User Study of Video Mediated Communication in the Domestic Environment with Intellectually Disabled Persons

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ABSTRACT

This paper presents a user study of Video Mediated Communication (VMC) involving six persons with mild intellectual disabilities. It took place at the "comHOME", a full-scale model of an "apartment of the future", showing innovative architectural and technical design with regard to the integration of VMC into the domestic environment. The design concept of the apartment is based on the creation of private and public digital places in the home expressed both architecturally and technologically. Two different zones for VMC, "comZONES", in the apartment were tested, the *videoTORSO* (a large screen set-up for informal everyday communication) and the *workPLACE* (a place for professional work tasks). The purpose of the study was, at an early design stage, to get a deeper understanding of *how* people use these two comZONES. The final discussion points out that the comZONES seem to be interpreted correctly and to function aptly in relationship to the participants of the study. Tentatively we might find an explanation in the fact that spatial recognition probably is a very fundamental human function, learned and trained for years, and thus, may be less significant with regard to the mental capacity of the individual. This might be even more true if the spatial design factors are still less abstract.

Keywords

Architecture, ICT, intellectual disability, observation, place, private, public, space, user studies, VMC, video mediated communication.

1 BACKGROUND

The development of the information and communication technologies, ICT, are currently very rapid and several trends indicate that video mediated communication, VMC, might become an important part of the communication also in our homes (Kraut and Fish 1997). Communication can support and complement at a distance a wide range of home based activities such as professional work, studies, care of elderly and others needing care and surveillance and, as well, e.g. leisure activities. These can take place despite the separation in space. Listing current common activities in our homes it will be obvious that a large portion of what could be called "living processes" will be prone to change with the increasing number of applications of ICT.

We know from many studies that long-term change of the process of "living-in-our-homes" is reflected in the architecture. This change is often slow in the beginning. With increasing momentum the change manifests itself successively. Preliminary findings related to "the living processes" indicate that our homes will be the place for more compound activities in the future, with more complex relationships in time and space. At the same time these processes will be supported by ITC (Junestrand & Tollmar 1998).

Obviously VMC and other ICT put specific new demands on the design of the dwelling. And, generally speaking, dwellings are not very well suited for VMC, e.g. due to unsatisfactory acoustics, light conditions, technical installations, floor-plan layout and spatial design. So, to create dwellings fitted for the new needs of the new information society seems to be a highly intriguing, but, non-the-less, a very timely and adequate problem. In this paper a user study that forms a part of the overall design process for ITC in our homes is presented.

2 THE COMHOME APARTMENT – THE PLACE OF THE STUDY

A conceptual apartment of the future called *comHOME* was designed as a laboratory and a showroom for a dwelling of the future where the primary goal has been to develop and integrate VMC solutions into a simulated home setting. The design of the dwelling is based on the idea of creating different *comZONES* - zones for video mediated communication - to support the demands for both private and public spaces within the home environment. The comZONES have one or more of the following characteristics: an inner, *public zone*, where you can be both seen and heard through VMC devices; in the middle *semi-public zone* you can be seen but not heard; in the outer *private zone* you can neither be seen nor heard. The different comZONES are expressed by technical solutions such as a screen and a camera and by the use of architecture in terms of spatial forms, colours, light, materials. The architectural space can then, in combination with ICT solutions, form an interface to the digital world.

The principal architectural issue was the establishment of the mental and physical boundaries between the *private* and the *public* digital places in the VMC supported communication zones, i.e. to uphold the absolute demand of not being seen nor heard when so desired. This has been proven to be a fundamental quality of a VMC system. Further, the design takes into consideration both the inside-out perspective (how the outer world is perceived through VMC from within the home) and the outside-in perspectives (how the dwelling is perceived from places outside the dwelling) supported by VMC (Junestrand & Tollmar 1999). In this study only the former perspective is effective.

The major difference from the traditional VMC set-ups is that the home is a radically different place compared to the more controlled office environment, e.g. poor lighting and audio conditions should be considered as normative rather than rare exceptions. In this study however, very favourable conditions in this respect were maintained, in order not to introduce secondary restrictions. The technical design concept of the video and the audio spaces in comHOME is based on several short-range cameras and microphones being mapped and routed through a common media switch. The switch could be seen as the heart of all incoming and outgoing media streams.

In this comHOME environment a favourable opportunity was offered to try novel communication technologies with regard to different and varying needs of people with disabilities. The concept of "design-for-all" is already very much acknowledged and will be more so in the foreseeable future. We also believe that the participation of persons with intellectual disabilities will contribute substantially to the development of knowledge in the field. The opportunity constituted an excellent possibility to bring in essential requirements early in the design process that may be more difficult to introduce later.

2.1 videoTORSO

The videoTORSO is a set-up enabling informal communication with a person as if he/she was in the

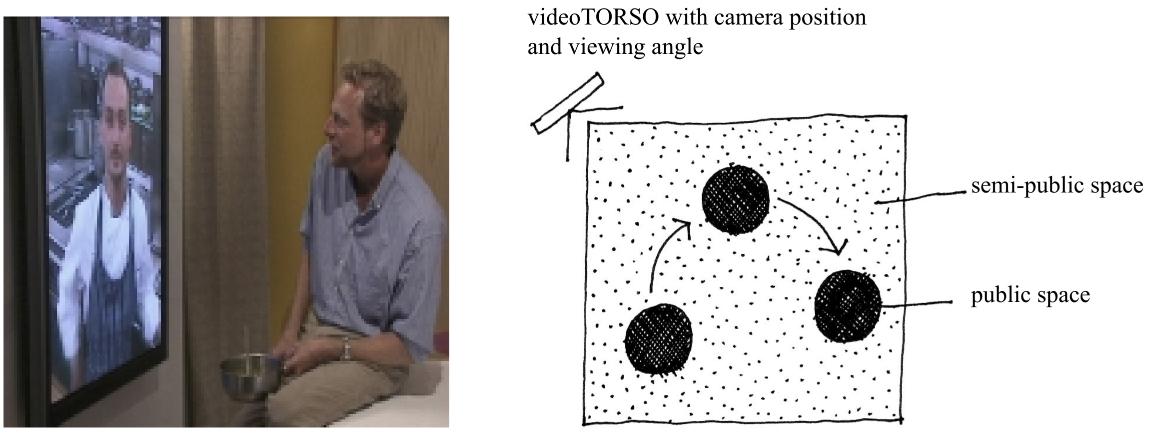

Figure 1. Left: an illustration of how the videoTORSO could be used in an everyday situation. Right: a Floor-plan sketch of the function of the videoTORSO indicates public and semi-public places.

doorway of a room. The set-up consists of (see also figure 1):

- A large flat screen placed on a wall, possible to adjust in height, thereby allowing for both tall and short standing users at home.
- Loudspeakers just above each side of the screen, making the sound to appear from the videoTORSO screen.
- A camera placed as close as possible beside the eye level of the person appearing on the screen.
- Microphones placed just beside the screen.
- Software for video communication, voice and gesture commands.

These parts are integrated in one single device, the *videoTORSO*, which makes it possible to convey social and emotional qualities similar to those that could be attributed to a person standing in the doorway of the room. The location of the videoTORSO in the room is also essential. If the objective is to simulate a person standing in the room, it is important to locate the videoTORSO at a place that is comfortable and natural to turn to. The limits of the view angles of the camera have to be controlled. This is done with architectural de-limitations and software/hardware solutions. The sound in the room is captured mainly from the person having the conversation. If several persons participate, the sound from all of them is captured. People in the room not participating in the conversation only appear as images producing background sound and images and thus are *semi-public*. The videoTORSO might well simulate a person in the room. The person at the other side of the screen, however, will not experience him/self being in the room. The set-up supports the inside-out perspective, see above.

2.2 workPLACE

The use of VMC for professional work activities in a home environment could cause many problems, both for the person performing the work and for the persons around and behind the workplace, whose integrity can be disturbed and who may feel uncomfortable. Therefore, it is important that one is able to feel private and comfortable when being or passing behind someone using a VMC set-up for professional work.

In a set-up developed for the comHOME project, the workPLACE is placed in a combined home-office and bedroom, which causes the camera to view not only the person at work, but the bed behind, as well. This pushes the aspects of private and public to its extreme and requires the development of architectural measures that facilitate the interpretation of the borders between *private* and *public spaces*, as well as complementary ICT devices and software. A table with two sideboards and a lowered ceiling with integrated light spatially defines the *public zone*, where the user can be seen and heard. The zone outside, with the bed, is *private*, figure 2 and figure 3.

3 A MULTI-DISCIPLINARY STUDY

The study is obviously multi-disciplinary. Knowledge and theory have to be derived from a number of different disciplines and, if possible, brought together in order to form a unified view of the studied matter. Here, however, we confine ourselves to outline the aspects most relevant for the conducted study, i.e.:

- the intellectual disability,
- the architectural design,
- the technology of video mediated communication.

Figure 2. Upper images: the user appears in the workPLACE as in the real home environment using the video conference system. Lower image: from the remote place (the partner in the VMC conversation) the user appears to be in an office environment.

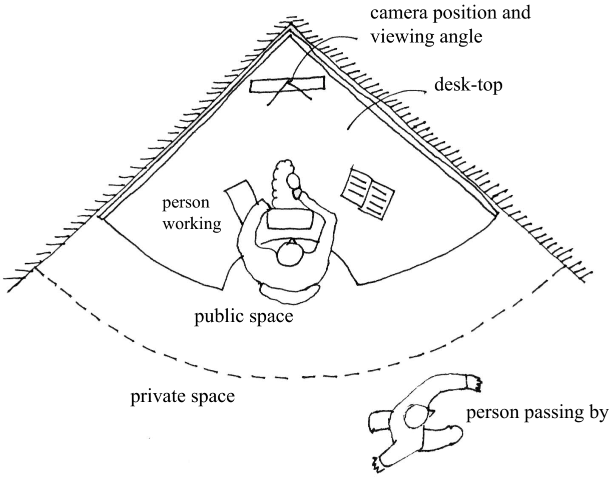

Figure 3. A Floor-plan sketch of the functions of the workPLACE.

3.1 Intellectual disability

The basic principles concerning intellectual disability in our work take a starting point with the ideas that Gunnar Kylén developed during several decades at the Ala foundation in Sweden (Kylén 1983). He studied the nature of intellectual disability and its significance for the cognitive development of a human being and his or her interaction with the environment. Intellectual disability manifests by increasing difficulties in responding properly when interacting with the environment with higher levels of abstraction. Four levels of abstraction were proposed which to large an extent was influenced by Jean Piaget and related theories of stages in human cognitive development.

Kylén has chosen to denominate the attainable abstraction levels of intellectually handicapped persons A, B, C. The fourth level can only be reach by people with what we consider as normal intelligence. Kylén arrived to the conclusion, which then have been used instrumentally in practice, that different individuals pass from childhood to adult, through the same levels of ability of abstract reasoning. Some, however, halt at some lower level, whilst most people advance to a level considered to be normal for the population. The three levels of intellectual disability, A, B and C, were considered appropriate for the classification in this study. In accordance to Kyléns findings, individual with intellectual disability were found to have substantial reductions of capacity in reasoning and ability to adapt to the surrounding world. The reduction of capacity was revealed successively during the individual's development period. The medical descriptions vary and include cerebral paralysis (CP), Downs syndrome, Minimal Brain Dysfunction (MBD), and DAMP. Difficulties reveal for concepts like space, time, quality, quantity and cause. In principle, these five categories are used also by Kylén (Kylén 1983). For this study only persons of level C (mild intellectual disability) were engaged

3.2 Architectural design

The design issues of the home environments have a primary methodological relationship with the explorative and creative development of the functional period of international architecture. This refers mainly to the development of new conceptual and practical ideas for the dwelling that took place at the beginning of this century. There is also direct reference to more formal aspects of architectural design as far as cognitive and psychological aspects are concerned (i.e. Hall 1966 and Weber 1995). Architectural projects and research related to the use of IT in the home environment, intelligent buildings or smart homes appear, in general, to be more focused on the technology than on the architectural design. One exception is the work done by Olindo Caso (Caso and Tacken 1993) that concerns the analysis and classification of different IT supported activities that can be carried out in the home environment. These studies aim at presenting a conceptual organisation and allocation of IT supported activities in time and space within the home.

3.2 The technology of V M C

Naturally, as VMC moves from the office environment to the domestic environment, we could learn many important lessons from research of video communication in the CSCW community (Kraut et al 1990). In the context of video communication for remote collaboration the major focus has been on whether the video media actually improve conversation or not (Whittaker 1995). In more current research in Mediaspace (Dourish et al. 1996) we could see a trend towards non-quantitative studies in an attempt to specify users' perception and awareness of others presence. The presence/absence of a social context deeply influences how conversations proceed and their results. Studies of video communication have suggested that the main contribution of the video media is the rich social context. It has hence been argued that by seriously improving media quality, informal communication will be easier to initiate and the conversation will flow more smoothly (Tang and Isaak 1993). Also been discussed is the interface issues towards VMC technology (Bellotti and Dourish 1997). Our principal premise, though, is that most imitations of architectural and urban spaces and places that are used in communication systems are too crude and superficial. Designers of today's electronic communication media unfortunately do not advocate and develop the architectural metaphors far enough. (Fish et al 1990) reflects on difficulties in a self-critical analysis of the Bellcore Cruiser system - "the mechanisms that were supported in the Cruiser system were abrupt, intrusive, and lacking in subtlety." Our general guidelines are to build the interface as transparently as possible. Ideally you will be able to use your body in the room as the main interaction device, not just one or two fingers on your hand. These "smart" or "reactive" artefacts will use information from devices including motion detectors, processed video, and contact sensors to control
the equipment of the meeting room (Junestrand & Tollmar 1999).

4 THE STUDY

The design and construction of the comZONES were nearly completed with almost working systems in spring 1999. At this point we found it important to involve users to evaluate some aspects of the ideas we have had about the design and to get new input for further development of the systems. We found it especially interesting to be able to involve users with intellectual disabilities in order to identify as many as possible questions and problems, not equally easy to catch with a more narrow selection of test persons. A control group was tested, too, but will not be discussed separately.

Age (years)	**Sex** (F/M)	**Medical diagnosis**	**Characteristics**
45	M	CP-injury at birth. Dysartri.	P. can express two to three words after each other. Difficulties to be understood at verbal communication. Communicates through single words, body language and pictures.
31	M	No diagnosis but corresponds to the DAMP criterion.	Concentration difficulties. Difficulties in understanding instructions, especially putting instructions into practice. Lack in mobility and perception.
25	F	Downs syndrome	In addition, defective vision on both eyes.
21	M	MDB/DAMP	P. is slightly intellectually handicapped. No physical handicap
31	M	CP-injury at birth.	Able to walk at 8 years of age. Difficulties to be understood by spoken language, due to difficulties in articulation. Communicates using sign language. Understands spoken language.
43	F	Spinal cord injury at birth.	P. is slightly intellectually handicapped. Uses a wheelchair and has a leg prothetis.

Table 1. Some characteristics of the six disabled persons involved in the study.

4.1 The design of the study

Figure 4. To the left: A male user of 45 years with CP-injury shows the content of a saucepan to the remote communication partner. To the right: a 25 years old female with Downs syndrome tries to show the text that she has written on the paper to the remote communication partner by putting the paper in front of the image. (She did not understand that the remote person saw her trough the video camera attached at the upper left corner of the portable PC.)

The study aimed at evaluating two of the comZONES in the comHOME apartment, the videoTORSO and the workPLACE, described above. The study took place in the apartment comHOME located at Telia Networks in Farsta, Stockholm, Sweden. The tests were conducted during three days in June 1999.

Two user groups, each with six persons, participated in the study. One group consisted of people with intellectual disabilities that worked at a special workplace for this kind of people in Stockholm. The persons in the group with intellectual disability were selected in collaboration with the personal at Kungsholmens Dagliga Verksamhet (KDV, their special daily workplace). The staff suggested a selection of persons thought to be most interested and suited to participate. Six persons were engaged, four males and two females. The group turned out to be rather young (25-45 years old). Some basic characteristics of these persons are found in table 1. It should be noted that all participants are supposed to belong to group C according to Kylén’s classification, i.e. persons with mild intellectual disability. Some of the users in the mentally disabled group had personal experience from the use of a PC. Three males and three females formed the group of non-disabled. In the control group all had personal experience from the use of PC. Only one person had experienced a video conference before.

4.2 Methods

The apartment was shown to the intellectual disabled on a video shot by one of the staff of the KDV at a visit to the comHOME apartment several weeks before the actual study. The study was also presented at a meeting at KDV where the majority of the intellectual disabled participated.

The main method used for the study was video recorded observations. The observations were carried out around the two different set-ups, the videoTORSO and the workPLACE. In each of these set-ups the user had to perform certain tasks that aimed at getting the individual to use the system and some of its functions. The users where sometimes “pushed” in some direction, e.g. asked to move to a place in the room where they could not be seen by the remote person, or to move closer to the screen in order to watch changes in their behaviour. The users where guided by two persons during the interview. One was a person in the room. Although some intermediate instructions were given, the intention was not to interrupt and interact. The other person was the remote communication partner. There was also a person in the room from KDV known to the user. This person stayed in the room primarily to make the user feel more secure and in case the user had to be supported. This person though, was asked to stay in the background as much as possible. The observations aimed at studying the use and behaviour of the users in action. Later analysis aimed at finding out if there was any "normal" use of the systems as well as to find interesting differences between different individuals of both groups.

A short semi-structured interview was carried out with the users, without the system running, as a follow-up of the experience thereby acquiring some more understanding of the study and clarifying some questions.

4.3 The tests

Every study took about one hour and consisted of the consecutive testing of the two comZONES described earlier. Initially the user study started with a welcome and a short presentation of the comHOME apartment and a description of the study. Each test situation started with an explanation of the functions of and the ideas behind the comZONE to be tested. This part worked fine and in general there was no problem to get the users to start to use the system although in some cases it was difficult to have the user fully to understand how the system worked before trying it. The person from KDV normally didn't have to support very much at this introducing interview. The workPLACE test set-up is illustrated in figure 4.

The test person was then invited to start the conversation. (For the videoTORSO the person on the screen appeared automatically without any interaction of the user. For the workPLACE the user had to enter the "public zone" under the lowered ceiling to make the person on the screen appear.) Each session took between ten to twenty minutes and the interview was monitored by the person on the screen. The person in the room only interacted when the communication tended to stop and could then bring the test forward. Observations and interviews of each comZONE were video recorded.

The six interviews with the intellectual disabled were then followed by the interviews with the non-disabled user group. The interviews with the non-disabled group where carried out in the same way as with the first group. The principle differences were that the tests generally continue a little longer and that the non-disabled test-person didn't know the person on the screen, in contrary to the case with the disabled.

The design of the comZONES during the study was modified from the normal set-up in the comHOME apartment. This was done with regard to the applied technology and to the adjustment of the limits of the private and public zones. These adjustments became necessary because the technical system of tracking the persons position was not yet working properly. Also, the turn on and turn off of the system had to be done manually.

4.4 videoTORSO

Most significant with regard to the videoTORSO set-up was that the whole room formed a *public zone*. The only restrictions were the limitations due to the camera angles and that the zone was turned on and turned off by the interviewer at the start and the end of the test session. All the technology in this set-up was fixed without any tracking function of the camera, which in fact was an early idea that couldn't be implemented for this study.

The set-up for the videoTORSO consisted of a Pioneer PDP-501HD 50" wide-screen monitor oriented in a 90

Figure 5. Left: a male user of 45 years with CP-injury tries to use sign language on the desk-top video set-up but it shows up to be almost impossible due to the small image and low resolution. Right: a 21 years old male with MDB/DAMP reads out loud the content of a directions for use folder at the videoTORSO.

degrees angle. On the side of the monitor was mounted a Toshiba IK M36PK video camera, chosen for its small size and to be noticed as little as possible. A Neumann KM100 microphone was positioned on top of the stand, and a Fostex 6301B active loudspeaker was placed at eye level beside the monitor, in order to simulate to high an extent that the sound originated from the mouth of the person displayed on the screen. The four signals were routed to a Fostex Hexamix MN06 mixer-board in the living room. In the room of the remote place, two large back-projection monitors mounted in the wall where used. The image of the videoTORSO camera was displayed on the left of these monitors. A Sony EV1-D31 video camera was mounted at eye level and in front of the monitor. The reason for this was to create a direct sensation of eye-to-eye contact, in spite of obscuring a minor part of the visual field, figure 5, right.

The person conducting the test was then placed in front of the camera at a distance of approximately 1,5 meters, which gave an exact match of the people' length on the wide-screen monitor. This person was wearing a Nokia LE-125 Microphone mounted to the chest, and the signal from this was routed through the aforementioned mixer-board to the videoTORSO loudspeaker. The person was also wearing a pair of small headphones, which were used instead of a loudspeaker to minimise audio leakage to the kitchen where the tests took place. Audio levels were adjusted to a subjectively correct level, checked by four different persons.

4.5 workPLACE

Regarding the workPLACE there were only a *public zone* and a *private zone*. No *semi-public zone* was simulated. The idea was that it should be made as easy as possible to evaluate and test the principal research question of the workPLACE, i.e. how the spatial design indicators where used and interpreted. Therefore the difference was made more clear, with a *public zone,* the inner araea indicated by the cloud-like ceiling and the shape of the table and a *private zone* as the outer area. The switch on and turn off of the system that was supposed to function through the user's positioning of himself in the room, by moving inside and outside the public zone had to be simulated manually in the following way. The interviewer stood in a doorway inside the room with the workPLACE. He had his arm outside the room within visual contact with the place where the remote person and supporting personal stood. By signalling he could have the remote person simulating mute microphones and a dark screen when the test person moved to the private zone and to appear again on the screen when reentering the public zone. The simulated system worked fine and seems to have fulfilled the requirements for the purpose of the test.

The set-up of the workPLACE consisted of a Dell Inspiron 7000 laptop computer positioned at the middle of the desk. On the top a Videumcam VC-1010 video camera was positioned connected to the computer, and the video communication was established through the video conferencing program CUSeeMe. Beside the computer was placed a Neumann microphone and a Fostex 6301 B active loudspeaker. The signal from the Microphone was routed through a Symetrix SX202 Dual Microphone Preaamp to the Fostex mixer in the living room. The size of the image on the 15" monitor was approximately 7" and showed the head and shoulders of the remote person.

The person monitoring the test was once again positioned in the room of the remote place, this time facing a Sony EV1-D31 video camera connected to a PC with a Framegrabber card. The sound was provided through the headphones and the Nokia microphone.

5 DISCUSSION

The involvement of users with intellectual disabilities has been very valuable and has very clearly shown the need for simple and clear set-ups with regard to both technology and spatial design. The close co-operation with Kungsholmens Dagliga Verksamhet during the whole period of the user tests - from the planning to the following up of the study - prevented us from committing simple mistakes. It also secured a smooth and enjoying interview process and provided us with a lot of valuable background information as well as interesting opportunities for reflexion.

One direct result of the collaboration in the planning of the study was that the *semi-public* zone, where one can be seen but not heard, placed in between the public and the private zone, in the *workPLACE* was. This was done to make the borders between the public and private more apparent to the users (WYSIWYG - what you see - and hear - is what you get, here is given an extended interpretation). This phenomenon with more clear borders is something to be pursued with the future development of this specific comZONE.

5.1 The method

The actual test situations worked out fine and it seemed to be little problems for the users to use the systems. Neither we saw much of fear for the technology nor for the test situation. This might, however, be an outcome from the earlier contacts with the users and the presentations of the study. The follow-up interviews did not give much information. The participants had difficulties in reflecting on their own experiences, most likely as a result of their disability.

5.2 The interaction with the videoTORSO

The key issue of the understanding of the idea of the videoTORSO is the question of representation. The fact that the screen figure is not a real person is obvious even for the individuals with intellectual disability of this study. As mentioned, Kylén (1983), has chosen to call the ability of abstraction levels of intellectually handicapped people A, B and C. On level B or higher, which refers to all participants in this study, picture symbols, e.g. photographs or mirror images, are understood as symbols. However, this does not explain how the representation we have produced *feels* like for an individual. By observations of the participants behaviour engaging in videoTORSO communication it appears as the behaviour is similar to what would be expected for a face-to-face communication. There is no noticable difference between the disabled and the non-disabled in this regard. The physical size of the pictorial representation on the screen is close to a 1:1 relationship to the real person, displaying about 3/4 of the full body. By acting as a present person, at same place as the representation, the remote person seems to get similar responses to her actions as for the normal face-to face communication. The user receives both mental and emotional confirmation that it works to assume that the person is present in the room. One intention of the design of the videoTORSO as a VMC-artefact was to allow socially oriented communication, taking into considerations the special limitations and possibilities that individuals with intellectual disability have. A conclusion from this study is that the videoTORSO has enabled the communication it was designed for. Another conclusion from the observation can be that it has a potential for all kind of users, maybe even for individuals with more severe intellectual disability than encountered in this study.

In several ways the videoTORSO can be designed for more realistic tests. It is, for example, not possible to keep eye contact when moving around in the room. In fact it is not even possible to look each other straight in the eyes, because the camera is not placed in the middle of the videoTORSO. Depending on the camera angle and the participants' different heights, the point where a natural eye contact is best perceived is moving, and sometimes it is not even possible to find the right angle.

Observation in the study show that participants chose to stand more far away from the person on the screen compared with what would have been a normal distance in a face-to-face communication. Why not as close as in normal conversation one might ask? One aspect might be the above mentioned difficulties to find an angle for natural eye contact, or may it be that it is unpleasant to be close to a bright 50" video screen or is it the representation on the screen that is unpleasant to get close to? Yet another aspect may be that being too close the small dots on the screen, building up the representation, will become visible; in other words, the illusion of reality will be lost. These and other aspects ought to be taken in du account at future studies of the VMC artefact, the videoTORSO.

5.3 Private and Public Zones

Design can aid individuals to observe cause and effect at different levels of abstraction. The private and public zones in the workPLACE can be addressed by design experiments. Although some of the users did not intellectually understand a certain function, all were more or less able to control the function of the public and private spaces moving their bodies in and out. The concept of private and public zones is obviously general. If the design supports the cognition of private and public zones at a lower level of abstraction, it will probably also increase the possibilities for others as well. The theories of different stages in human cognitive development might be a way to understand how to design artefacts and the environment to best serve human needs. Intellectual capacity enhances understanding. Understanding, however, often is not necessary for an individual in order to act in his best interest. Relaying on emotions may offer better results. As Kylén (1983) describes, the thought process for decisions and weighting is made between emotional information and knowledge. This is important because the intellectual disability is not direct related to the emotional capacity, but can indirectly affect and limit the emotional development. Generally speaking, much insight for the development of genuine user-oriented interfaces could be gained by acknowledging emotional capabilities. Studies with persons with intellectual disability may be an important source in this respect.

5.4 The design of a home

How the architectural design supports the individual in his home environment depends on the level of abstraction of the design. This has to be taken into account at the design of homes for people with intellectual disability. "The limits of abstraction level of thought cannot be increased through training, but the experiences gained at that level can be rich, adequate and extensive. ... The functional intellectual capacity is the product of the biologically determined abstraction level and the experiences the individual has the opportunity to undergo." (Kylén 1983). The design of the home environment, especially with the integration of VMC, gives the home a certain structure and symbolic meaning. The design can as a language be executed at different levels of abstraction. There is a choice at the design of a home, including VMC functionalities, supporting the concepts of space on either an intuitive, concrete or an abstract level.

5.5 Conclusions

The idea of *private* and *public* spaces seem to have been captured by the users and our feeling is that video mediated communication with its rich information environment in general can well be used by people with intellectual disabilities. This rich media environment also might permit a user with less physical or intellectual capacity concerning some aspects of the communication to compensate this with other qualities the user may have.

A final conclusion with regard to artefacts, including homes and VMC, is that they ought to be designed to allow communication and decision-making based on emotional information as well as on a simpler and more concrete picture of reality. That would be one way to consider the special limitations and possibilities that individuals with intellectual disability have. This consideration will increase the possibilities for other groups as well, for example children, and perhaps to some extent, for all users.

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