of the space was emphasised in the interviews and further verified in the 1:1 tests. The participants talked of using their sense of sound, as opposed to their sense of hearing, as they relied on acoustic information being communicated through vibrations in the floor and other surfaces; they pointed to this architectural feature as crucial to feeling what they cannot hear.

Hard of hearing

Hearing and vision are primary senses for this group of participants.
In the interviews this group expressed somewhat ambiguous desires regarding spatial proportions; openness and a large volume were required to feel comfortable and unrestricted, yet large spaces were perceived as synonymous with high reverberation time and hence negative acoustic experiences.

However, the 1:1 tests showed that the large rooms were not perceived negatively because of their spatial proportions. The acoustics were assessed as uncomfortable in several of the spaces, but they were not perceived consciously as connected with the spatial proportions which in turn were positively connected to the desire for space and openness around them.
The assessments were based on the relation between spatial proportions, quality of daylight and the connection to the outdoors though the participants are mostly unaware of this fact. Thereby this group shared many requirements with the deaf participants for whom spatial proportions, daylight

and connections to the outdoors were strongly interlinked and in fact inseparable. However, the difference between these two groups was found in the significance of the remaining hearing ability. Irrespective of the individual hearing ability, hearing was considered the primary sense and was used as such, even when it is was almost gone.
In general it was obvious that this group was very conscious of acoustics, and their descriptions of their experiences were incredibly nuanced and exact. They described the acoustics in minute details and their observations were varied and considered. The nuances of their words and experiences got more intense the lower the reverberation time was, but at the same time none of the spaces offered an acceptable reverberation time to this group. In fact they did not consider any of the tested spaces usable or accessible as far as the acoustics were concerned.
Without doubt the acoustics were the most dominant architectural feature to this group, and the significance was perhaps best illustrated in one space where connections, window openings, daylight, spatial proportions and complexity were all assessed as a quality, in several instances even described as good. Still their overall assessment of the space was that it was not usable as a home for them due to the reverberation time of 0.7 seconds. There was strong consensus that solely due to the acoustics they would never be able to live in such a space.

The interviews pointed to ambivalence in regards to the perception of window openings; the need for daylight and openness was a very high priority, yet glass was perceived as a hard material reflecting sounds and causing bad acoustics. This conflict was not verified in the 1:1 tests, where there was no doubt that it was the daylight and the openness that was a priority. The large glass areas being a hard material was not mentioned at all. It was the physical and visual connection to the green space outside, to the air and daylight and to the sense of breathing freely that was noted and appreciated.
As for the deaf participants, the interior visual connections were of great importance. This need was stated in the interviews and further verified in the 1:1 tests, and it was explained by two reasons; the need to see the faces when communicating and the need to see what cannot be heard. Only the space with a double high zone was assessed negatively as their sense of balance and physical well-being was significantly disturbed by it. On the other hand, the physical connection via the floors, which were wooden in all the rooms, was highly appreciated and considered a quality.

Discussion

Iwarsson and Ståhl emphasises the usability aspects of accessibility and these are also relevant with regard to sensory impairments. But the research findings presented showed that a sensory impaired person met a different level of barrier when a given space was not designed to accommodate his sensory abilities and inabilities. The sensory barriers were different to physical barriers, but equally crucial to the person living with a sensory impairment.
Access to sensory aspects of architectural design through conscious design of architectural features could increase the sensory impaired person's ability to remain in the room and participate in activities or simply just live there. On the other hand if sensory considerations were not included in the architectural design and sensory accessibility was not assured, the impaired person was highly likely to find the room inaccessible and the aspects of usability to be irrelevant.
This suggests various levels of accessibility, which is also what Iwarsson and Ståhl point to although their focus is on the degree of usability and ethical aspects of user perception. In his work Lifchez pointed to sensory aspects of architectural quality, expressing the need to assure access to less quantifiable and more emotional aspects of architectural quality. The research findings described in this article demonstrates an apparent need to include these less quantifiable aspects in the accessibility realm and expand the idea of accessibility.

Although design requirements varied with each participant group, there were important common denominators. The blind and visually impaired groups required smaller spaces in which a point-of-reference could be reached within a few steps. Low reverberation time was of decisive importance and reverberation time must reflect spatial proportions as it was a source of information about the size and layout of the space.
The hearing impaired required openness and spatial volume, and a very low reverberation time. Their acoustic sensitivity was remarkable and the negative physical implications of acoustic barriers were paramount to sensory accessibility. The deaf participants required very large spaces and great

volume as well as enormous window openings and almost needed the exterior to be brought into the interior. Acoustic information was not necessarily inaccessible to deaf persons if the design communicated vibrations through spatial surfaces like walls and floors.

The decisive meaning of acoustics as primary barrier to sensory accessibility was evident as it was the one design requirements that all participants had in common, and it was consistently demonstrated throughout the 1:1 tests as the deaf participants generally assessed the spaces differently from the other groups. In this context the deaf participants demonstrated that acoustics play a crucial and a much more important role for the experience of a space for those who can hear than they are aware of themselves.
It may be concluded that there was no single solution that accommodated everybody's needs and physiologi¬cal condition. But as Pallasmaa also emphasises, the quality of the architectural experiences lies within the significant multi-sensory synergy between architectural features such as spatial proportions, acoustics and connections. Many of the requirements were concerned with the interrelation between these features, and the proper accommodating design solution needed to emerge the synergy of the specific spatial context and sensory impairment.
When all architectural features were perceived as being of quality and in mutual balance - and acoustics were not negatively dominating the experience - the participants all experienced a sense of ease and comfort. When this happened, they all described a rare ability to imagine and associate spatially and thereby demonstrated the amount of energy normally being used just to manage or navigate in a space. Once sensory accessibility was assured, access to a different experience of just being in the world and in the moment was simultaneously granted, which is what Pallasmaa classifies as the meaning of architecture.

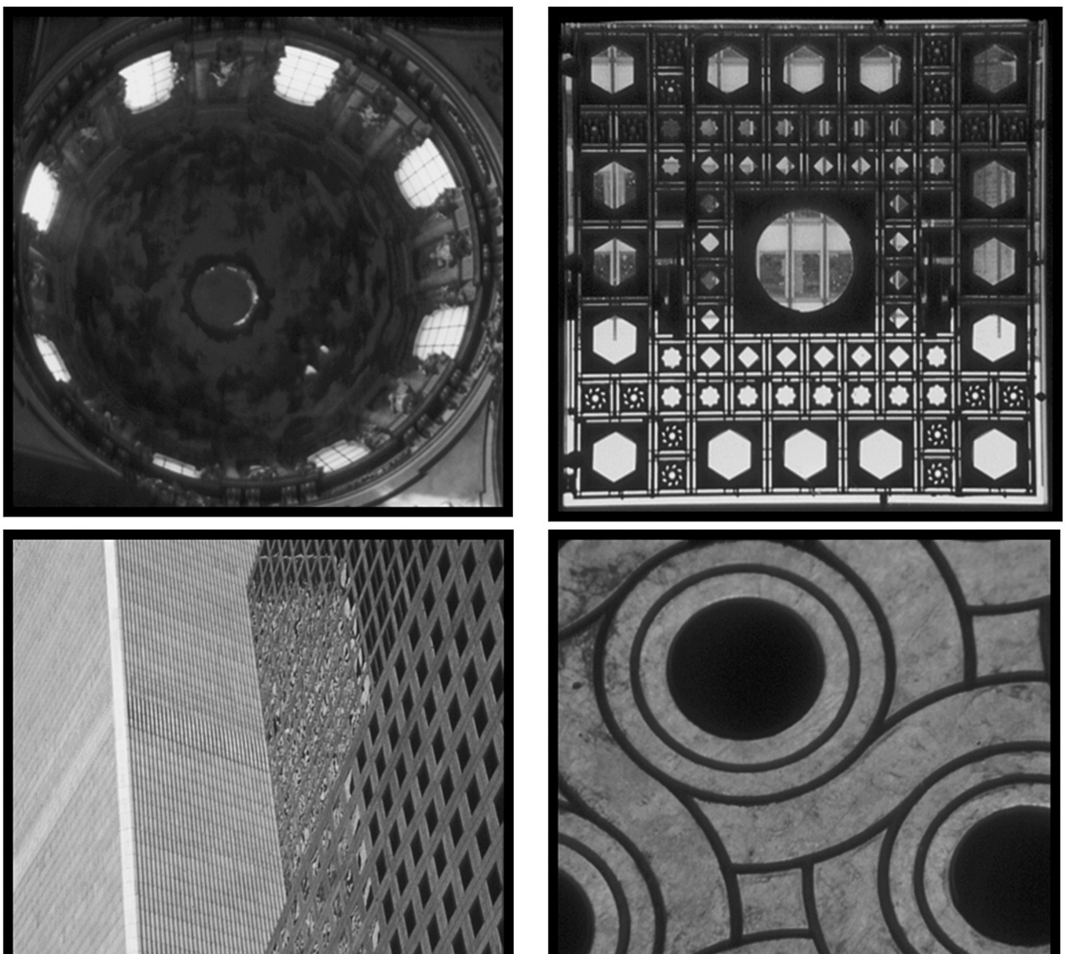


Fig. 7:
Details of architectural features

Besides increasing accessibility to the experiences of architectural quality, sensory accessibility also increases access to other decisive aspects of architecture. Pallasmaa's phenomenological work on the existential aspects of architecture and architectural experiences emphasises the universal human need to be assured of our existence in a larger context. Sensory accessibility emphasises sociological and existential aspects of being and as such also increases the quality of life not only for people living with a sensory disability but for everyone.
Assuming the role of lead users, the sensory impaired participants demonstrated this basic human requirement as well as the importance of enhancing social and existential aspects of architecture by emphasising the need for visual and acoustic connections to the exterior context. The findings clearly confirmed both Lifchez's and Pallasmaa's ideas of how crucial the emotional aspects are for the experience of sensory accessibility and architectural experiences.

As a reflection of Imrie's work on the meaning of an accessible dwelling and the ethical and aesthetic implications of designing for people living with impairments, it has been shown that not only physical but also sensory impairments as a universal human condition must be included in the general perception of user abilities and user requirements. Ten percent of Western populations live with a hearing impairment and the acoustic sensitivity accompanying the impairment is paramount to their experiences of architectural quality. It has been shown that acoustic requirements should include reverberation time within the dwelling unit and individual space, as the consequences of negative acoustics is a sensory inaccessible dwelling to people living with a sensory impairment. This point is further emphasised by Karlsson's research on the life world of congenitally blind persons. His findings are verified by the data presented here and further validate the need to consider the dwelling as an architectural typology requiring specific sensory design requirements to accommodate sensory impairments.

Conclusion

Sensory aspects of disability and accessibility have generally been limited to issues of wayfinding and communication. Yet specific design of basic architectural features has been shown to be of decisive importance for the experience of architectural quality and accessibility to people living with sensory impairments.
Recognising the small scale of the qualitative research study, including the number of participants, the study still points to important universal sensory qualities of architecture and accessibility and the need to study the issue further.

It is not sufficient to design for physical accessibility to ensure the ability to remain in a given space and participate in activities as well as experience the architectural space for someone living with a sensory impairment. The significance of access to the sensory aspects of the design was crucial for some and pointsto a need to introduce the concept of sensory accessibility. The concept of sensory accessibility includes other aspects of accessibility than physical accessibility and should be considered as a critical complementing concept to the existing one.
In some cases the absence of sensory accessibility requires people to leave a given space, even if absolute physical accessibility is present. Access to sensory aspects of the architectural experience was shown to be of such importance that the concept of sensory accessibility must be included on the accessibility agenda and given high priority.

Architectural features are generally linked, mutually reflective and perceived in combination, but a few seemed more important to the experience of architectural quality than others for people living with a sensory impairment; acoustics, spatial proportions and openings. These were not easily changeable features post-construction, and design specifications taking sensory impairments and experiences into account, should be included in the overall planning and programming of any architectural project if the end result is to be sensory accessible to everyone.
Furthermore it was shown that acoustics were often a decisive barrier to architectural experiences and usability for people living with a sensory impairment and hence must be considered as a paramount parameter of sensory accessibility and of accessibility in general.

Based on qualitative research findings, it was shown that a specific sensory impairment requires specific design consideration related to the architecture of dwellings and hence that the concept of *sensory accessibility* is a decisive aspect of accessibility.

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