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Editorial Preface

Psychnology is a very young journal, but is developing rapidly. Each successive number attracts broader interest, both in terms of the span of approaches contributed and the geographical origin of contributors and, presumably, readers. This is exactly how it should be. Psychnology is an electronic-only journal, which permits more rapid and flexible editorial approaches than are possible with traditional print-based publications. But Psychnology is also a serious journal, with peer reviews of articles, professional presentation, and full archival status. So, young and yet serious: much like the field the journal covers, the evolving relationship between people and ICT (information and communication technology). Each sides of this relationship impacts on the other. Technologies must be designed, or evolve, in ways that match the capabilities and limitations of the people who use them. On the other hand, technology changes people; in fact it could be argued that without ICT, understood in its widest sense, people wouldn't be people. While this has always been the case, the rapid pace of technological innovation makes the changes to people brought by technological advances vastly more salient than in earlier times.

The target topic for this issue of Psychnology, Future Interfaces, puts the focus firmly on the potential changes to everyday life that new ICT will bring to us. As the Call for Papers indicated, a clear trend is to design and develop technologies for specific purposes, needs and situations, such as mobility, group collaboration, disability, age, and so on. And of course another trend, as exemplified by this journal, is towards virtualisation; not only of information, but also of processes, organizations and activity patterns. The call produced a rich response in the form of a large set of submitted papers from around the world, on a diverse range of topics highly relevant to the theme of the issue. So much so that accepted papers had to be distributed over two issues; in issues three and four you will find a total of 10 papers on the special theme of Future Interfaces, and 3 papers of more general interest, from Finland, France, Germany, Italy, Japan, Spain, Sweden and the UK.

The first series of papers in response to the call open issue number three. Our own invited paper on the Exploratorium (*Waterworth et al*.) presents a way of linking the body, the mind and the emotions. A wearable device called the Body Joystick allows immersants to explore a multi-level virtual world using only breath and balance. By linking the emotional contents of the levels to the way of breathing of the immersant, we aim to provide a form of "psychofeedback" through embodied navigation.

Looking at more specific uses, *Fukuda and Bubb* present a study of eye tracking to compare young and more elderly users of an electronic timetable service. While both groups exhibited common difficulties arising from poor design, the elderly group were less flexible in their information gathering behaviour. The paper provides a usefully detailed description of the use of eye tracking as an evaluative technique.

The following paper by *Carmichael at al.,* on the VISTA project, deals with the important topic of accessibility of guidance to services available through digital television. As the authors point out, the expanding range of such services into areas such as e-banking, e-government and e-business provides many new opportunities, but often at a high cost in terms of complexity of use. The authors describe evaluations of an

on-screen, talking and listening avatar who provides an intermediary between users and services. The results indicate both the potential and the difficulty of providing flexible conversational interaction, and also draw attention to the need to take the characteristics of specific groups of users into account. What is clear is that such activity based design will be increasingly important in the future.

Moving to the World Wide Web *Garcia and Sicilia* suggest a more general ontology-based approach to supporting information seeking on the web. This permits more nuanced styles of querying for information than are currently provided by query-formulation interfaces based on word indexing. Essentially, the approach calls for the identification of shared semantic categories in the way groups of people make sense of information, and using this knowledge to design more meaningful interactions with sources of information. This is an important step towards the evolution of a more "intelligent" Semantic Web. *Menezes* examines the role of feedback when education is carried out "in virtuality", both in terms of discussion groups and on-line courses. She uses an ethnographic approach to identify strengths and, especially, weaknesses and suggests that, through extended experience and communication, feedback can lead to a viable community of learning – a "collective intelligence" built by all participants.

The two papers of more general interest in the current issue both concern highly topical research. *Retaux* suggests an account of the sense of presence, in this case within video games, based on activity rather than separation between the physical and the virtual. This is important work, which will hopefully lead to a more fruitful conception of the role and determinants of presence. *Castelnuovo* et al. expand work in the burgeoning field of VR for mental rehabilitation. They analyse the value added by VR over more conventional environments, and describe the V-STORE and its use in the treatment of patients with Dysexecutive Syndrome.

It has been a great pleasure for me to serve as Guest Editor of these two themed issues of Psychnology journal. The collection of papers in this and the forthcoming issue provide clear and fascinating pointers towards Future Interfaces.

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The Exploratorium: An Environment To Explore Your Feelings

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ABSTRACT

The Exploratorium is a virtual environment within which immersants can explore both places and feelings. The "narrative" it implements is structural/architectural rather than linear/story telling. Different areas of the Exploratorium present different experiences: scary, normally busy, or very calm. At the same time, the Exploratorium as a whole is fundamentally safe, a self-contained play area. Immersants are free explore the different areas, under their own control. Navigation is by means of the Body Joystick, using only breath and balance. Using balance for movement and turning feels natural, like riding a bike, flying, or skating. Using breath control maps naturally onto vertical navigation, as in diving and snorkelling. Physiological changes induced by breathing patterns are reinforced by mood changes induced by moving from one zone to another, creating a form of "psycho-feedback by navigation". The goal of the Exploratorium is to stimulate curiosity, leading to navigation and a consequent sense of control and empowerment, at the same time as the user experiences, explores and investigates her own feelings and emotions.

Keywords: *feelings, emotion, the body, navigation, exploration*

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1. Introduction

Emotions are a very controversial and intriguing concept. Nobody fully understands them and yet no creature can function without them. In fact emotions are essential to the survival of all animal species. They play a very important role in the life of every human being. All people have emotions, can recognise emotions in others and sometimes try to control or suppress their own feelings or affect other people's feelings. Without emotions we would not be able to cope with everyday life, make decisions or solve problems (Damasio, 1994).

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New information technology has shown great potential in evoking both feelings and emotions in users. Many computer games are very successful in engaging the player in this way. A relatively recent and related research area within Human-Computer Interaction is to understand how and when a feeling of presence is connected to the use of new information technology, how presence relates to emotion and if it is possible to increase the level of experienced presence to abnormal levels (so called Superpresence, see Waterworth, Riva and Waterworth 2003) by the use of technology.

In this paper, we describe a virtual environment, called The Exploratorium, which is based on a novel way of interacting with a virtual world. The interaction is designed to be natural and in harmony with both the user and the contents of the environment. A basic principle behind the design is that the interaction should not need much of the user's conscious attention to control the navigation itself.

The Exploratorium was developed as part of the EU-funded EMMA project -Engaging Media for Mental Health Applications [http://www.emma.upv.es/].

The main idea behind the Exploratorium is to evoke different kinds of emotion in different areas of the virtual space, and when the user explores and experiences these areas she recognises, becomes aware of and gets in touch with her own feelings and emotions. One of our hypotheses is that the user, after practice in the Exploratorium, will learn to some degree how to control her feelings and to stay in balance with herself. The main aim is that, in that way, she will be better able to act in everyday life by getting a harmonic balance between body and soul.

An additional goal of the Exploratorium is to investigate the relation between presence and emotions. One hypothesis to be tested is whether different kinds of emotion, such as fear and calmness, evoke different degrees of presence and its opposite - which we call absence (see Waterworth E, Waterworth J. 2001). In other words, are some emotions more specific to a sense of presence, and others to a feeling of absence?

The article starts by describing the theoretical background behind the environment and the interaction style. Following that is a description of the environment (The Exploratorium) and the interaction device (The Body Joystick). The article ends with a discussion about future work with the Exploratorium.

2. Presence and emotion

Today there is a big debate about what presence is and what it is not. There exists no unifying definition of presence that everybody agrees about. Waterworth and Waterworth (2000) suggest that presence arises when we mostly attend to the currently present external environment. An implication of this is that a person has to perceive the environment that presently surrounds her, through her senses rather than in imagination, whether it is a virtual environment or physical reality. By this account, presence is primarily determined by the balance between processing internal (imaginal or conceptual) information and external (perceptual or sensory) information, and it can be experienced in response to both the physical (external real) and a virtual (externally modelled) environment. We have extended this two-dimensional model to include a third dimension in later publications (Waterworth E. L. and Waterworth J. A., 2001). In this three-dimensional model, the *Focus* dimension refers to internal (conceptual) versus external (perceptual) processing, the *Locus* dimension refers to presence in the physical versus a virtual world and the *Sensus* dimension refers to the level of conscious attention ranging from unconscious to fully alert.

In a later paper Waterworth, Riva and Waterworth (2003) further developed the model and explained it from an evolutionary perspective, where it is possible to view presence as originating at three evolutionary and neurological levels; Proto presence, Core presence and Extended presence. The three level model aims to capture and reinterpret several currently widespread formulations of the factors underlying presence, such as attention level (Stappers et al., 1999), shifts in attention between the real and the virtual (Slater and Steed, 2000), immersion (Slater et al, 1994), and fidelity (Bystrom et al., 1999).

2.1 Emotion and Feeling

Like presence, emotion is another concept that is very hard to define and even here there is no unifying definition that everybody agrees about. In contrast to presence, which is a relatively new concept, the concept of emotion is very ancient and has been debated for centuries, although until recently it has been relatively disregarded in modern psychology. When discussing emotions it is inevitable to include a distinction between the conscious versus the unconscious impact of events on emotions. As long ago as 500 B.C. Anaxagoras stated that both animals and plants experience pleasure

and that all sensations (sensory perceptions) are accompanied by pain (which is unconscious). The feeling of pain becomes conscious only when excessively intense. Contemporary associates of his often tried to locate different emotions in different parts of the body. For example Diogenes of Apollonia (460 BC) argued that pleasure and pain are a result of blood aeration that is mediated by the tongue. Democritus (460 B.C.) asserted that happiness, a positive emotion, is a state of mental and physical equilibrium, while thoughts (cognitions) are a distributed interaction of some localised corporeal components. For example he argued that rationality resides in the chest, the control of behaviours in the head, resentment in the heart, while appetite resides in the liver.

Damasio (1999) differentiates between emotions and feelings and argues that feelings are the private and mental experience of an emotion, while emotions are outwardly directed and publicly observable. Hillman (1962) makes a simple distinction between emotion and feeling as that between the whole and a part. Hillman claims that "*Feeling is a particular psychological function disposable to consciousness*" (Hillman 1962, page 269) and that "*Emotion is an activity of the psyche as a whole*". Moreover he states that it is possible to have feelings under one's control while "*emotion always is partly beyond ego control*". It follows from these two modern views that we can have an emotion without being aware of it, but that having a feeling always involves consciousness.

Emotion can be seen as a gatekeeper between consciousness and the unconscious. There is an ongoing debate about consciousness, what it is, whether we humans are actually conscious, and if there is a split between consciousness and the unconscious. Velmans (2000, p 3) suggests that "*Our conscious lives are the sea in which we swim, so it is not surprising that consciousness is difficult to understand*". Some people suggest that consciousness is what differentiates human beings from other species of animals. To be conscious implies a state of wakefulness, whereas being in dreamless sleep or in other states such as coma usually signifies a state of unconsciousness. Consciousness and unconsciousness can be viewed as two different states of mind, given that the mind exists even when we are unconscious. Sometimes the term consciousness is used to represent current knowledge, even though much knowledge is unconscious at any particular time, such as that stored in long-term memory (Velmans, 2000). It is obvious that the relation between unconsciousness and the unconscious is extremely complicated, but we consider both aspects of mental life to

be important, that they are related to each other and that they both play a considerable role in evoking emotions and feelings.

Emotion is a very important constituent in order to create interesting, engaging and educational virtual environments. New technology can create emotionally arousing sensations in the user in order to produce motivation and interest. But too much emotion can give rise to the opposite effect, when the door to consciousness is closed.

2.2 Perceptually-Seductive Technology

In the design of the Exploratorium (see below) we have applied the ideas behind Perceptually-Seductive Technology, PST (outlined in Waterworth E. 2001). One important constituent of PST is the evocation of emotion through design. PST could be viewed as a general class of sensory augmentation given that it appeals to multiple modalities at the same time. The information is presented in concrete forms, non-linguistic forms that are directly interpreted by the body and thus not requiring abstract thinking. This form of presentation is much faster to understand than information that has to be interpreted conceptually (i.e. in a linguistic form) and produces higher degrees of presence than more abstract forms.

Usually the information in PST is presented in a 3D space. This 3D space could either be a personal or a shared space. Furthermore it could be based on and implemented as physical, virtual or as mixed realities. One approach to use it is to present information in so-called memory theatres (see Waterworth E.L. 2001), software instantiations of the mnemonic “method of loci” (Yates, 1966).

Recent technology such as virtual reality (VR) and augmented reality (AR) also makes it possible to experience the same information through several senses at the same time. This could be viewed as a simulation of the experience of synaesthesia, although the experience is through the technology, e.g. the technology is projecting the information in several different modal forms to the user. This characteristic is important in Perceptually Seductive Technology (PST) as a synaesthetic experience is assumed to be emotionally appealing.. For a non-synaesthetic person it is very hard to imagine this kind of experience, which has a life of its own and is emotionally-charged, sometimes even distressing. In Ihde's (1991) terms, there is an embodiment relation between the person and the technology; it is as if the technology were part of the user's body.

3. Rationale And Structure Of The Exploratorium

The Exploratorium consists of three “zones” arranged vertically, very loosely based on Dante’s Divine Comedy: Purgatorio (central zone), Paradiso (top zone) and Inferno (lower zone). Navigation between zones is by means of the body joystick (using only breath). Navigation on the horizontally arranged plane of each zone is also by means of the body joystick (using only balance).

The Exploratorium is intended to offer a virtual environment within which immersants can explore both places and feelings. It could be viewed as an environment for the user to learn, experience and enhance her own emotions and feelings. The "narrative" it implements is structural/architectural rather than linear/story telling. What happens there depends on what the immersants do in terms of navigation; if they don't do anything, nothing will happen. Different areas of the Exploratorium present different experiences: scary, normally busy, or very calm. At the same time, the Exploratorium as a whole is fundamentally safe, a self-contained play area. Immersants can, if they wish, experience the more challenging parts or remain in the more relaxing ones. They are free to explore the different areas, under their own control.

The goal of the Exploratorium is to stimulate curiosity, leading to exploration and a consequent sense of control and empowerment, at the same time as the user experiences, explores and investigates her own feelings and emotions.

We have chosen to limit interaction to navigation. Immersants are not able to select or move objects in the space, only to move around using the "body joystick" as navigation device. We thus emphasise exploration, and it is important that the Exploratorium should evoke enough curiosity in immersants so that they become self-motivated to explore.

The space is arranged in such a way that it relates metaphorically to mood or feeling state. The idea is that immersants can navigate between different zones within the Exploratoriuim and encounter surroundings that suggest, and even provoke, particular emotional states. The Exploratorium differs from most virtual environments as in that it emphasises the vertical dimension of navigation as well as the horizontal. In addition to visual features, the Exploratorium contains sound effects and music appropriate to each part of the Exploratorium.

Upward movement suggests improving or lightening mood, whereas downward movement corresponds to deteriorating or darkening mood. This rather obvious linking can be theoretically supported by, for example, the Experiential Realism of Lakoff and Johnson (e.g. 1980, 1999). The user should be able to move between zones to

experience different states, and using the body joystick should emphasise or amplify the changes as well as the sense of control over those changes. The Exploratorium is conceived as an environment in which to learn about oneself and one's body.

3.1 Purgatorio (central zone)

Purgatorio, the middle world, consists of a park, a part of a small city and a beach. In Purgatorio the user gets the right feeling of normality and there are features such as sounds (traffic, birds, children, wind, sea) in the appropriate places. This zone was partially based on existing work by our partners at the Universidad Politécnica de Valencia and Universitat Jaume I, Castellón (see Alcaniz et al. 2003). Given that the Purgatory is an image of everyday life with a park, city and beach it is large and interesting enough for visitors to spend a reasonable amount of time exploring the zone. In certain places it is possible for the visitor to navigate up into Paradiso (the top zone) and in other places the visitor might fall down into Inferno (the lower zone).

Figure 1 - An image of the Purgatorio zone

The city, beach and sea do not actually completely encircle the Park. Rather, it is implemented as a segment beyond which the user cannot stray. Buildings, rocks, and other features provide barriers to make this seem natural. The sea extends out to a horizon where it meets the sky in the distance. No sun can be seen, but this level is well lit.

3.2 Paradiso (heavenly zone)

"The only perfect view is of the sky over our heads"

Paradiso is designed so that the user will have an experience that reflects a relaxed, even transcendent state of mind – where things happen as if internally. Paradiso is located above the clouds, so the sun always shines. The sun remains fixed in one place. The view from Paradiso shows infinite sky above (and to the sides) and cloud layer below. As the visitor moves around Paradiso, she hears various Heavenly sounds in different places. The sounds are modulated according to how high the visitor flies. In the sky are mandalas with floating fairy castles in the background.

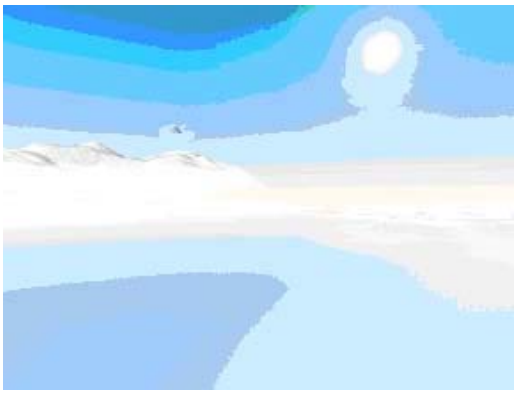

Figure 2 - Image from Paradiso

The visitor can sink down into the cloud, but only to neck level, i.e. the lowest viewpoint is the level of the top of the clouds. Collision detection prevents the visitor from going down through the clouds. If the user navigates into some specific areas she "falls" down to inferno (the hellish zone).

3.3 The Inferno (hellish zone)

The Inferno is large and complex enough to evoke feelings of getting lost and/trapped, of a bounded maze-like set of interlinked places, with no obvious way out. Outside the maze is a dead, dark garden. The entrance of the maze area provides access to "The Gates of Hell". The entrance is dark and wooded, with tense expectant music. Inside the Inferno, the visitor must navigate around the maze to get anywhere. This implies that collision detection is used to make the walls impenetrable. He cannot fly while in the inferno, but navigates around the floor.

This is an unpleasant place, with discordant sounds, sudden loud noises in unpredictable places, screams, noises of machinery, low frequencies, and explosions. Fog pervades the whole zone, with both distance and particle-based elements. Ghosts, or other unpleasant-looking things, sometimes emerge out of the fog. The centre of the

Inferno is a lively, large and noisy fire. Here there are also some of the most off-putting noises: screams, things smashing and breaking. It is unpleasant to be close to the fire.

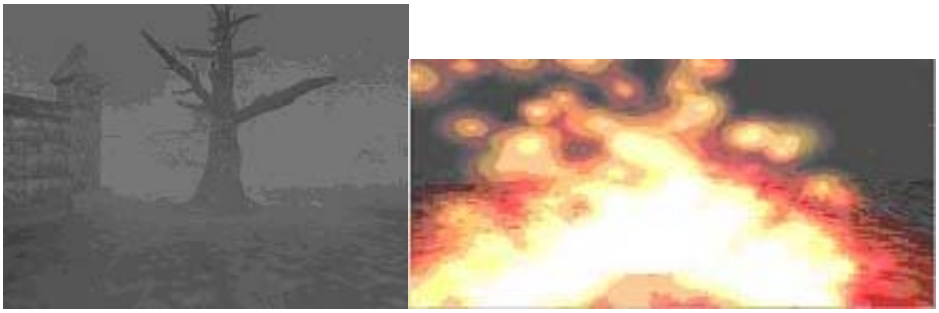

Figure 3 - Two images from the Inferno zone

The Inferno is bounded by the floor and roof, both impenetrable, and is circled by mountains forming a bowl. The mountains extend beyond Paradiso (above) and form a cusp into which the visitor falling from above will land. The visitor can climb a little way up the mountains but as they become more vertical no progress is possible – the falling visitor lands within this barrier.

There are a few places that can take the visitor out of the Inferno, via correct breathing (see 3.3 below) or “right” actions. Depending on the place the visitor is transferred to Purgatorio or to Paradiso.

3.3 Navigation in the Exploratorium – The body joystick

It is possible to navigate in the Exploratorium using a variety of devices, such as joysticks, wands, and so on, but the design is more specifically intended for use with the Body Joystick. The Body Joystick concept uses a vest, worn by the immersant, which includes sensors for both body orientation and chest expansion in breathing. It was inspired by the powerful immersive artwork Osmose of Char Davies (Davies, 1998). We have adapted the navigation idea by making the vest lightweight and wireless, and we do not use a Head Mounted Display but rather passive stereo using polarising lenses – which are extremely light to wear.

The immersant slips on the vest, and it is fastened across the chest. A small sensor and wire across the front detects expansion and contraction of the chest during intake and expulsion of air while breathing. Breathing in and holding the breath will result in the immersant moving up in the virtual space of the Exploratorium. Breathing out and

holding will cause the immersant to move down. Normal breathing will maintain the immersant at a steady vertical position. Movement on the horizontal plane is controlled by balance. If the immersant leans forward she will move forward in virtual space; leaning backwards results in backward movement. The immersant can turn right by leaning to the right, and left by leaning to the left.

Figure 4 - The body joystick

4. The Technical Set-Up

The Exploratorium set-up consist of two parts, the main part, the Aide Sensorielle, that is a practicing and experiencing component, and the Aide Memoire that can transfer the person back to the emotional state the feelings experienced in a certain part of the Exploratorium via memory evocation.

4.1 The Aide Sensorielle

The Aide Sensorielle consists of a one-wall CAVE made up of a standard PC with a decent graphics card. It runs under Windows and the VR software we use is called Brainstorm. For the immersive experience we use a Luxus™ Deluxe Screenwall Filmscreen 150 which is a 150 inch back projected screen with high contrast. The graphics card has two outputs and connecting them to two separate projectors we achieve passive stereo. We use two DLP™ projectors with a minimum of 2500 ANSI lumen. Each projector projects a picture for one eye. The light is filtered with circular polarized filters. This means the user has to wear special glasses, where each glass is also a special filter, but these are light and unobtrusive. For the user to be able to use her body movement via the Body Joystick (see below), there is a tracking system

involved. We use a wireless system from Intersense™ called IS-900VET. It is a 6-DOF tracking system giving instant feedback, and since it is wireless the user does not need to bother about cables.

4.2 The Aide Memoire

The Aide Memoire comprises a PDA and will be used as a reminder of the actual immersive environment (the Aide Sensorielle) and that can be used in an emotional situation in real life. For example when one has a panic attack on a bus, one could use the Aide Memoire to recapture the memory and mood of the Paradiso zone in the Exploratorium. The main goal of the PDA application is to enable users of the more comprehensive VR-applications to re-experience feelings from the 3D environment independent of time and place. The main idea is to bring to mind the feelings that the user experienced in the 3D environments in order to handle the emotional situation at hand.

The pocket-pc-application primarily uses a combination of small films, sound effects and images to achieve these goals. The films consist of short films from the 3D environment, and the sound effects are selected pieces from the VR-application. These small films and sound effects are in other words the same that are experienced in the 3D environment. The user is also able to choose audio-only presentation, and in this way can recapture, for example, a relaxing experience in an unobtrusive way while looking at other things (while walking around town, for example). In this way, the user will simply appear to others as if listening to music on a Walkman.

The small films enable a direct link between the two different applications and thus render possible a coherent experience for the user. The user will be able to select which part of the 3D environment he or she wants to be exposed to and that is most appropriate for the actual situation. Thus the pocket-pc application can elicit and arouse several different types of moods and in such a way act as a multiple mood device.

5. Conclusions

This article outlines the Exploratorium, an environment for getting in touch with one's own feelings. The environment encourages its user to explore, experience and develop her inner being. The main idea behind the implementation is to investigate the extent to which it is possible design environments and styles of interaction that maximise this

effect. Another main idea is to investigate the relation between presence and emotion. The environment supports and evokes different emotions and a future aim is to test whether different kinds of emotions produce different degrees of presence and absence.

Initial trials confirm that the Body Joystick is simple and intuitive to use to navigate around the Exploratorium. Using balance for movement and turning feels natural, like riding a bike, flying, or skating. Using breath control maps naturally onto vertical navigation, as in diving and snorkelling. Physiological changes induced by breathing patterns are reinforced by mood changes induced by moving from one zone to another, creating a form of "psycho-feedback by navigation".

The Exploratorium can be viewed as a form of sensory stimulation that helps its user to get closer to her true emotions and associated feelings, and in this manner get to know herself and her reactions better. This should support learning about how to stay in balance with herself in a way that extends to her everyday life.

Current information about the Exploratorium is available here: http://www.interactiveinstitute.se/tools/projects/emma/exploratorium.htm

6. Acknowledgements

We are grateful to all our partners in the EMMA project for their many contributions to the work and ideas presented here. See http://www.emma.upv.es/.

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Eye tracking study on Web-use: Comparison between younger and elderly users in case of search task with electronic timetable service

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ABSTRACT

The World Wide Web provides a variety of information and services, however, its usability is still under discussion. In order to clarify concrete difficulties in Web use, the behavior of younger and elderly users was observed with eye tracking during a timetable search task using electronic timetable systems on the Web. The result shows on the one hand common difficulties for younger and elderly users caused by an inconvenient navigational structure and an inappropriate page design. On the other hand, several important differences between the two age groups are confirmed. It suggests the necessity of particular consideration for elderly users in Web design.

Keywords: *WWW, navigation, eye tracking, ergonomics, elderly*

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1 Introduction

1.1 Methodology for studies on Web usability

The World Wide Web (WWW) has become one of the most popular services of the Internet. It does not only offer diverse information resources but also various online services such as banking, shopping, booking etc. Various technologies for Web design are developed and applied, however, they sometimes make Web use difficult. A questionnaire about the difficulties in Web use shows that a slow download of the page or data, time-consuming search for information, a complex site structure and out-of-date links disturb more than 60 % of the users (Van Eimeren & Gerhard, 2000). Of these a time-consuming search for information and a complex site structure are very critical issues from the ergonomic point of view. As these problems are also pointed

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out by the users with longer user experience, they are presumably not caused by the lack of the user experience but by inappropriate Web design.

The usability of a Website is already investigated by various methods. One of the most popular methods is the subjective evaluation. By using a questionnaire or an interview individual Websites are evaluated. One other popular method is the analysis of the log-files. The navigational behavior can be traced by using log-files and the search duration, applied hyperlinks and the followed way of navigation can be analyzed. Some investigations show that the hyperlinks provided in Websites are mainly applied for the navigation and that the “back” button of the browser is also frequently used (Catledge & Pitkow, 1995; Tauscher & Greenberg, 1997). However, the use of the “back” button of the browser sometimes causes confusion. Cockburn and Jones (1996) revealed that users lose their bearings if they do not understand the stack model for the “back” button correctly. Additionally they pointed out that the navigational button embedded in Web-pages such as “back to homepage” is less confusing. For the improvement of the orientation it is a useful way to indicate the current position on the Website. Of course the site and navigational structure itself should be clearly designed. An analysis of navigational behavior is also accomplished by combining the comparison of the hierarchical structure with different width and depth (e.g. Zaphiris, 2000) or different navigational structure (e.g. Bachiochi et al., 1997; Kim, 1999; Kim & Yoo, 2000) and their influence on navigational behavior is revealed.

In order to investigate the page design eye tracking can be applied. As human beings perceive 80 % of the information through the visual channel and human eyes voluntarily and involuntarily fixate on those elements of an object which carry or may carry essential and useful information (Yarbus, 1967), eye tracking data provides us plenty of cues in order to understand human behavior. Reading, visual search, scene perception, auditory language processing, problem solving, human-computer interaction, driving, sports, marketing, aviation, plant operation etc. are only a part of the issues which are investigated by using eye tracking (see e.g. Rayner, 1998; Duchowski, 2003; Hyönä et al., 2003 for the overview of eye tracking studies). Concerning Web use, unfortunately there are not many studies with eye tracking. However, they have revealed some important issues. Stanford Poynter Project (2000), for instance, analyzed the eye movements during free reading of online-newspapers and revealed that most of the fixations concentrate on text and not much on graphics. Photos are regarded frequently in a limited situation such as getting back to the

homepage after reading some pages. The eye tracking study in the specific information search by Ohno (2000) shows that users tend to focus frequently on the left hand side or upper part of the page rather than on the right hand side or lower part of the page. A similar effect is also confirmed in the study of Goldberg et al. (2002) which assigned navigational tasks and specific tasks such as customizing the displayed elements on the Webpage. Ohno (2000) shows furthermore that the fixation duration is mostly between 200 and 500 ms and hyperlinks and menus are regarded for a long time. Goldberg et al. (2002) revealed that the eye movement-derived parameters such as dwell time, scanpath length, and number of fixated objects, provided measures of task comprehension and expertise. These studies outline the characteristics of eye movements in Web use. However, the influence of the page design on the visual information perception is not clearly shown.

The conventional research studies mentioned above regarded either navigational aspect or page design aspect. As page design is strongly related with navigational structure (hyperlinks are provided on Web-pages), these two aspects of the Web design should actually be discussed together. This study therefore investigates the navigational behavior of users by using eye tracking data. The interaction between the visual information perception of Web pages and navigational behavior will be discussed.

1.2 Comparison between elderly and younger users

The user population of the WWW is continuously increasing. In recent years the increase of elderly users is especially striking. In Germany, 13 % of people older than 60 years old are using the Internet. The users in this generation account for 5 % of all Internet users. The popular services for elderly users are quite similar to those for younger users: retrieval of the latest news or economic information, trip reservation, online-shopping or online-banking (Fittkau & Maaß GmbH, 2000; Morrel et al., 2000). On the other hand there are also Websites aiming especially at elderly people typically providing healthcare information, information about senior-friendly products, information about internet courses for elderly people etc. As information and services help to improve the daily life of elderly people, the WWW can be regarded as one object of gerontechnology[1].

[1] The study of technology and aging for the improvement of the daily functioning of the elderly (Bouma, 1992).

Actually, the usability of the WWW is still under discussion. Even younger users sometimes have great difficulties with using the WWW. For elderly users the situation is more crucial due to the influence of the aging process. For instance, it is pointed out that elderly people have difficulties with memory or organizing of visited pages (Fittkau & Maaß GmbH, 2000). It is regarded as the influence of memory function on navigational behavior. The deficit of visual function can negatively influence the visual information perception from various Web pages. Tiny characters and navigational buttons, low contrast of individual elements to the background etc. can disturb it. Furthermore, due to deficits in fine motor control placing the mouse cursor on small hyperlinks can be a difficult task for elderly users.

The problem is that the technologies exceed the capacity of human beings. The technological development in this area is very rapid. Sometimes technologies precede human beings as users and it is no longer “for” users but “against” users. As already mentioned, this issue is particularly serious for elderly users. It is easy to imagine that the deficit due to the aging process can lead to a larger gap between technologies or products and user in the case of elderly people than in the case of younger people. However, technologies and especially all so-called high-technologies are mostly developed by younger people, not by elderly people. Such products aim mainly at younger people and special remarks for elderly users are not made. Therefore, there is still a lack of data on elderly people.

The acquisition of data on elderly people is not easy. Difficulties with recruiting the elderly people as participants due to the lack of contact to elderly people, foreignness of “investigation” or “experiment”, accessibility of elderly people to the research laboratory and inconvenient construction of experimental devices are factors which can disturb the cooperation with elderly participants. However, all these factors can be solved in some way. For instance, the conventional eye tracking devices require that goggles are worn for the measurement. It is quite inconvenient for elderly people, because they often require their own reading glasses to look at visual objects. The modern type of eye tracking devices requires no goggles or helmets and they are applicable also for the elderly people wearing reading glasses. By using such devices, the comparison of data between younger people and elderly people will be possible.

In this study therefore the focus is not only on younger people but also on elderly people as target users. It should be clarified what is common and what is different between the two age groups with regard to difficulties in Web use.

2. Experimental method

2.1 Participants

14 elderly people (age: 62–74, mean: 67.15) and 13 younger people (age: 17–29, mean: 22.54) took part in this experiment. All the participants were German native speakers and had no problem with using a keyboard and a mouse. Each age group was divided into two groups according to the experience of Web use. An intermediate group consisted of the users with an experience of one year or longer. The participants with less than one-year experience belonged to the beginner group.

2.2 Tasks and Procedures

The task assigned to the participants was to search for a certain subway timetable. It consisted of the following subtasks.

1. Navigation from the homepage of each Website to the electronic timetable service (the page with input form).
2. Input of the search conditions (name of departure stop and destination stop, date and time are given by the experimenter).
3. Retrieval of the timetable (navigation from the input page to the corresponding timetable).
4. Navigation between timetables (for same route but for different time – earlier or later connections).
5. Navigation from the timetable page to the input form of the electronic timetable service.

During the task accomplishment the use of the browser buttons was allowed.

The experiment was started by giving the instruction for this experiment to the participants. If a participant had no experience with using the electronic timetable service, the whole task was also demonstrated. During the demonstration participants could also try it by themselves for practice. Subsequently the eye tracking device was calibrated and the experimental session was started. The above mentioned subtasks were accomplished step by step according to the instruction of the experimenter. During the task accomplishment participants were requested to express their thoughts as much as possible. After finishing the task in one Website, participants evaluated the

Website according to 22 criteria using a seven point scale. This procedure was repeated for three Websites. The order of the Websites was changed among participants.

Thinking aloud is sometimes difficult for participants because it is not natural. In order to complete a deficit in protocols of utterances and to clarify reasons for particular behaviors an interview was carried out after finishing all the sessions. As the eye movement recording is a powerful tool to support verbal retrospection (Hansen, 1991), the recorded eye movement data with utterances was shown to participants during the interview.

2.3 Stimuli

Three German Websites, here called A, B, and C, of local transportation organizations were applied for this experiment. All these Websites differed in their navigational structure and page design. No modification was made in the Websites in order to investigate the difficulties of the users in a real situation. The specifications of the applied Websites are shown in Table 1.

For the analysis of the navigational structure at first the so called nominal navigation flow for the task was defined according to the procedure in system ergonomics (Bubb, 1993). It is based only on the user demand for the corresponding task and independent of currently available technologies or the navigation flow in existing Websites. With regard to the subtasks in this experiment all the navigation (subtask 1, 3, 4, 5) should be accomplished by one click on the corresponding hyperlink. The required search conditions can be input in arbitrary order (subtask 2). For the selection of Websites the deviation between the shortest navigational flow realized in each Website without using browser buttons and the nominal navigational flow was considered. If there is a deviation in navigational flow, namely, at least two or more steps are required for a given navigational subtask, some confusion is expected. In the analysis this point will be especially focused on.

2.4 Experimental Setup

During task accomplishment the eye movements, navigational behavior and the utterances of participants were registered. For the eye movement analysis the eye tracking device “Free View” (Takei Scientific Instruments, Co. Ltd.) was applied. This system was a video-based eye tracker utilizing the corneal reflection and the center of

the pupil for the eye movement measurement. No helmet or goggles was required for measurement, instead the camera set in front of the participant recorded the picture of the eye. The data collection frequency was 30 Hz and the data accuracy was 0.2 deg in visual angle. The locus of the eye movements was superimposed on the displayed Web pages in real-time and video recorded. With the help of a microphone the utterances of participants were also recorded on this videotape. All the coordination data of gaze points was recorded on the computer during the measurement.

The Web pages were displayed with the browser "Netscape 4.5" on the flat panel display (17 inch) at a viewing distance of 65 cm. This display size corresponded to 28.07 deg width and 20.49 deg height in visual angle. Figure 1 shows the experimental setup. The participants sat in front of the display and were fixed their head with using the chin rest in order to secure the data accuracy.

Table 1: Specifications of applied Websites

Features		Website A	Website B	Website C
Position of hyperlinks	Main menu	On the left hand side in the frame	On the right hand side in the frame	At the bottom of the page in the frame
	Submenu	Below the selected item in main menu	On the top of the main part of the page	(No submenu)
	Navigational button	At the bottom of the page	At the bottom of the page in the frame, on the input page far from the input fields	At the bottom of the main part of the page
Visibility of hyperlinks	Main menu	Always visible	Always visible	Always visible
	Navigational button	On the timetable page invisible without scroll	Always visible	On the timetable page invisible without scroll
Character size	Main menu	10pt	10pt	12pt
	Submenu	10pt	8pt	(no submenu)
	Navigational button	10pt	8pt	12pt
	Main part of homepage	14pt	10pt	12pt
	Main part of timetable	12pt	10pt	12pt
Required navigation per subtask	1 From homepage to input page	twice	once	twice
	3 From input page to timetable	twice	once	once

	4 Between timetables	Three times	once	Whole search process (input of search conditions and retrieval) is required
	5 From timetable to input page	once	once	once
Other remarks		Part of the design had changed during the experiment. 20 participants made this experiment with the old design and 7 participants with the new design.	Includes animated banners	For the second step of the navigation from the homepage to the input page of electronic timetable service, the instruction was given, because only one of two given alternatives did function.

Figure 1: Experimental setup.

3. Results

3.1 Visual search of the required navigational button

Eye movements in visual search for the task relevant navigational button differed from page to page. Figure 2 and Figure 3 show the examples of the observed eye movements in the case of Website B and C. The given subtask for both cases was the retrieval of the timetable (subtask 3). On the input page of the electronic timetable

service, subsequent to the input of the search conditions (subtask 2), the corresponding navigational button should be clicked on. On Website B (Figure 2) the required navigational button “send inquiry” (originally in German: “Abfrage senden”, (12) in Figure 2) was far from the input fields. Instead of the correct navigational button, directly under the input fields, a navigational button to the other electronic timetable service was provided ((10) in Figure 2). Furthermore, under this confusing navigational button there were animated banners ((11) in Figure 2). Between the banners and the correct navigational button there was some empty space. Therefore the gaze point hardly moved to the navigational buttons and most of the participants sought for the correct navigational button for a long time.

Contrary to this in Website C (Figure 3) the navigational button for the timetable retrieval “search connections” (“Verbindungen suchen”, (4) in Figure 3) was located directly under the input fields. Therefore participants had no difficulty with finding the correct navigational button.

The gaze point mostly moved to the nearest element in the search process. The large “jump” occurred only toward salient elements or familiar elements such as the main menu which was provided in a fixed position.

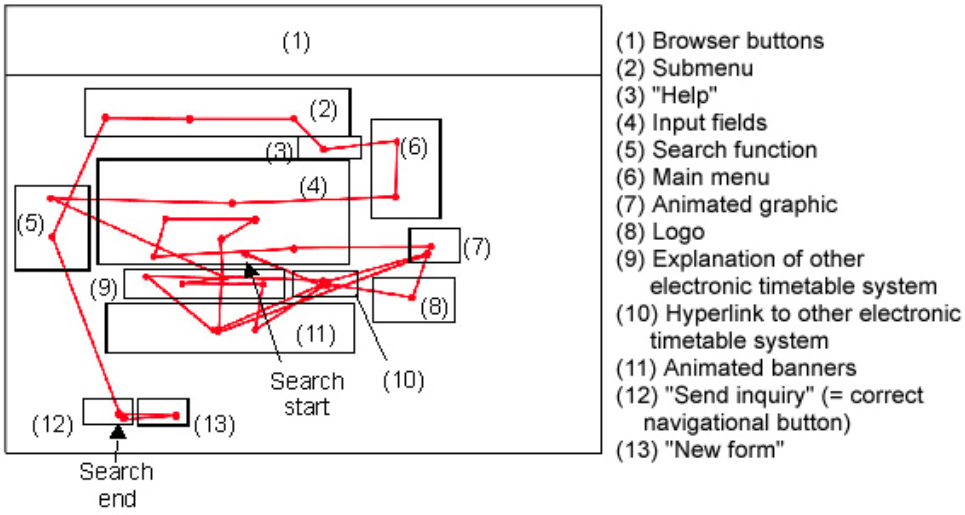

Figure 2: A typical example of eye movements for the retrieval of the timetable (subtask 3) on Website B: for the required navigational button “send inquiry” (12) was far from the input fields (4), as a result most of the participants required long eye movements to find.

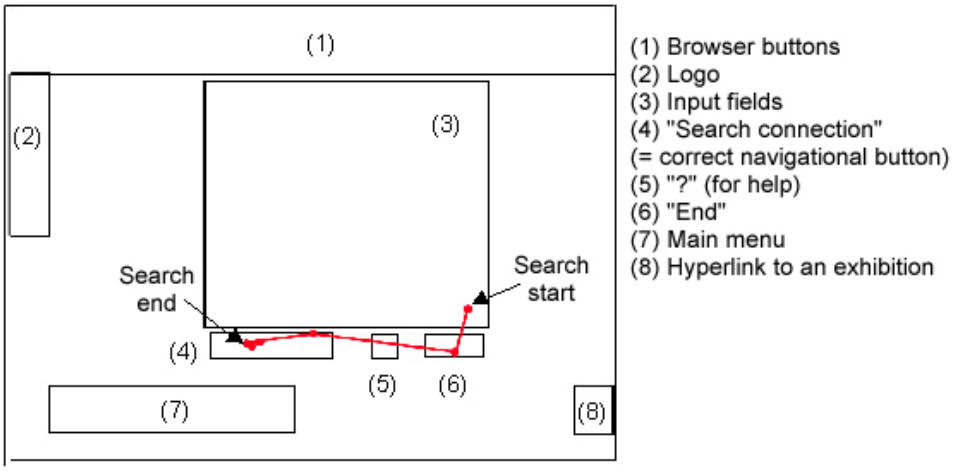

Figure 3: A typical example of eye movements for the retrieval of the timetable (subtask 3) on Website C: the required navigational button “search connection” (4) was directly under input fields (3), therefore it could be found with short eye movements.

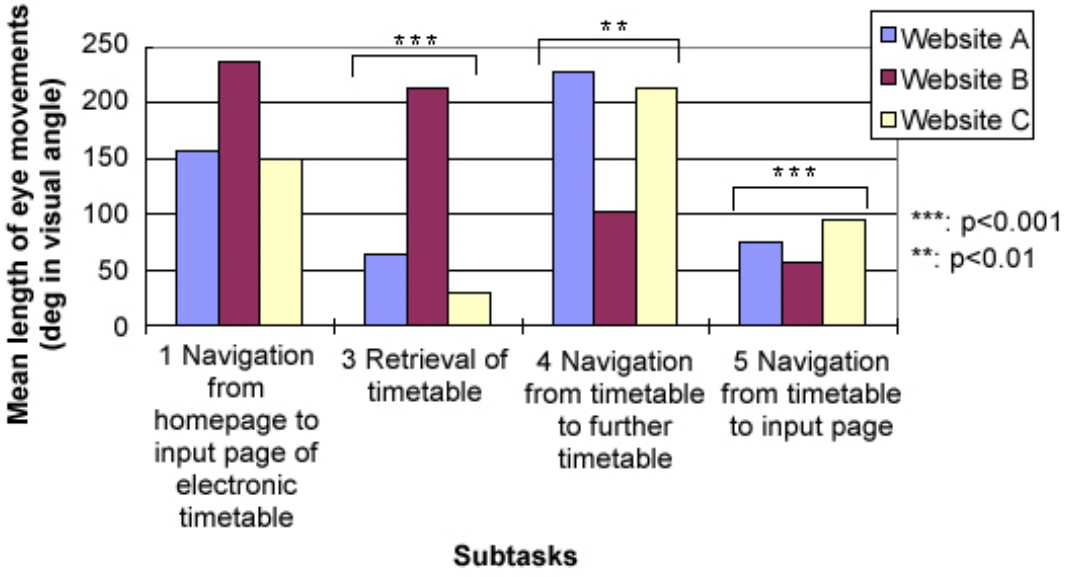

Figure 4: Comparison of length of eye movements between Websites regarding navigational subtasks: the required eye movements for retrieval of the timetable on Website B, for navigation from timetable to the further timetable on Website A and C, for the navigation from the timetable to the input page on Website A and C were significantly longer than on other Websites.

The length of eye movements on each page is outlined in Figure 4. For the navigation from the homepage to the input page of the electronic timetable service (subtask 1) and for the retrieval of the timetable (subtask 3) on Website B as well as for the navigation between timetables (subtask 4) on Website A and C extremely long eye movements were required to find the corresponding navigational button.

The homepage of Website B was designed as a subway map. Each hyperlink was likened to a station in a subway map. They were labeled with tiny characters and the correct hyperlink leading to the input page of the electronic timetable service was located on the top left of the page, immediately above a graphic in the middle of the "subway map". This graphic attracted the attention of the participants so that the elements below this graphic were mainly regarded. This task could also be accomplished by using the main menu. However, the main menu was located apart from the main part of the page. Similar to the retrieval of the timetable on Website B described above, most of the participants required long eye movements here due to the inconvenient location of the required navigational buttons.

With regard to the navigation between timetables on Website A and C (subtask 4) the corresponding navigational button was not visible without scrolling (Figure 5). In these cases participants looked around the page first of all and confirmed that the required navigational button is invisible. Consequently the page was scrolled and the required navigational button was sought further. This way long eye movements were required in order to find the corresponding navigational button. The difference between the Websites in the navigation from the timetable to the input page (subtask 5) was caused also by the invisibility of the required navigational button.

In addition the influence of the size of the required navigational button was observed. The design of Website A had changed during the experiment. For the navigation to the input page of the electronic timetable service the old version provided the choice "timetable" ("Fahrplan") in the main menu. It was so small that it was not conspicuous at all in comparison with the other larger hyperlinks in the main part of the homepage. Therefore most of the participants first looked around the main part of the homepage. Contrary to this the new version additionally provided a larger hyperlink "timetable information" ("Fahrplanauskunft") in the main part of the homepage. The attention of the participants was attracted immediately to this hyperlink. Therefore the length of the required eye movements was significantly shorter in the new version (67.7 deg) than in old version (181.0 deg).

The comparison between younger and elderly participants revealed a clear difference if a page consists of many small elements including the desired navigational button. On the above mentioned homepage of Website B elderly participants required longer than 300 deg on average to find the corresponding navigational button "timetable" and this was twice as long as younger participants take.

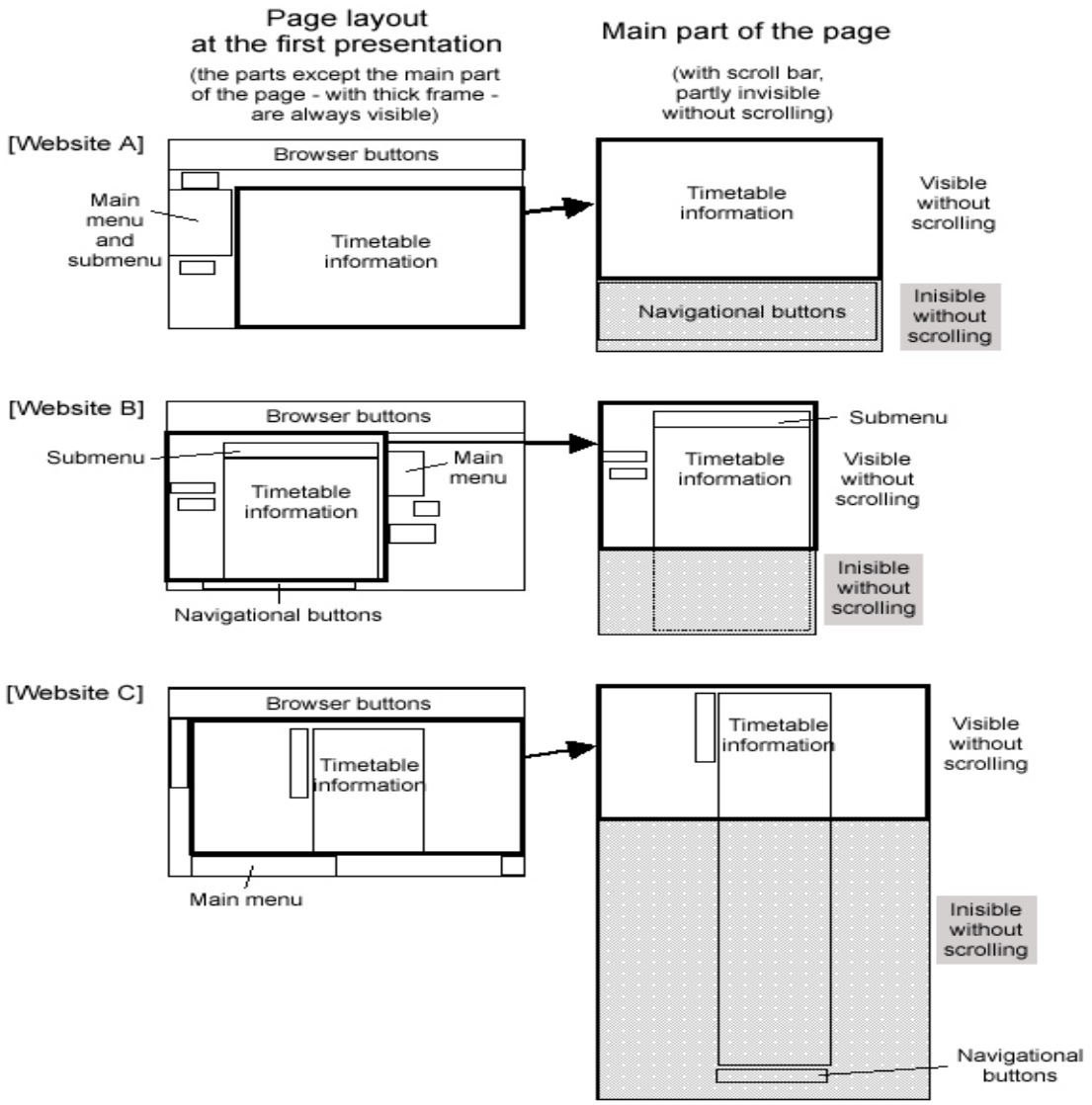

Figure 5: Design of timetable pages of Websites used in the experiment: navigational buttons required for the navigation from a timetable page to another timetable page (subtask 4) and to the input page (subtask 5) were invisible without scrolling on Website A and C.

3.2 Fixation Duration

The fixation duration indicates the difficulties in the perception of visual objects. It can be influenced both by their physical condition and by their semantic content. Figure 6 shows the average fixation duration on elements on the display. The main part of each page brings the essential information for the users. This part was mainly “read” by the users. Contrary to this the main menu and navigational buttons provide the possibility to navigate to other pages. Browser buttons have a similar function. The functional difference of each element was clearly observed in fixation duration. Fixation duration

on the contents for reading was generally shorter than on the navigation tools. Among all it was striking that the fixations on the main menu of Website A and B as well as on the navigational buttons of Website B were significantly longer than that of other Websites. These elements consisted of small characters, namely characters in 10 pt or smaller.

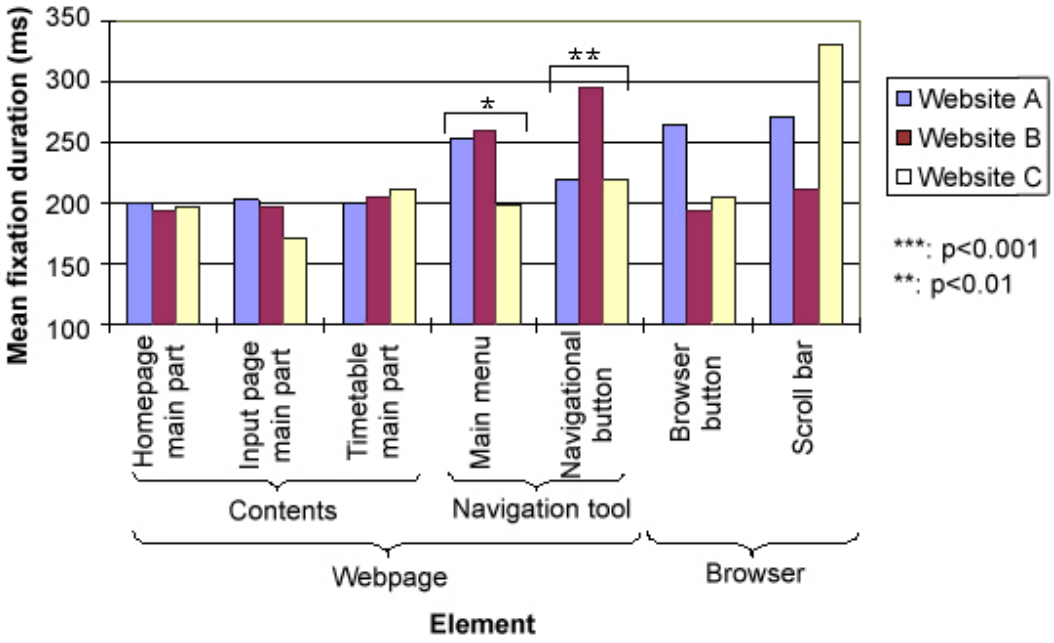

Figure 6: Comparison of mean fixation duration on elements on the display between Websites: fixation duration on navigation tools were generally longer than that on contents, especially small navigation tools caused longer fixations.

In general elderly people required longer fixation than younger people. In relation to the above mentioned small elements the difference between the two age groups was very obvious. As Figure 7 shows, elderly people required longer fixations than younger people for the main menu of Website A and B which consisted of characters in 10 pt, whereas the main menu or Website C labeled by characters in 12 pt made no difference. Although the difference regarding to Menu A ($p = 0.072$) and Menu B ($p = 0.100$) did not reach the significant level ($p < 0.05$), the contrast to Menu C should be remarked. The strong influence of the size of the element to handle was also observable on the narrow scroll bar. Elderly people definitely needed longer fixations than younger people.

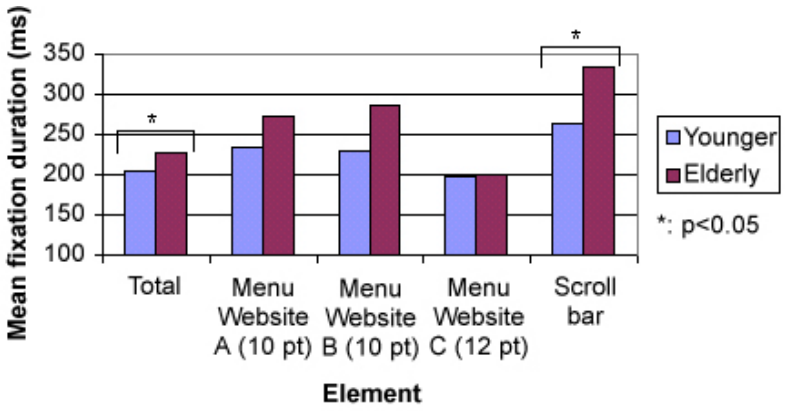

Figure 7: Comparison of mean fixation duration between younger and elderly participants: elderly participants required longer fixations especially on the small elements.

3.3 Navigational behavior

In the navigation some participants took the long way around. Among all, 85.2 % of the participants navigated differently from the shortest navigational flow for the navigation between timetables in Website A. Furthermore, for the navigation from the homepage to the input page of the electronic timetable service (subtask 1) in Website A (old design), for the retrieval of the timetable (subtask 3) in Website B as well as for the navigation between timetables (subtask 4) in Website A and C more than half of the participants did not follow the shortest navigational way. All these subtasks except the retrieval of the timetable in Website B required at least two or more navigational steps. These subtasks could be accomplished by one click in a nominal navigational flow. It is assumed that the gap between the imagination of the users and the real design caused confusion and different navigational behavior than the expectation of the Web designer. That becomes especially obvious in the utterances of the participants such as “There is no corresponding navigational button” during searching for the corresponding navigational button or “It is not the expected page” after reaching a new page by clicking on a navigational button.

On the other hand the retrieval of the timetable on Website B required only one click. This navigational step itself matched the imagination of the users. However, as mentioned in 0 (see also Figure 2), the visual search for the corresponding navigational button was difficult. As a result, more than half of the participants failed to find the correct navigational button. Here the influence of the page design on the navigational behavior was observed.

If the participants did not follow the shortest way, how did they navigate? Figure 12 shows an example of observed navigations from one timetable to another timetable (subtask 4) on Website A. This subtask could be accomplished by one click on the navigational button such as “earlier connection” in a nominal navigation. In the real navigation design on Website A however, three navigational steps were required: (1) go to the timetable overview by using the navigational button “overview” (“Übersicht”), (2) go to the timetable for the earlier time by using the navigational button “earlier connection” (“frühere Verbindungen”), (3) retrieve the detailed timetable by using the navigational button “detail” (“Detail”). At the first step the participants looked for the expected navigational button through which the timetable for earlier connections was directly retrieved. After the recognition that there was no such a navigational button the participants sought for the alternative navigational way. More than half of the participants here selected the browser button “back”. Some of them remembered the navigational button “earlier connection” on the timetable overview. Other participants thought that it could be a useful way to go back to the input page of the electronic timetable service, to modify the time and to repeat the timetable retrieval. A similar idea could also be realized by getting back to the input page through the navigational button “new inquiry” (“Neue Anfrage”). In order to “change” the timetable the navigational button “timetable change” was plausible, but it was the notification of the current change in timetable and did not correspond to the given subtask.

Concerning this example it should furthermore be noted that the deviating navigation also occurred due to the invisibility of the correct navigational button. The required navigational button “overview” was embedded at the bottom of the main part of the page so that it was invisible without scrolling (Figure 5). Some participants sought for the navigational buttons, however only in the visible area without scrolling. These participants therefore selected another hyperlink or the browser buttons that were visible. As the navigational buttons on the timetable page of Website A and C were laid out in such a way, the deviation observed on this page (subtask 4 and 5) was also influenced by the invisibility of the required navigational button.

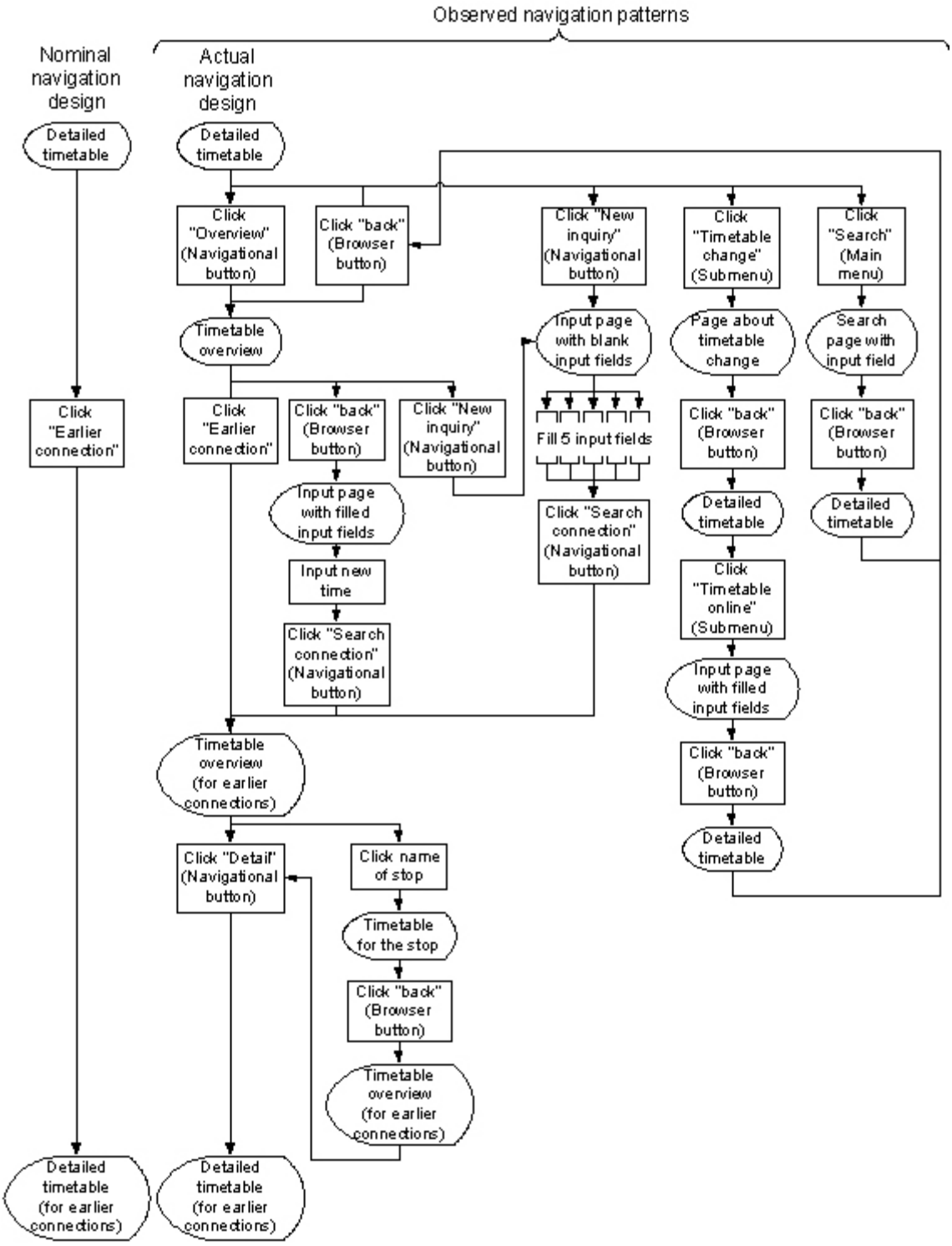

Figure 8: Flow chart of nominal navigation design, actual navigation design and observed navigation patterns in the navigation between timetables (subtask 4) on Website A: due to the deviation between a nominal navigation design and the actual navigation design, various navigation patterns were observed.

The observed navigation patterns which were deviated from the shortest navigational way can actually be divided into two groups according to the consciousness of the participants. In most cases the participants were conscious of having made a mistake after reaching an “unexpected” page. In such cases the participants frequently tried to get back to the page where the incorrect navigational button was selected and search for the “correct” navigational button. On the other hand the participants sometimes followed a different navigational way from the shortest navigational way in the given Website because that navigational way differed from their expectation. Due to the inconvenient navigational structure the participants had to think of an alternative way. Therefore the participants were not conscious of making a mistake in this situation. In addition, once the participants had noticed the inconvenient navigational structure they tended to apply their own navigational strategy in further navigation. A good example for that is the navigation from the timetable to the input page (subtask 5) on Website A and C. For this subtask about one third of the participants navigated differently than the shortest navigational way on the Website. Frequently the browser button “back” was applied instead of the navigational button provided by the Website. Because the foregoing subtask (subtask 4) could not be accomplished by one click due to the inappropriate navigational structure, some of the participants used the browser button “back” for that subtask (see also above the detailed description of the navigation between timetables on Website A). With this navigational strategy the participants reached the input page of the electronic timetable service. Based on this experience they did not regard the given navigational button much. The eye tracking data reveals that: the gaze point moves directly to the browser button in such a situation.

The application of one’s own navigational strategy was frequently observed in the case of elderly users. If they knew that one strategy had a success, they applied this strategy repeatedly. It sometimes caused a long way around. The elderly users tended to require more navigational steps. Among all the difference in the navigation between the timetables (subtask 4) on Website C and the navigation from the timetable to the input page (subtask 5) on Website A was significant ($p < 0.05$).

3.4 Duration of task accomplishment

Figure 9 summarizes the duration of each task accomplishment. With regard to three subtasks a significant difference between Websites was confirmed. The difference in the input of the search condition (subtask 2) was caused by the difference in the number of input fields. Website A provided only one input field each for the departure

and destination station whereas the other Websites provided two input fields each. Most of the remaining differences were caused by the navigational structure. If a subtask in a Website required two or more navigational steps (columns with dotted part in figure 10), it took longer than on Websites which required only one navigational step for that subtask. In these cases the duration until first click (lower half of each dotted column in figure 11) was rather short and not different from the duration on other Websites. Especially in order to retrieve the timetable (subtask 3) on Website A it took much shorter time for the click on the navigational button “search connection” (“Verbindung suchen”) than on other Websites. In this case further navigational steps caused a longer duration of task accomplishment.

On Website B it took also very long time to get the timetable although only one navigational step was required for this task. In this case not the navigational structure but page design was regarded as the main cause for the longer task accomplishment duration.

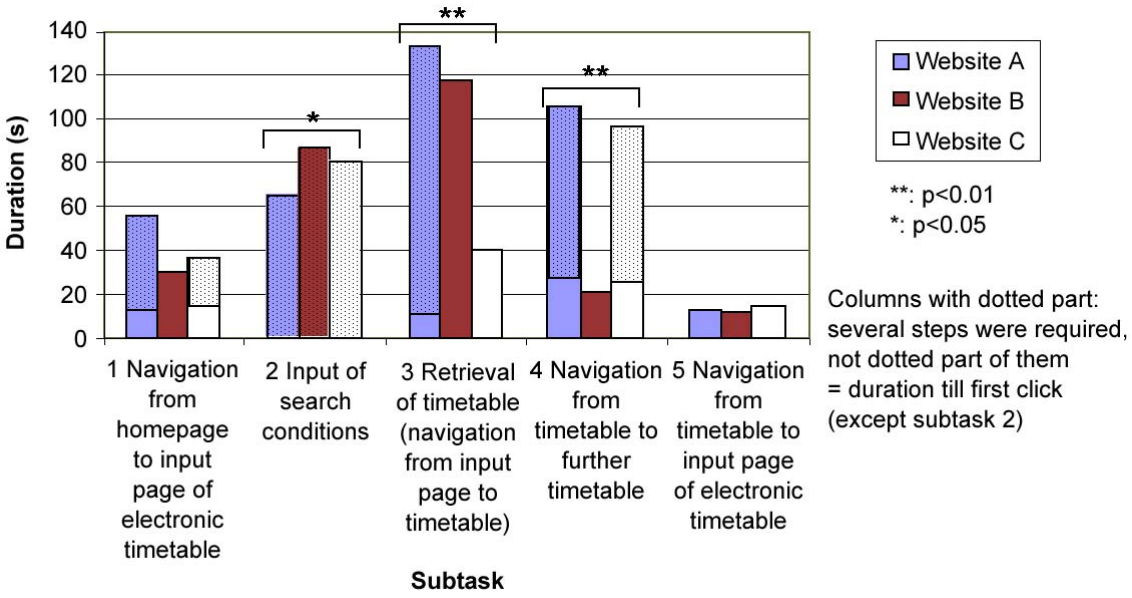

Figure 12: Comparison of accomplishment duration of each subtask: longer accomplishment duration was mostly caused by the multiple steps, in subtask 3 on Website B however by the inconvenience page design.

The difference between younger and elderly participants was very obvious. As shown in Figure 13, elderly participants required significantly longer than younger participants for most of the subtasks on all the Websites. Both inconvenient navigational structure

and inappropriate page design could strongly influence the task accomplishment duration of elderly users.

In addition it was revealed that the elderly users required more time to handle the input devices. Figure 14 shows the detailed analysis of the duration of various actions of the input task (subtask 2). It consisted of repeated placing of the mouse cursor on the target field, changing the hand from the mouse to the keyboard, input by using the keyboard (= typing) and changing the hand from the keyboard to the mouse. For all kinds of action, elderly users required approximately 50 % longer than younger users. Together with the longer duration on the scroll bar the difficulties in handling of the input devices due to deficits of fine motor function were observed.

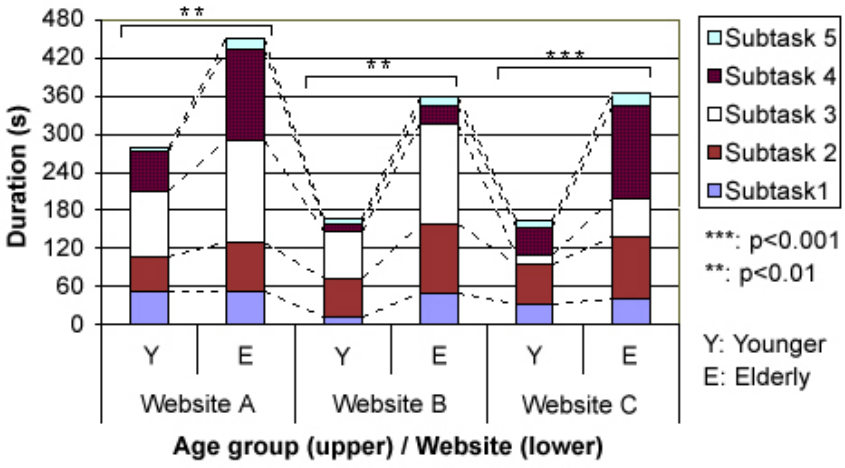

Figure 13: Comparison of task accomplishment duration between younger and elderly participants: generally elderly participants took longer time than younger participants, especially for the subtasks which required multiple steps and were accomplished on an inconveniently designed page.

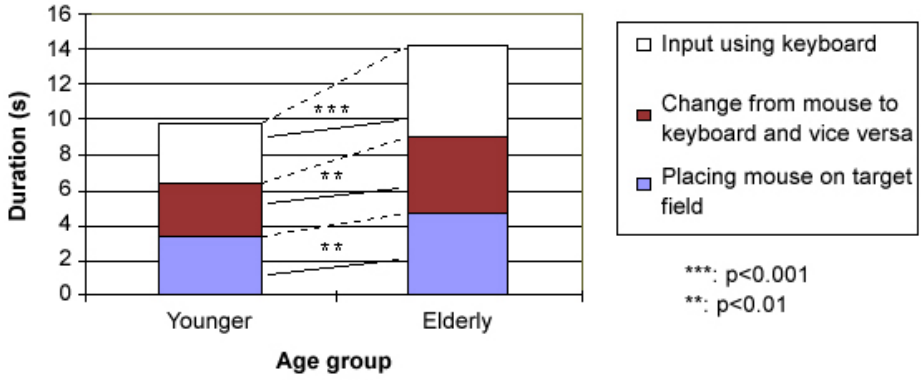

Figure 14: Comparison of duration of input task between the two age groups: for all kinds of action, elderly users required approximately 50 % longer than younger users.

3.5 Subjective evaluation

Although the above mentioned objective data revealed several difficulties in the search task most of the subjective evaluation was positive on average (Figure 15). Only the evaluation of the legibility of Website B was slightly negative on average. The differences between Websites were only observable with a view to the evaluation criteria which could be directly related to the objective data showing a clear difference between the Websites. With regard to legibility, layout, comprehensibility, orientation, and flexibility, there was a significant difference between the Websites. Among all, the legibility of Website B and the flexibility of Website C were obviously considered to be worse than that of the other Websites. Legibility is an important factor of page design and flexibility is related to navigation.

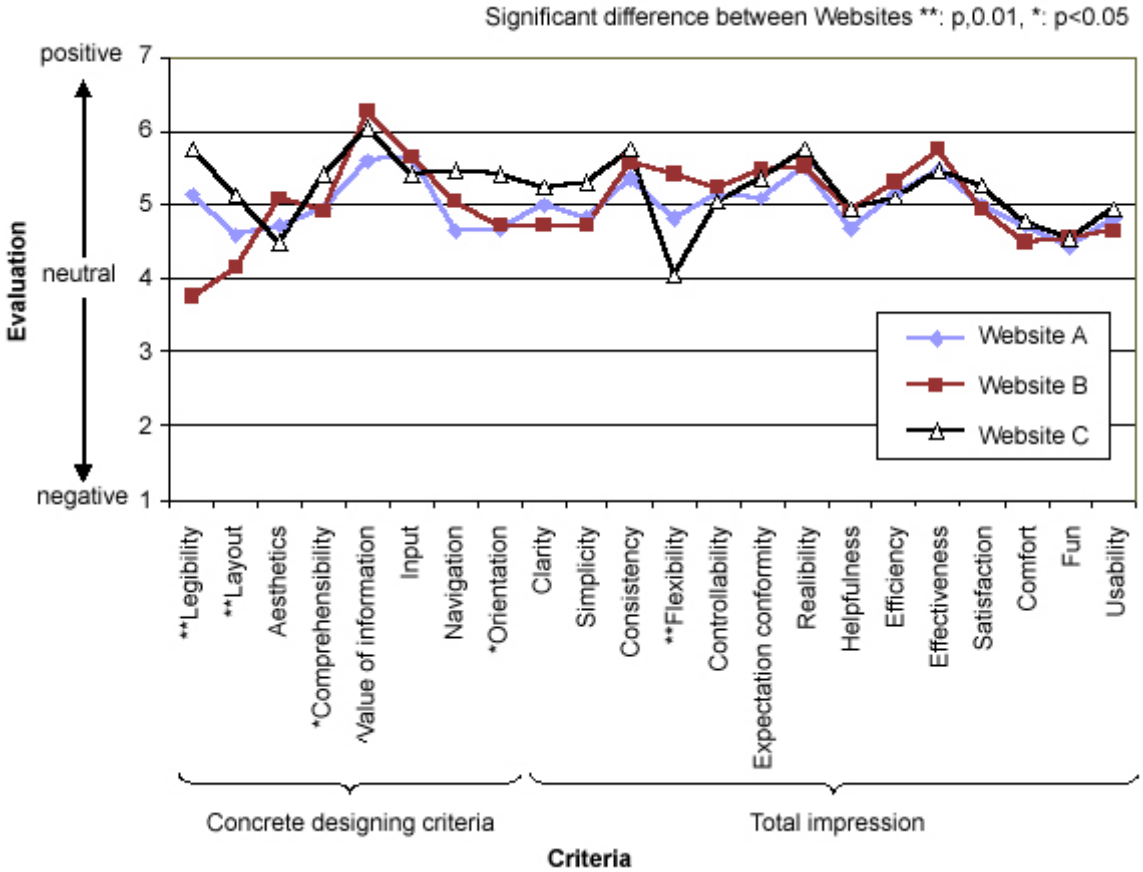

Figure 15: Profile of subjective evaluation: a significant difference between Websites was only observed with regard to few criteria.

With regard to the comparison between the two age groups, the evaluation of legibility by elderly people could be worse than the evaluation by younger people because elderly people required longer fixation and more eye movements to find the target navigational button. Actually, the difference according to age was not clear. On

the other hand the comparison between beginners and intermediates showed some significant differences. The evaluation by intermediates was generally more negative than that by beginners.

4. Discussion

4.1 Common difficulties for younger and elderly users

The results showed various common difficulties in Web use for younger and elderly people. Eye tracking data revealed that inconvenient page design leads directly to an inefficient visual search for the required navigational button and further navigational failure. The following three factors for inconvenient page design should be mentioned.

- Visibility of navigational button

If the target navigational button is visible only with scrolling this is very critical for easy use. First of all it takes long time to notice that the required navigational button is not visible. Therefore, long eye movements are spent for the visual search on the visible area of the page. After that the page is scrolled and further visual search is done in the area which appears new. As a result, in order to find such “invisible” navigational buttons, obviously longer eye movements are required than for the visual search for navigational buttons which are visible without scrolling.

More crucial is the fact that there is no guarantee that all the users scroll the page. In worst case the users fail to find the appropriate navigational button after a long visual search in the visible area of the page and select another hyperlink in that area without scrolling. The effect of the invisibility of the navigational button on the navigational behavior was observed in this experiment.

- Location of navigational button

Even if the target navigational button is constantly visible without scrolling, its location can influence the visual scan performance. In the visual search the gaze point moves mostly to the near elements. That means the elements apart from the other elements may possibly be disregarded. Some very important navigational buttons such as main menu can always be gazed at immediately after the gaze on any other elements. However, it is only possible if such navigational buttons are already familiar to the participants.

This characteristic of the visual search also implies the importance of the consideration of the tasks which are accomplished on the page. The elements relevant to the tasks which are accomplished one after another should be located nearby, so that the relationship between these tasks is easily seen. If an irrelevant element is located between them it confuses the user.

- Size of navigational button

The size of the navigational button affects its conspicuousness. A large element attracts more attention than a small one. In addition, it also influences the approximation of the importance of each navigational button. If the important navigational buttons are designed as small elements it affects the visual search for them negatively. Longer fixations on them are then required and the length of the required eye movements becomes longer. Disregard of such small elements is also possible.

Concerning the navigational design, as supposed before, the difference between the expectation of the user, namely the nominal navigational flow, and the given navigational structure caused confusion in Web use. The problems are classified in two issues: unclear navigational structure and lack of the desired navigational possibilities.

- Unclear navigational structure

All the tasks in this experiment except the input of search condition could actually be accomplished by one click. However, some of them required two or more navigational steps. If the click on a plausible navigational button or hyperlink leads to an unexpected page, the users are confused by it. Then on the displayed page, the users should search for a further navigational button to reach the desired page. This could be observed in the task accomplishment duration. It did not take long till the first click because the selected navigational button is plausible for the user. The duration till second try obviously took longer due to confusion and surprise.

- Lack of the desired navigational possibilities

Contrary to the above case sometimes a Website does not provide the expected navigational button. If this is the case the users should think about the alternative navigational way by themselves. It helps the development of one’s own navigational

strategy. As a result it influences further navigational behavior and causes the deviation in navigation from the shortest navigational way sometimes meaning the long way around. The visual search strategy for the navigational button may also be influenced by one's own navigational strategy.

As mentioned above the problems in page design also influence navigational behavior and the problems in the navigational structure can affect the visual search on each page. The combination of analysis of navigational behavior and eye tracking revealed the interaction between both aspects in Web design.

4.2 Elderly users' specific difficulties

In the objective data some clear differences between younger and elderly users were confirmed. They are related to the decline of visual and fine motor function.

- Visual information perception

The visual information perception of elderly people is less efficient than that of younger people. For individual fixations elderly people require longer time. This tendency is especially strong if the regarded visual objects are very small. Concretely, this experiment revealed that characters in 10 pt or smaller were crucial for elderly people. This point is common with the assertion of Ownby et al. (2003). Such small elements also cause long visual search for the expected navigational button. Especially characters in 8 pt were not readable for a part of the elderly participants even with their reading glasses.

- Eye-hand coordination

This problem is also strongly related to the deficit of visual function. In order to move the mouse cursor to the target hyperlink or scroll bar these elements must be gazed at carefully. For the handling of the input device itself fine motor function is required. However, this function declines also due to the aging process. Small navigational buttons and/or the narrow scroll bar make their handling very difficult.

- Inefficient navigation

Elderly users tend to apply their own navigational strategy if they have learned that their navigational strategy works. It corresponds to the argument of Gilbert (1996) that elderly people may develop an inefficient strategy which is difficult to change

afterwards. The application of their own navigational strategy sometimes causes more navigational steps.

Although elderly users had more difficulties than younger users, the relevant subjective evaluation was not always worse than that of younger users. The deficiency of sensory perception and motor functions due to the aging process is, so to speak, “normal” for elderly people. Therefore, they blamed their difficulties on themselves not on an inconvenient design of Websites. Generally said, elderly people are afraid of so called high-technologies. It could also be one reason for the disproportionately good subjective evaluation by elderly users. It implies the limit of subjective evaluation and importance of objective data.

4.3 Some recommendations for Web design

In order to avoid the observed difficulties some recommendations can be made.

- Character size

With regard to page design, it should be emphasized first of all to apply the characters in appropriate size. This point is especially important for elderly users. As the elderly users in this experiment had definite difficulty with characters 10 pt or smaller, especially in the case of Websites aiming at elderly users, the character size should be at least 12 pt. It not only influences reading them but also finding them. Small characters applied to navigational buttons do not attract much attention from the users.

- Design of navigational buttons

It is recommended to make the navigational buttons constantly visible. The application of frame function would be useful for that. Moreover, the layout of the whole page should also be balanced. Though this experiment did not investigate the influence of the different locations (top, bottom, right, or left) of navigational buttons, the bottom of the page would be appropriate for the navigational button because the navigational button is required mostly after looking at the contents of each page. Provided that the gaze point generally moves downwards, it is quite natural to seek for the navigational button below the content part after looking at it. Actually, the navigational buttons are frequently located at the bottom of the page. The function of the navigational button is in most cases strongly related with the contents of the main

part of the page. As the gaze point tends to move from one element to the nearest element, a great distance between the contents and navigational buttons should be avoided.

As regards the size of the navigational buttons it should be not too small. It is important both for the visual search for it and for clicking on it. This point is particularly important for the design of Websites aiming at elderly users.

- Detailed analysis of the nominal navigation flow

The deviation between the nominal navigation flow and the actual navigational structure frequently causes confusion in the navigation. In order to avoid such confusion a detailed analysis of the required navigational steps is recommended. In order to understand the demand and expectation of the users a cooperation with the users is an effective way. Ellis & Kurniawan (2000) already show a successful example in the cooperation with elderly users in “participatory design”. The ideas of elderly users certainly support a better design of Websites.

5. Conclusion

This experiment investigated the navigational behavior by using eye tracking. The result showed that most of the difficulties in Web use were common for younger and elderly users. In addition, some elderly user specific problems were confirmed. Most of these problems were related with the aging process such as the decline of the visual function and motor functions. The result of this experiment itself is maybe relatively easy to imagine. However, the important thing is that the difficulties for elderly people and their influences on human behavior were concretely shown based on objective data. Subjective evaluation also provides useful data for a better user interface design. However, as this experiment has revealed, subjective evaluation is filtered from the users’ point of view. Objective data is, on the contrary, convincing and skills from experimental studies are directly applicable to product development. The issues treated in this study are only one part of the whole aspect of Web design. Further experiments regarding other factors are expected.

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The Vista Project*: Broadening Access To Digital TV Electronic Programme Guides

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ABSTRACT

VISTA is a multidisciplinary/cross-sectoral project aimed at developing a 'virtual assistant' embodying a speech based interface between digital television viewers and the content and functions of an electronic programme guide (EPG). While it is anticipated that the resulting interface will make EPG access easier for all, the main target groups are visually impaired (VI) and older viewers who experience disproportionate difficulty using currently popular GUI style EPGs.

Despite their great potential for improved usability, speech interfaces are unlikely to prove the 'universal panacea' some anticipate. Rather they raise a host of new human factors issues. For example, current technology disallows a truly 'conversational' interface, thus a structured dialogue is required which raises issues about keeping users 'on-script' (e.g. prompts and other additional support) and providing efficient routes to the information users require. Many of the VI population are elderly and thus also have hearing problems which emphasizes the intelligibility of the synthetic speech output. Qualitative results are presented from iterative evaluations involving (non-VI) elderly users and a wide age range of VI users of a PC based prototype designed to be compatible with digital broadcast technology.

Keywords: *digital television, electronic programme guide, virtual assistant.*

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1. Introduction

In recent years the UK has witnessed the advent and rapid take up of multi-channel digital television delivered via satellite, cable and digital terrestrial broadcasting technologies. Viewers can now choose programmes from literally hundreds of channels as opposed to the 4 or 5 channels available through analogue terrestrial technologies. In addition, with the convergence of telephone, computing, and broadcast technologies, digital television (and currently at least, the accompanying set-top-boxes) may well become *the* communications focus of the home. If so, they will act as platforms both for TV and enhanced information and entertainment services. For many homes they may become the only means of accessing the internet for e-mail, e-

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commerce, e-banking, and e-government. Thus the range of services and tasks supported by the TV is likely to increase substantially in the coming years.

Clearly such convergence provides more opportunities for consumers, in terms of service choice but it also brings the potential for additional complexity. In particular, viewers will need to navigate larger and more complex information structures. With hundreds of channels available, even the relatively simple task of finding out 'what's on now' could prove challenging to some viewers. Similarly, finding out what's on later in the evening, or another day, and remembering what programmes are on and at what time, has the potential to become increasingly difficult. New services also bring new tasks, such as setting reminders, saving programmes to a hard-disc; 'buying' programmes on-demand, and so on. As the range of functions, services and the associated user tasks increases it becomes ever more important that the user interfaces to such services are well-designed to enable all users to gain optimum benefit from these new opportunities.

Currently access to programme listings and services through the on-screen Electronic Programme Guide (EPG) is controlled by a 'traditional' TV remote control (or indeed more than one). The design of these EPGs has generally been influenced by the established approach of windows, icons, menus, and pointers. With multiple services and channel listings available over several days, this generally means 'step-by-step' navigation through a very large matrix of information. Of course, this style of interaction does not cause all users problems. Indeed, the services accessed by users who are comfortable using technology, who perceive clear benefits in being able to access them *and* who have the visual ability and manual dexterity required mean that current systems are evaluated relatively positively by such users (Freeman et al, 2003).

However, given the central role that TV plays in the lives of the vast majority of people, it is important that all sectors of society can benefit fully from digital multi-channel television. Barriers faced by people with, for example, sensory and/or motor impairments exist because of inherent features of graphical user interfaces (GUI). Simply 'optimising' the graphical-approach, particularly if based on the concept of the 'average' user, is unlikely to substantially help visually impaired (VI) or elderly viewers (Carmichael, 2002). Further, the cognitive effort required to navigate through

hierarchical menus (Rama et al, 2001), sets of icons (Rogers, 1986) and other traditional features of the GUI approach is somewhat incongruous in a domestic setting where viewers are more likely to want to sit back and relax. Whilst many users may report that some current EPGs provide “a simple and attractive” interface (Rosengren, 1996), it has been reported that using EPGs can be problematic even for some young, unimpaired users (Daley-Jones, 2002).

As a result of recent advances in speech-technology it has become feasible to develop an alternative means of accessing these EPG services (and potentially, other similar data structures). That is to say, the VISTA Project has developed an interface which accepts spoken input and provides (synthetic) spoken output. The interface is visually represented as an on-screen avatar, which incorporates mouth movements synchronised with the speech output and is also capable of various gestures and facial expressions. The system can also access a ‘real-world’ EPG database to interrogate it for times, channels, titles etc. and can present the user with similar information including programme synopses etc. as shown in Figure 1 below.

Although this alternative approach effectively avoids the well known human factors problems of using a GUI with a ‘traditional’ remote control, it does however raise new ones mainly due to the fundamental differences between the modes of communication involved. The rest of this paper describes some of the main human factors issues that have emerged throughout the project. Some of these issues have been addressed by developments within the project while some will remain to be addressed by future research and development and will be identified as appropriate.

User:	***[Switches on VISTA]***
VHI:	Hello. Do you want to watch something now or later?
User:	***Now.***
VHI:	I can search for a programme title or a channel name or I can just read a list of what's on now?
User:	***Inspector Morse.***
VHI:	Inspector Morse starts at seven thirty pm on Sky One. Do you want to hear more or have I got the wrong programme?
User	***Hear more.***
VHI:	Morse and Lewis investigate a murder in Oxford…
User:	***Watch it.***
VHI:	Please wait a moment while I switch to Sky One.

Figure1: VISTA Avatar and example dialogue excerpt

2. Evaluations

Early versions of the VISTA system have been evaluated with a range of users, consisting of both blind and partially sighted users and (non-VI) elderly users. The objectives of these initial evaluations were to understand the users' overall grasp of the concept and to identify usability issues to be addressed in subsequent iterations. One of the major challenges for the evaluations has been the development of suitable dialogue specifications. That is, most other speech based interfaces (to information structures of comparable size) have been developed to replace a human interface (e.g. flight reservations). In such cases, there is usually a large corpus (recorded and transcribed) of the spoken interactions users have had with a functionally equivalent system, which forms an obvious basis for initial dialogue specifications (Bernsen et al, 1998). With no equivalent forerunner, the VISTA Project had to develop the dialogue specifications 'from the ground up'.

Thus, starting with the very basic tasks of 'finding something to watch now' and 'finding something to watch later', the dialogue structure was developed in light of user trials. The other main factors which shaped the dialogues were the structure and format of the real-world EPG data base the system interrogates and the need for 'repair' dialogues to recover from the inevitable recognition errors.

2.1 Participants

All participants involved in the evaluations were drawn from extant volunteer panels administered by the two Human Factors partners involved in the project. That is, The Centre for Human Computer Interaction Design at City University which focused on VI and blind users; and The Age and Cognitive Performance Research Centre at Manchester University which focused on elderly users. The VI volunteer group included a range of visual limitations and had an average age of 34 years (range; 18-48 years). The elderly volunteer group included a 'normal' range of hearing and visual ability (some wore corrective lenses but none had hearing aids) the average age was 69 years (range; 57-91 years). The findings reported below are based on the contributions of forty volunteers at each centre.

2.2 Procedure

User evaluations were run on an individual basis with each session lasting approximately one hour (occasionally slightly longer for the elderly users). Following a brief explanation of the system and its function, users were encouraged to explore the system on their own and then were asked to perform specific tasks, such as; "Can you find something to watch now" and "Find out when Inspector Morse is on next". Generally, the VI volunteers could follow this protocol, whereas many of the elderly volunteers could not. This latter was mainly due to the various disproportionate difficulties the elderly volunteers experienced with the system (more on this below). Thus, overall, the elderly volunteers required significantly more encouragement, prompting, and occasionally intervention by the experimenter. Although the system was initially set up to record logs of the interactions, this relative lack of task and session structure (exacerbated by a variety of system failures) severely limited the utility of this potentially quantitative data. Therefore, at an early stage in the evaluations the emphasis was placed on more qualitative feedback from users. Following the interaction tasks the volunteers were asked about their experience and were encouraged to give any general and/or specific comments about the interface.

As will be seen below, although VISTA is primarily aimed at both elderly and VI users on the basis of their similarities (e.g. difficulties accessing on-screen text-based information and in using a 'traditional' remote control) it became apparent early in the

evaluations that development of the interface would need to accommodate the various diverse needs of these (and mainstream) user groups. Some of this diversity can be addressed by a suitably flexible system, but some may be better addressed by different 'modes' or entirely separate systems.

3 Findings

3.1 Perceived Need

The initial evaluations showed a marked difference in the perceived need for this system between the (relatively young) VI volunteers and the non-visually impaired older volunteers. For example, many VI volunteers following their evaluation sessions at City University made comments such as "*This would open a whole new world to me*." and "*It's instant access… better than trying to scroll through Ceefax pages*". Such comments indicate that the problems these blind and partially sighted volunteers experienced during the evaluations were effectively out-weighed by the perceived benefits of being able to find out what programmes were showing and when. This supports other anecdotal evidence which suggests that the main barrier to VI people watching TV is not the visual nature of the medium itself, but rather the difficulty of accessing information about the content.

By contrast, the elderly volunteers who evaluated the system at Manchester University did experience relatively more problems using the system (more on this below) but showed that these were far from out-weighed by any perceived benefits. That is, although some of the elderly volunteers showed the common tendency to blame themselves for the systems failings (Levy, 1996), others were somewhat more forthright. For example, one elderly volunteer said, "*It's very hard and she's stupid… it's far quicker to look in the TV Times.*" Alongside indicating a lack of perceived need, this and similar comments also indicate a lack of awareness about various implications of digital television (despite explanations and numerous prompts during evaluation sessions). Given that the current capacity for digital TV in the UK is around 400 channels, paper based listings (such as *TV Times*) are becoming increasingly unfeasible, particularly with regard to informing the viewer of more than just the start time and title of a programme. Despite various attempts to explain the potential benefits of digital TV to such older volunteers it was apparent that some felt that more

channels simply represented "…*more rubbish and repeats*…" and that they were happy to stick with what they are familiar with. Whether this will remain a tenable position following the analogue switch-off seems unlikely. However, it highlights the importance of ensuring easy access for all to information about the content of TV if sections of the population are not to be disenfranchised.

3.2 Vision

It was perhaps obvious at the outset of the project that people with no vision have no need for the visual element of this interface. However, this group represents a fairly small minority of the VI population, and others may derive some benefit from, or simply prefer the inclusion of, the avatar (and other potential variations within the visual element as discussed below). It is likely that for a future 'product' many potential users will consider the trade-off between the potential benefits of the visual element and the associated (monetary) cost. That is, aside from the infrastructure for integration with EPG data structures and basic TV functions, a no-vision version of this system would require effectively only a microphone as the remote control. Whereas, the 'full' version would require some method for presenting the visual element which would likely have some associated extra cost. The project has not specifically addressed such issues but volunteer comments suggest possibilities like picture-in-picture (on-screen) or a small screen on the (PDA like) remote control. Another aspect of a no-vision (or rather, voice-only) version is the possibility of remote interaction via a mobile phone which some 'telly addicts' may find beneficial.

3.3 Hearing

Beyond simply embodying the 'assistant', one of the roles of the avatar was its possibility for helping the many older people who, due to presbyacusis (i.e. age related hearing loss *and* 'slowing' of signal processing), may have some difficulty with the synthetic speech output (Helfer & Wilber 1988). It is known that (particularly older) people can benefit from 'speech reading' when listening to degraded or 'noisy' speech (Sumby and Pollack, 1954), although the benefits are less certain if the face/mouth is not faithfully reproduced, for example because of low frame rate (Williams & Rutledge, 1998). Unfortunately technical compatibility issues have meant that an overall delay in 'lip synch' has only been removed in the most recent version (using 24 'visemes'), for which evaluations are planned.

As mentioned above, the elderly volunteers generally experienced more difficulty using the system than did the younger VI volunteers. Some of this may be due to different levels of motivation (perceived need) during the evaluation sessions, but much qualitative evidence from the evaluations suggest that limited redundancy in the synthetic speech played a major role. One example of this relates to the lip movement delay mentioned above. That is, the quantity and nature of the elderly volunteers' complaints about this strongly suggest that (consciously or not) they were attempting to 'speech read' in order to ameliorate the limited intelligibility of the avatar's speech but were thwarted by the delay.

3.4 Implicit & Explicit Prompts

As can be seen from the dialogue excerpt in Figure 1, the current system has a relatively fixed dialogue structure with the system utterances implicitly prompting the user with the 'commands' they can use. This limitation is mainly due to the necessity for all titles and channel names to be in the system's active recognition 'vocabulary'. Although this is unlikely to be the optimum approach for the future, most volunteers adapted quickly to the convention and generally responded appropriately. However it soon became apparent that many of the older volunteers failed to respond to the implicit prompts, and were often left unsure what to say. This would often lead to out-of-vocabulary utterances and/or filled pauses (e.g. "er"s and "uhm"s) 'contaminating' otherwise in-vocabulary utterances. These recognition problems would in turn lead to further difficulty. This problem has been reduced to a great extent by the inclusion of an 'explicitly prompted' version which can be selected by the user when the system is started up. Thus, the 'default' version is as reported in Figure 1, whereas the prompted version follows the same structure but appends an explicit prompt to each system utterance (e.g. "…Do you want to watch something now or later? ***Please say now or later***."). Following the implementation of this, the elderly volunteers' reactions suggest that many would use it like a 'training mode' whilst some may require it as a permanent part of the system.

3.5 Text Support

The most recent version of the system also includes the possibility of 'text support' such that the speech output is duplicated as on-screen text. This followed

suggestions from elderly volunteers who claimed their difficulty was due less to the intelligibility of the synthetic speech *per se*, but more to their difficulty in *remembering what to say* (once they had decided what they wanted *to do*). Thus the on-screen text can both support the speech output as it appears and act as an memory aid after the transient speech wave has disappeared. Not only does this approach have potential benefits for some older people but also for others such as those with other types of hearing problem (so long as they can speak reasonably well) or those who have English as a second language.

3.6 Synthetic Speech

Partly as a further enhancement of the intelligibility of the speech output and partly as improvement in general acceptability would be the incorporation of suitable prosody/intonation in the synthetic speech. In regard to acceptability many volunteers commented that the speech sounded rather 'robotic' and that they would prefer it to sound more 'natural'. Although mostly general, such comments seemed disproportionately aimed at those instances when the system reads out a programme synopsis. It seems likely that this stems from familiarity with the common practice of many television announcers to reflect the 'mood' of the programme in their intonation. Beyond this, there is good reason to believe that better synthetic prosody would generally improve the acceptability and 'understandability' of synthetic speech. In addition there is the possibility that appropriately 'exaggerated' prosody may be of particular benefit to older people. However, this is beyond the bounds of the current project and whilst there are some possibilities that may be implemented in the near future there is still a very large gap between knowledge of what occurs in human speech and how this translates to the generation of synthetic speech (Hirschberg, 2002).

3.7 Role of the Avatar

As mentioned above, the avatar has had its lip movements connected to the speech output, other than this it has until recently only displayed 'ambient' movement (e.g. slight body 'sway' and quasi-random eye blinks). The most recent version however allows the incorporation of other gestures and facial expressions, which can also be linked to the speech output. Similar to that described for prosody above these elements have the potential to enhance the interaction in a range of ways, from

supporting comprehension of the speech output to making the avatar more personable. For example, comprehension may be improved by appropriately placed 'beat' gestures, which are often used by speakers to mark clause boundaries and the like. Similarly changes in eye gaze can be used to facilitate turn taking in conversations. However, as with prosody, there is a lack of knowledge as to how these could be used to best advantage and what is known strongly suggests that 'inaccurate' implementation can be more damaging than none.

Less directly related to the speech output *per se*, other gestures may improve interactions with this system. One banal example is for the avatar to wave as she greets the user at start up (see Figure 1). Other possibilities include a suitable degree of 'frown' to distinguish 'repair' dialogues ("I'm sorry, I think you said…") from 'normal' ones, and other suitable gestures to indicate system activity which the user may otherwise take as a (frustrating) delay. Examples of this could be a 'thoughtful' gesture (hand-on-chin) during recognition delays, or looking off to the side during a 'search' delay. At the most general level it might be beneficial to include movement and expressions that would give the avatar some degree of 'personality' (an element many volunteers commented that she lacked). The issue of the avatar's 'personality' (including appearance), although well beyond the scope of the present project, is an interesting one as there was virtually no consensus among the preferences expressed by volunteers (those who made negative comments about the avatar were asked to suggest how they would improve it). Such preferences ranged from "a nice teddy bear" to "my grandson". While it may be technically feasible to customise the appearance of the avatar, associating that appearance with an appropriate 'personality' and speaking voice, may prove not to be.

3.8 Future Improvements

In general the issues described so far have emerged in response to the requirements of target users in order to allow them to effectively access the systems functionality. However, other issues have been raised by the requirements of target users for whom basic access has proved less problematic and thereby have offered some insight into the rather more nebulous domain of the 'efficient' use of the system's functionality (including potential functionality). In the main these latter issues were raised by the evaluation sessions involving VI volunteers, although those involving the older volunteers also contributed. At present these issues are

necessarily somewhat abstract and certainly beyond implementation in the present project, but could prove important to future developments in this area, and will be briefly described below.

The overarching issue of this type relates to the dialogue structure. Various factors suggest the need for a more flexible structure. For example, many volunteers who completed tasks involving 'browsing' for information on programmes several days away, commented that it often seemed rather laborious. On the one hand it seemed relatively more acceptable if they were simply 'browsing', while on the other hand it seemed less acceptable if they were effectively 'searching'. That is, 'searching' implies that you already have some criteria and that if you do you should be able to give it to the system 'all-at-once'.

Handling such 'compound' enquiries is possible for current technologies. However, as touched on above these tend to involve relatively restricted 'vocabularies' that are effectively 'fixed' (e.g. airport names). In the domain of EPGs a similar approach would need to be able to distinguish (for example) between an enquiry about programmes showing on Friday night and one about programmes with the title *Friday night*. Development of a suitably flexible dialogue structure will take considerable research effort and the VISTA project has taken initial steps in this direction with colleagues at the University of East Anglia undertaking (albeit necessarily small scale) 'Wizard of Oz' studies in order to indicate the ways people may want to use such an interface without the constraints of real 'speech understanding' technology. In addition to the dialogue structure itself similar effort will likely be required to develop suitable 'repair' dialogues which will require an entirely different approach to those developed for the current system.

Despite the potential difficulties it is apparent that flexibility of this kind will be needed to accommodate the diversity of people's requirements and the diversity of ways they may want to use such an interface. Accommodation of such diversity will be vital if an interface of this sort is going to gain wide acceptance rather than be viewed as effectively 'assistive technology'.

Another issue that is likely to be important for future development is the introduction of 'intelligence', one aspect of which would likely be involved in the development of the

flexible dialogues described above. Other aspects could include the ability to make suggestions for viewing options based on the user's prior behaviour and/or their explicitly stated preferences. Other aspects likely to require some form of 'intelligence' relate to the fact that often televisions do not have a single user. This raises issues such as different sets of preferences (including possibly a 'family' set), and handling potential 'clashes' (e.g. two household members book pay-to-view programmes due to be screened at the same time). However it seems unlikely that even the most sophisticated 'intelligence' will be able to solve the speech based equivalent of fighting over the remote control.

Finally, as the functionality of digital TV increases with interactive programme content and the like, and with the prospect, as mentioned in the introduction, that the TV could very well become an important access point for various internet based services including e-government (or rather, t-government) important decisions will need to be made about which interactions/transactions can be effectively controlled by voice and which will be more suited to other modes of input/output.

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User Interface Tactics in Ontology-Based Information Seeking

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ABSTRACT

Ontology-based information seeking is one of the most promising approaches to enhance existing search interfaces with features enabling users to better express their information needs or to improve exploratory search styles. This entails the interaction of users with concepts and relations embodied in ontologies in a dialogue process that can be interpreted as a query or used as a sign to suggest other paths that could lead to casual encounters. In this paper, we describe a number of ontology-enabled search tactics that have been experienced in prototype experiments, along with other possible techniques that would eventually be useful, as pointed out by existing research on information seeking models.

Keywords: *information seeking, ontology search tactics, interfaces.*

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1. Introduction

Information seeking (IS) on hypermedia systems – and especially on the Web – is a complex human activity that originates from an information need and entails some form of strategy, in some cases including search and browsing on several disparate information sources. A number of behavioural models have been proposed for such activities. For example, the model proposed by Choo, Detlor and Turnbull (2000) includes four main models of information seeking on the Web: undirected viewing, conditioned viewing, informal search, and formal search, and a number of different *moves,* like chaining, browsing or monitoring. These characteristics entail that interfaces for search engines and other applications should explore new query formulation

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paradigms that enable interacting with users to a higher extent than current query-formulation interfaces, which are mainly based on typing words and matching word indexes. In addition, studies on Web search behaviour through conventional search engines have pointed out that most people use few search terms, and they rarely use advanced search capabilities (Spink *et al.*, 2001).

If we consider the richness of information seeking modes and behaviours together with the relatively simple query formulation usage patterns of search interfaces on the Web, it becomes clear a need to support diverse seeking moves or tactics in Web user interfaces, but without increasing their complexity or overcrowding them with facilities that will be rarely used. These somewhat conflicting requirements call for a new research agenda in user interface design that takes as a point of departure existing research on information seeking models and also on the human factors-oriented branch of information retrieval (Robins, 2000), often referred to as *interactive information retrieval* (IIR).

Every model of information seeking provides an account of what the concept of information need, which originates the seeking or search process. From a cognitive perspective, those needs – which are in many cases vague – can be expressed through high-level concepts (Sutcliffe & Ennis, 1998), which in turn are connected to other concepts that pertain to a given domain or the intersection of a small number of them. Thus, computer-based conceptualizations appear as a promising approach to guide search, both for the fulfilment of information needs and also for serendipitous or casual discovery of interesting information connected to the current search process. From among the knowledge representation formalisms (Davis, Shrobe, & Szolovits, 1993) that have been proposed and applied in the last years, ontologies have become the most interesting one from the perspective of developing Web applications. This is due to the fact that modern ontology description languages (Fensel, 2002) are prepared for interoperation on the Web through XML formats, and the logics that underlie them (Baader *et al*., 2003), have been carefully selected to provide a good compromise between richness and computational complexity.

In this paper, we review the different kind of user interface tactics that can be implemented with the help of ontologies in the context of information seeking, along with some of the conceptual and technical issues that surround them. The issues described here are based or similar to experiences reported elsewhere about ontology-based search interfaces (García & Sicilia, 2003; Sicilia *et al.*, 2003), search based on thesauri

(Papazoglou, Porpoer & Yang, 2001) and also other specialized search interfaces like (Jacenek & Pu, 2003).

The rest of this paper is structured as follows. Section 2 introduces the context, motivations and assumptions for ontology-based search. Then Section 3 provides the description of tactics that can be supported by ontologies. Finally, conclusions and prospective future research directions are provided in Section 4.

2. Assumptions and Rationale for Ontology-based Information Seeking

Ontologies *per se* are structured knowledge representations in the sense given by (Davis, Shrobe & Szolovits, 1993). But the concept of shared ontology, as envisioned by researchers on the so-called *Semantic Web* (Berners-Lee, Hendler & Lassila, 2001) goes further by considering that those representations are available for use in the Web, and they represent the consensual vision of a group or community of individuals. Some public ontology repositories like the *DAML Ontology Library*[2] already exist, and their number, quality and the range of domains they support can be expected to grow in the near future. This will eventually result in a coverage of domains with enough depth to enable the *annotation* of the vast majority of the resources available through the Web. These annotations would provide the basis for new search and browsing functionalities that will be able to take advantage form precise statements regarding document contents. For example, it could be possible to state that a given document provides "*details about*" linear regression, while other provides "*examples*" or "*a SPSS tool description*" regarding the same topic. Furthermore, applications could use ontologies to retrieve the fact that linear regression is a concrete form of "*regression*", and that even that it is usually "*taught in statistic courses*". Virtually any fact in the scope of ontologies will be available to diverse search and browsing tools. This vision subsumes also previous attempts to provide semantic types to links in hypermedia systems (Trigg & Weiser, 1986), since annotations can be used to automatically generate links (Carr *et al.*, 2001).

Classical information retrieval (IR) algorithms are based on the assumption that information items (or documents) are modelled logically by keywords pertaining to some natural language (perhaps considering also some lexical or even syntactical structures in some cases). But the Semantic Web essentially advocates "crossing the chasm" from

[2] http://www.daml.org/ontologies/

unstructured keyword-based models to richer logic-based annotations that would eventually provide a basis for reasoning. This entails that the logical model of a document becomes a set of logical assertions (annotations) about its contents (and perhaps also about its physical structure, its relationships with other documents and other meta-information). In addition, the form of the queries becomes a logic expression with an arbitrary level of complexity in its structure. It should be noted that the use of ontologies for the annotation of Web resources is not limited to categorization processes, as those that have been extensively used in Web catalogues like the popular *Yahoo!* (Labrou & Finin, 1999).

Ontologies can be use for the purpose of search in several ways. One of the possible approaches is the use of an interface in which users type terms – like in *Ontoquery* (Andreasen, Fischer-Nilsson & Erdman-Thomsen, 2000) –, and use ontologies later for the expansion of the query. In consequence, these approaches still rely in natural language processing, and gives no advanced search control features to the user. Other designs expose the technical structure of the ontologies in the user interface – like the OntoBroker query interface (Fensel *et al*., 1998) –, thus hampering their usability for non-specialist audiences.

Our approach for ontology-based search interfaces is based on a number of assumptions about the evolution of *Semantic Web* technology, combined with an attempt to investigate the provision of user features to control the search process, as described by Bates (1990). It is assumed that a large number of annotated Web resources will be available in the future, and that such resources will be properly annotated by using logical assertions that relate them to terms or concepts in ontologies in semantically precise ways. In addition, it is also assumed that *description logic* languages (Baader *et al*, 2003) like those currently available will be used. The query formulation process is intentionally *iterative*, since the main point of the paradigm describes here is that search proceeds through guided navigation of the knowledge stored in ontologies. That is, the relationships among terms in the ontologies are used to build the user interface, and the system gets actively involved in suggesting alternative paths or possibilities that end up in a query comprised by the navigation and selections of the user.

In the Figure 1, a classical IR view is depicted, in which document representations (e.g. indexes) are used to match a query formulated after some given information need, usually in textual form.

Figure 1: Classical IR model

Figure 2 depicts how the availability of shared ontologies changes both the query formulation and document representation parts of the IR process. On the one hand, the query formulation process can be supported by interacting with one or several ontologies, initially selected according to the domain of the information need – an important element in Bates' model described in (Bates, 1989) –. On the other hand, the representation of the document includes logical assertions that make it an integrated part of the ontological structure. This way, the matching process can be generalized to an exploration process that can be implemented in a number of different ways, depending on the form and logical interpretation of the query.

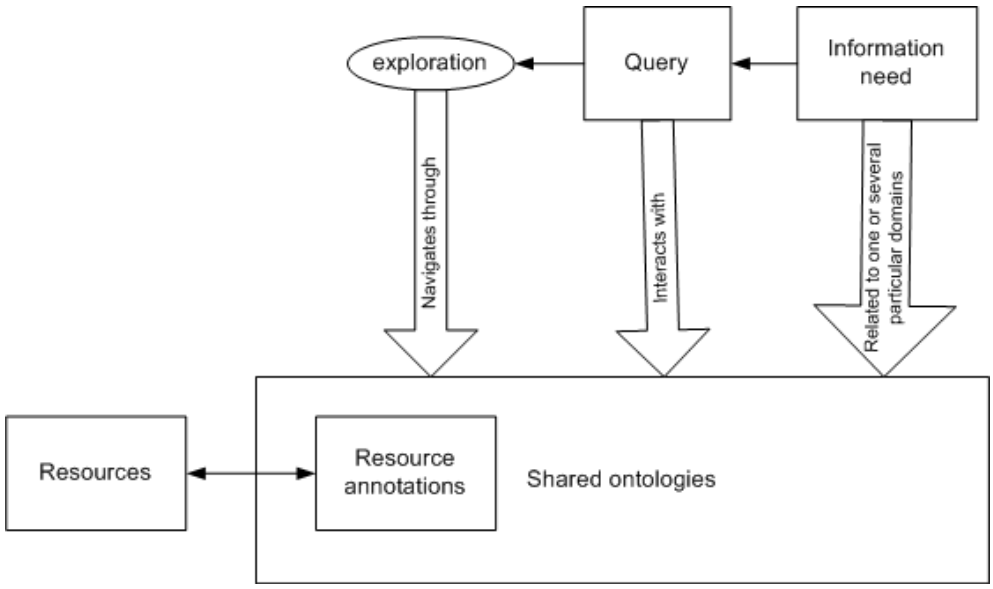

Figure 2: Ontology-based IR model.

3. Ontology-Enabled Search Tactics

As pointed out by Bates (1990), sometimes the user prefers to control the search process to some extent, according to certain search strategies and tactics that can be effectively supported in user interfaces. Tactics are defined by Bates as “one or a handful of moves made to further a search”, and include, for example, changing a term by a more specific one or adding similar terms. Strategies are entire plans for search that may comprise several tactics and have a far-reaching scope. Ontologies can be used to give direct support to tactics, and user models can be used to represent and reason about strategies. Here we focus on the former, since they constitute a more specific level, and tactic support can be used effectively even with anonymous users about which the system do not carry out any kind of profiling activity.

Table 1 provides a summary of some of the tactics described in (Bates, 1990) that can be effectively supported by ontologies, along with the move/s inside the ontology required to implement them. A simple notation is used to describe implementations, where capital letters are used to denote terms (A, B, C), the subset symbol is used to denote subsumption.

Tactic	Bates’ description	Ontology-Based Implementation	Example
SUPER	To move upward hierarchically to a broader (superordinate) term.	Change B by A, where $B \subseteq A$.	Move from *Siamese_Cat* to *Cat*
SUB	To move downward hierarchically to a more specific (subordinate) term.	Change A by B, where $B \subseteq A$.	Move from *Cat* to *Siamese_Cat*
RELATE	To move sideways hierarchically to a coordinate term.	Change B by C, where there exist a concept A such that $B \subseteq A$, $C \subseteq A$ (“directly”).	Move from *Siamese_Cat* to *Angora_Cat* (through *Cat*).
CONTRARY	To search for the term logically opposite from that describing the desired information.	Change B by C, where $B \cap C = \varnothing$ (*at least*)	Move from *LateHarvest* to *EarlyHarvest* (as wine categories)
RECORD	To keep track of trails one has followed and of desirable trails not followed up or not completed.	Store ontology traversal paths while browsing.	The path *Pet* $\rightarrow$ *Cat* $\rightarrow$*SiameseCat* is recorded, so that the system may later suggest other traversals.
SELECT	To break complex search queries down into sub-problems and work on one problem at a time.	Split the ongoing search, pruning some branches that can be joined later.	When searching for information on *softwareTestMethods*, split on the different techniques (unit, integration, etc.)

PARALLEL	To make the search formulation broad (or broader) by including synonyms or otherwise conceptually parallel terms.	Add term *C* where *C* is similar to any of the terms that form part of the current navigation.	When searching for information on *softwareInspection* include also *softwareReview*.
PINPOINT	To make the search formulation precise by minimizing (or reducing) the number of parallel terms, retaining the more perfectly descriptive terms.	The inverse of PARALLEL.	-
SPECIFY	To search on terms that are as specific as the information desired.	Allow for stepwise refinement by going to the more specific in the subsumption hierarchy, combining several terms with "and"-like semantics.	(later explained as the main guiding design principle of *OntoIR*)
EXHAUST	To include most or all elements of the query in the initial search formulation; to add one or more of the query elements to an already-prepared search formulation.	Allow for multiple selection of terms and "or"-like semantics.	(later explained as a feature of *OntoIR*)

Table 1: Ontology support for search tactics

The SUPER and SUB tactics are straightforward navigations through the generalization-specialization hierarchy of the ontology, and have been applied yet in a number of systems like in (Papazoglou, Porpoer & Yang, 2001). The RELATE tactic involves "crawling" the generalization line of the concept up to its immediate covering concept (possibly more than one), and then deciding which specialization is closer to the original one. The "immediate" covering concept can be computed in some way by ordering the covering concepts by extent size, but deciding where to move up and down where several alternatives are available is not a simple decision. Models of "resemblance" or distance from concepts to super and sub-concepts have been developed elsewhere (Sicilia *et al.*, 2003), but such meta-information requires an elaboration of the ontology that virtually none current ontology provides. Providing a systematic account of the CONTRARY tactic is a challenge in the general case, provided that ontologies are not lexical thesauri, and thus antonyms (which represent relations between words) are not often explicitly stated. An approximation to this tactic may be that of using the disjointWith predicates that are included in the OWL[3] ontology language, but the changes would not always be useful, e.g. changing general concepts, like Male by Female, rarely would produce meaningful results. Once again, a

[3] http://www.w3.org/TR/owl-ref/

supplement to ontological structures should be designed for more effective tactic application. The PARALLEL tactic exhibits similar difficulties, since synonymy is in general not inferable from the ontology. Concrete cases for PARALLEL include the trivial situation in which C is completely equivalent (for example, owl:equivalentClass statements) to any of the terms in the current navigation, and also entity similarity measures that have been proposed elsewhere (Rodríguez, & Egenhofer, 2003). PINPOINT operates on the same information, but in this case allowing the user to eliminate some terms that are marked by the system as parallel.

The RECORD tactic requires user profiling, storing the traversal paths inside the ontology. Paths include both subsumption but also any arbitrary relation among concepts. Since the number of unexplored alternatives may grow significantly when interacting with large ontologies, it makes sense to left the decision of what tracks to store to the user, in a sort of “bookmarking” of ontology branches.

The SELECT technique can be implementing by using a child browser window for each branch, thus maintaining the link with the original one for an eventual re-joining. SPECIFY and EXHAUST indicate the need for “and”-like and “or”-like semantics for query formulations including several terms, so that more specificity or flexibility in selecting search results is provided.

Some of the ideas described so far have actually been implemented in several prototype-Web tools described elsewhere (Sicilia *et al.*, 2003; García, Sicilia, Díaz & Aedo, 2003; García & Sicilia, 2003). Figure 3 provides a screenshot of the OntoIR tool, illustrating the interface design of some tactics. OntoIR enables ontology-based search on collection of annotated resources by stepwise refinement of the query, according to the subsumption structure of the ontology. Since its main interaction mean is selecting terms presented to the user, two actions are required before starting the search:

- Domain selection. This entails selecting a concrete domain (ontology) to initiate the search. Nonetheless, ontologies in Web languages can be linked arbitrarily to reuse existing concepts, so that the search process may eventually jump to terms in other related ontologies.

- Presentation of the higher-level concepts (entry points) for the given domain. These are typically the higher level and more common concepts of the ontology, and will ideally be marked in the ontology, and later personalized according to the history of each user. It’s important that the selected collection of entry points for a given domain

covers completely the terms in the domain, that is, that every term can be reached eventually by traversing some term relation (or several).

It is important to remark that not every concept included in an ontology is appropriate for user selection in this kind of interfaces. Concretely, terms in "upper ontologies" are often excessively abstract to be recognizable by users as indicators of information needs. For example, concepts in the "upper" part of the *Cyc* ontology (Lenat, 1995) like *Thing*, *SetOrCollection* or *TemporalStuffType* are useful for the purpose of internal representation inside the ontology, but they are seldom used as a concept in a search process, since they are excessively general to become representations of meaningful information needs.

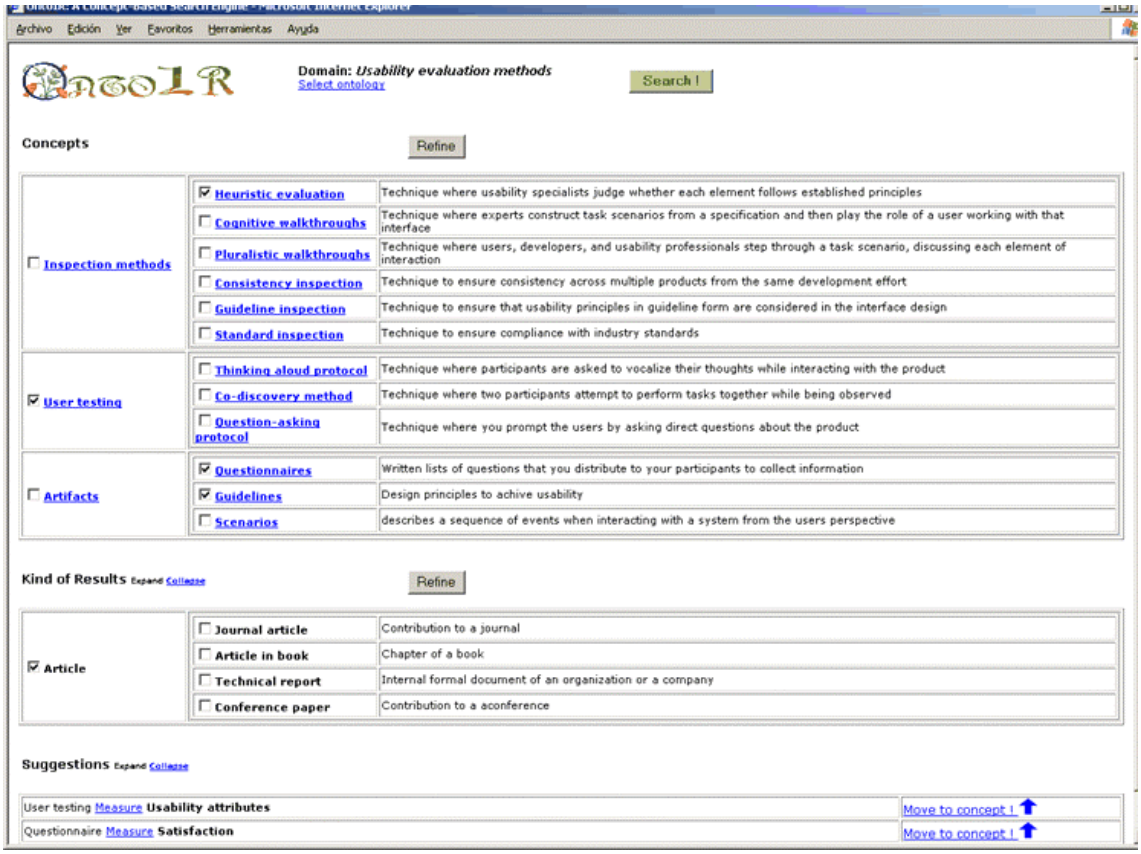

Figure 3: OntoIR ontology-based query formulation

OntoIR implements a number of tactics from among those described in Table 1. Concretely, its progressive refinement philosophy is based on the SUB and SPECIFY tactics, in an attempt to give the user the choice to specify queries to a large extent of detail. To do so, *OntoIR* allows the navigation from the entry points to lower levels of the

subsumption hierarchy, pruning the branches that are not explicitly selected (checkboxes and the “Refine” button in Figure 3). The same stepwise philosophy is applied to the type of documents to be retrieved (“Kind of results” section in Figure 3), so that the form of the results can be pre-determined if desired, independently of the concepts that represent the information need. In addition, a form of the RELATE tactic is supported by the section “Suggestions” (at the bottom of Figure 3), that dynamically traverse the relations applicable to concepts currently selected, in an attempt to widen allow the user to widen the query (by “moving up” the concept with the corresponding link), thus providing a sort of modified EXHAUST technique, that eventually jumps to other ontologies not initially selected.

Once the user considers that his/her navigation through the ontology is finished, the results are obtained by exploring the resources annotated with the ontology. The current interpretation of the results of the navigation is described in detail in (García & Sicilia, 2003), that provides an “or-like” behaviour, but with an additional ordering or relevance of resources designed to show first the items that are heuristically considered more appropriate.

The OntoIR design interface represents an attempt to find a balance among common usability design guidelines and the potential contents of ontologies. First, the interface has intentionally avoided typing terms to eliminate errors coming from natural language interpretation, although it may be eventually convenient to produce a hybrid of the two approaches. Second, a necessary balance among interface readability (i.e. minimizing scrolling and not overcrowding the screen) and richness of the available paths is required, specially when traversing arbitrary relations to provide suggestions, since many terms large ontologies are often equipped with dozens of relations, many of them inherited from upper level terms, and thus of little relevance to the current context. And third, the assumption that users prefer a two-step process has been made, i.e., the user first elaborates the needed concepts, and then the system provides the results, just like in most conventional Web search engines. Breaking this assumption may lead to richer models, but they were not considered for the sake of simplicity and memorability. In addition, the evaluation of OntoIR has suggested the convenience of expanding its range of supporting practices to include others, like SUPER as a way to “backtrack” from explorations, i.e. supporting also RECORD for the previous traversal steps.

An additional important element of OntoIR is its intentional restricted support for casual discovery (Toms, 2000), somewhat provided through the “Suggestions” section,

but also available in the results page, that list existing related information about each resource and also enables the initiation of additional queries, as showed in Figure 3.

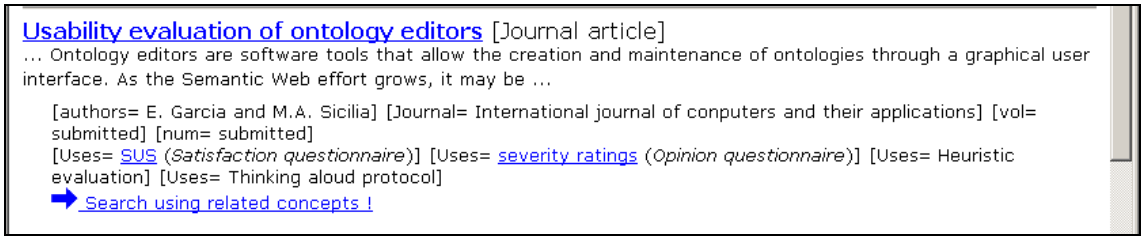

Figure 3. Example OntoIR result *snippet*

4. Conclusions and Outlook

Ontologies are shared formal conceptualizations that can be used to support a range of well-known user interface search tactics. Since information needs can be roughly cognitively represented through a number of high level concepts, ontologies appear to match seamlessly the inception of information seeking processes. In consequence, ontology-based user interface design for search or information seeking represents an open avenue for further research, including both usability issues and also technical issues regarding the interpretation of the queries. The former includes the design of the search interface and its placement in the overall information architecture of the Web application. The latter is a problem of interpretation of user moves as query-construction steps, involving both cognitive hypotheses and also logical representations.

The ontology-based implementation of a number of existing well-known search tactics have been described, along with a concrete design for search that follows a concrete, stepwise refinement approach from more general to more specific concepts, but enabling also the combination of terms related to the ongoing query through any arbitrary relation. Further work should explore other alternative designs, comparing their performance for given seeking styles or user profiles. One interesting class of such alternative designs is that of hybrid approaches that use classical IR algorithms to try to enhance ontology-based navigation, e.g. by explotiting lexical relations to recommend terms, connecting concepts to lexical structures as described in (De Bo, Spyns & Meersman, 2003).

A wide range of open issues remains with regards to ontology based search interfaces, since the most effective metaphors and models have not yet been investigated. Moreover, the role of personalization may significantly affect typical design

decisions – a review of some existing work can be found in (Brusilovsky, 2001) –, and existing collaborative filtering algorithms (Sarwar *et al*., 2000) can be used to exploit commonalities, search patterns and collaboration between users (Twidale, Nichols & Paice, 1997). For example, the system may change its collection of features for novice users, and the history of previous queries and processes can be used to inform new ones, for example, changing the collection of entry point to search for a particular user. Collaborative filtering recommendations could be applied, for example, to automatically include terms in a search depending on the commonalities of the history of the current user with other users of the system, just as e-commerce product recommendations are based on preferences of other similar users.

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Feedback In The Virtual Environment

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ABSTRACT

In this paper, I intend to discuss the role of feedback in interactions in a virtual environment along with the various ways it is manifested, as much within human-to-machine interactions as among members of a virtual community, giving emphasis to feedback in discussion groups for educational purposes. This discussion will be followed by an attempt to classify the main types of feedback found in data collected in virtual classes, which were divided into two categories: evaluative and interactional. The names cited in the examples are all fictitious to protect the students' anonymity. Unchanged names are only the undergraduate course teaching assistant's and my own name. All the students have authorized the use of their messages and the original forms were kept.

Keywords: *feedback, virtual environment, virtual community interactions, HCI.*

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1. Introduction

Rinvolucri (1994) states "The term originates in biology and refers to the message that comes back to an organism that has acted on its environment"(p.287). Despite this, Robert de Beaugrande (personal communication) is certain that the term was first used in electrical engineering. In fact, the Second Edition of the Oxford English Dictionary declares that the term originated, in 1920 in the area of electrical engineering.

> "***1a**: the return to the input of a part of the output of a machine, system, or process (as for producing changes in an electronic circuit that improve performance or in an automatic control device that provides self-corrective action). **2 a**: the partial reversion of the effects of a process to its source or to a preceding stage **b**: the transmission of evaluative or corrective information to the original or controlling source about an action, event, or process; also: the information so transmitted*."

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Or, in the words of the Encarta® Electronic Encyclopedia,

> "***return of output:*** *the return of part of the output of a machine, system, or circuit to the input in a way that affects its performance.*" The same encyclopedia offers another definition more appropriate to our purposes – *feedback would be a response, that is, comments in the form of opinions about and reactions to something, intended to provide useful information for future decisions and development*."

This idea of reaction is also present in the Longman Dictionary of Applied Linguistics, which considers feedback to be "any information, which provides a report on the result of behaviour", as well as in the American Heritage Dictionary, which defines feedback as "the return of information about the result of a process or activity; an evaluative response".

In foreign language learning contexts, Penny Ur, (1996) sees feedback as "information that is given to the learner about his or her performance of a learning task, usually with the objective of improving this performance" (p.242). Ellis (1985) focuses on the question from a communication standpoint, defining feedback as ". . . response to efforts by the learner to communicate. Feedback can involve such functions as corrections, acknowledgement, requests for clarification, and backchannel cues such as 'Mmm' " (p. 296).

In the virtual context, according to Stemler (1997) "Feedback can be defined as output, usually displayed on a screen, to tell students how successful they have been in solving problems or to provide information about the quality of their response to a test-like event" (p. 339). As this author says, feedback should be used for more than correction, also to send motivating messages.

As we can infer from the above definitions, feedback has been traditionally identified with the response of the teacher (tutor, computer) to the student, and motivated by some action related to that student's learning.

I would like to define feedback in the context of on-line classroom interaction as: **reaction to the presence or absence of a given action with the purposes of evaluating or seeking evaluation of the performance in the teaching-learning process, or to reflect on the interaction in order to inspire, control or evaluate it**. In my proposed definition, I don't include the terms learner, student, teacher or even computer, because our data shows that feedback can also be provided by a

classmate, or even by someone who is not a member of the learning environment per se. My definition includes, besides the learning aspect, interaction, because in the virtual context, interaction is also an object of evaluation. Such a decision is supported by Ypsilandis (2002) in his comments on the new concept of feedback.

As he says:

> *The recent and welcome shift of interest form language teaching to language learning affected the way feedback is perceived by both learners and teachers. Consequently, feedback is now recognized as an assistance mechanism, a key factor for successful learning, offering support to the learning process. As a result, feedback is now understood to be (or 'as being') provided also by other learners (peers), or generated by the learner himself/herself. (p.169)*

Vigil e Oller (1976), quoted in Allwright e Bailey (1991), mention two types of feedback – cognitive feedback that gives information about the use of the language, and affective feedback, which relates to emotional reactions as response to the interaction itself (pp.92-93). I would say that, in on-line interactions, feedback can work as evaluation of the learning process, as a mechanism to catalyze, inhibit or measure interaction. That gives us, then, two basic types of feedback: **evaluative** or **interactional**. I call **evaluative feedback**, that which gives information about academic performance of the student, or of the teacher, and **interactional feedback**, that which records the reactions or interactional behavior of the student or teacher and which could be considered similar to the affective feedback named by Vigil and Oller.

2. Feedback in the interaction between humans and machines

Feedback is the fuel for interaction in any context in which it occurs, even when such interaction occurs between humans and machines. For this reason, some researchers have studied ways of providing feedback in human-computer interactions. The programs that we use, give responses to each action: the computer tells us when the system is busy and when it is processing, E-mail software says that the addressee has received the message, but cannot respond at that exact moment. Even printers can give feedback usually by means of different light colors. The printer Compaq IJ600, however, is fitted with an oral feedback – a voice informs the user when the print job will start and when it finishes, as well as any problems that crop up to prevent successful printing. When such a response is not received, the user usually repeats

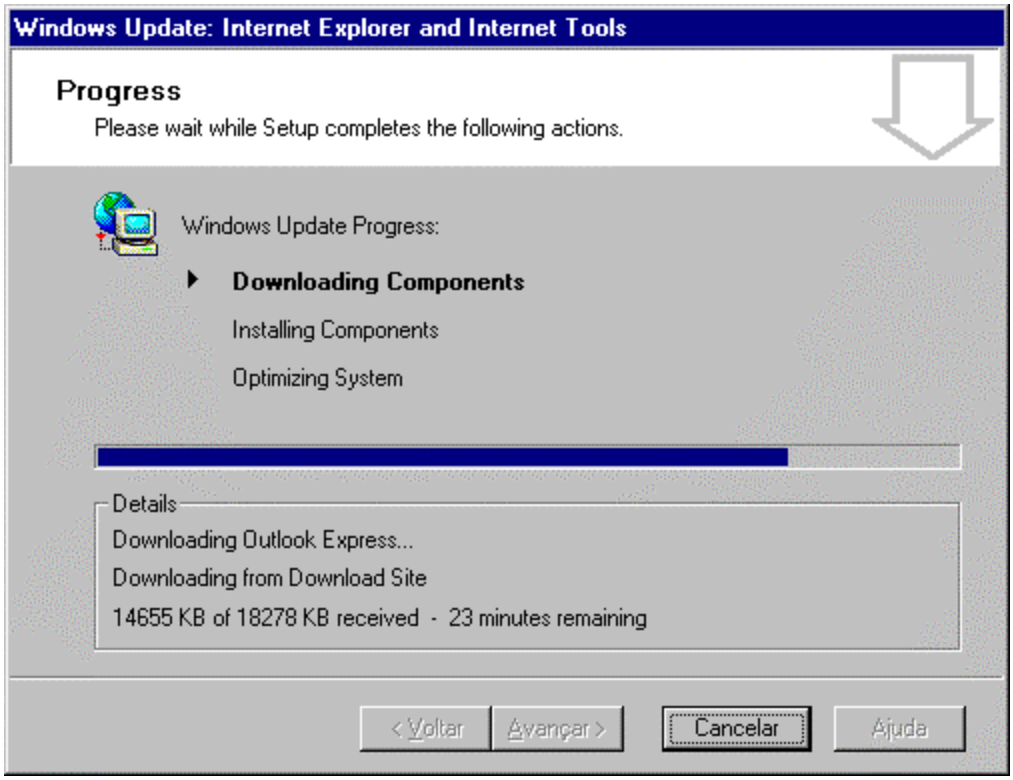
the command. It is like when we call an elevator. We press the button and if there are no lights showing movement from floor to floor, we press the button again. It's a reaction to the absence of a signal.

Models of feedback designed for human-machine contact have been based on human interaction models, as the response to the effort of the user is essential to the success of operations (Pérez-Quiñones & Sibert, 1996). In this way, feedback should be understood not only for its evaluative side, but also interactional, like any kind of sign that we are paying attention to the other or even that something is being processed when the interaction is with a machine. Some examples of feedback provided by the machine to keep our attention or give information are:

1. The automatic correction of a word wrongly typed when we are using a word processor;
2. The sound some programs make when a bad or non-permitted operation is executed;
3. The blue bar that slowly fills in the rectangle showing that a task (e.g. download, saving a file) is in process, nearing completion, etc;
4. Internet warnings and announcements (e.g. your message was sent successfully, your software needs updating)
5. Automatically generated e-mail messages (e.g. your message has been received and a reply is forthcoming, you have been added to/removed from x-discussion list, an e-store informs you that your purchase is complete, etc.)

The first two examples may be classified as evaluative and the others as interactional as they inform the user about his interaction with the machine.

On the screen reproduced below, we can see the feedback given to the user during the download of a file. Besides the blue bar slowly filling in the rectangle, you can see the constantly changing information about how many Kbytes are being received and how many minutes are left to complete the operation.



Some web pages take a long time to load, but keep informing the users that everything is fine through verbal or non-verbal signs, so that they won't give up waiting. Look at some examples: An interesting series of these messages can be found at page http://www.chambinho.com. While the page is being uploaded, these messages appear at regular intervals:

The site is being uploaded
Just another second
Only a tiny little second
Now it's almost there
On its way
Stay cool
Just another second

This sequence of messages repeats until the page arrives in its entirety.

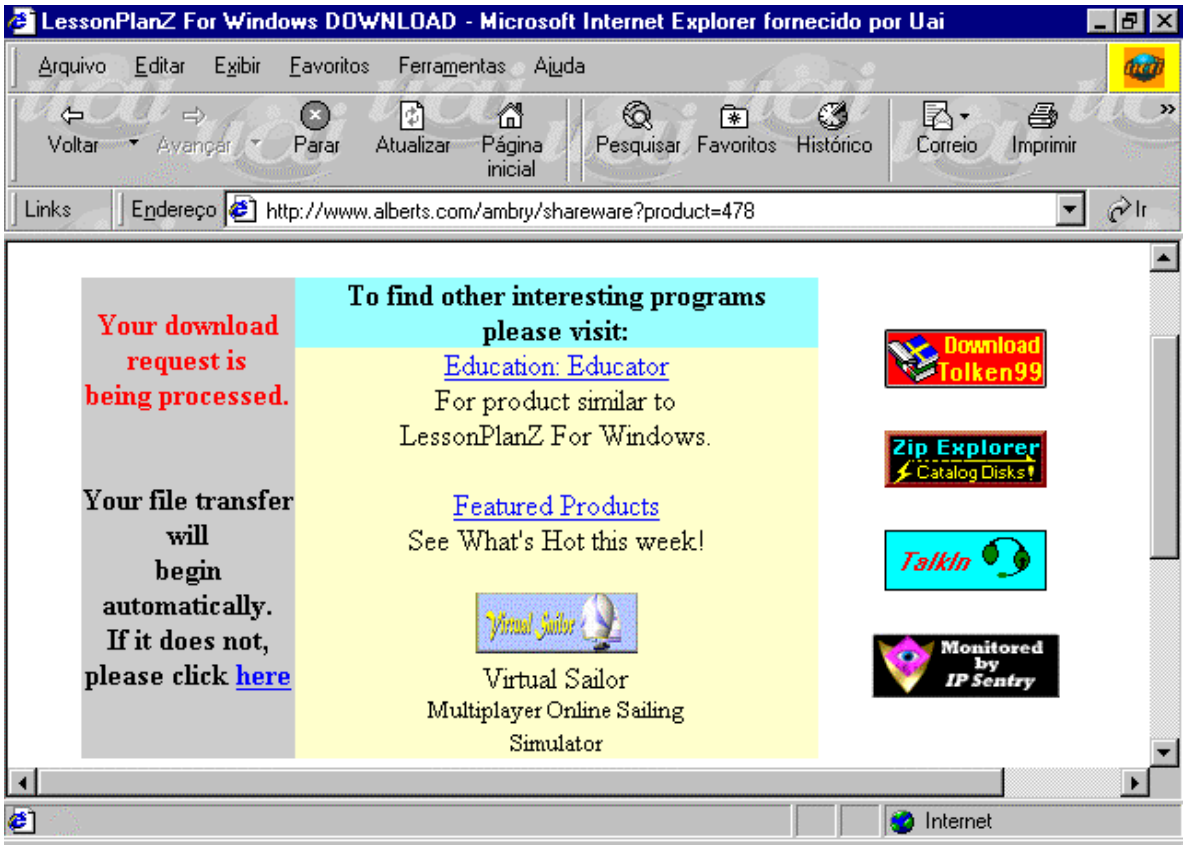
When downloading the software Macromedia Flash Player, the user is told that a video will appear as soon as the download is finished and that it should take about 2 minutes with a 56.6K modem to complete the process.

http://www.macromedia.com/shockwave/download/index.cgi?P1_Prod_Version=ShockwaveFlash.

On the site *American English Pronunciation Practice* http://www.manythings.org , where you can access lots of things, like the tune “Row, row, row your boat,” for example, http://www.manythings.org/ pp/row_your_boat.html, the word “loading” appears, followed by dots that expand into lines until the site is fully uploaded.

Loading……
……
……
……

On the screen reproduced below, the vertical bar on the left side tells the reader that a file is being downloaded and gives instructions about what to do if the download does not start automatically.



All these examples show the need to give the users feedback so that they will not stop in the middle of an operation that is being processed with no difficulties. There are also messages designed to alleviate the users anxiety through feedback. An example would be the message “This could take a few minutes. Please be patient,” given to the client of Norton AntiVirus®, before a download of software updates takes place.

It is not only the machine that gives feedback to the user, of course. There is also the expectation on the part of the webmasters and site-builders that users will provide feedback to them. Almost every site includes an e-mail address, usually in the form of links named “talk to me” or “send your opinion” or with icons that look like letters, post-office boxes, or labeled “e-mail.” Some sites even specify the type of feedback they expect: requests for support about a technical difficulty, suggestions, praise, accusations of copyright infringement, complaints, wish list (list of desired services the site does not yet provide), bug reports (in the case of the site interfering with the browser, for example). An example of a request for feedback can be found at http://www.freeservers.com/cgi-bin/feedback.

3. The role of feedback in human interaction

Feedback plays an important role in human interactions, whether they be in spontaneous conversation, classroom interaction or on-line interaction. When we interact, it is important for the listener/s to show that they are paying attention to what we say, and to do so, they need to give us some sign: a look, a facial expression, a gesture, a word, a non-verbal signal, etc. This indication could be of an evaluative nature – agreement, support, disapproval, doubt, suspicion, – or an interactive nature, when the interlocutors show that they are attentive to what we say, or that they want us to speak.

The absence of feedback in face to face conversation usually causes a certain discomfort in the interlocutor. In on-line interactions, an intense anxiety for feedback on the part of undergraduate or graduate students has been recorded in the data collected in discussion lists among specialists of a certain area or in on-line courses. The need for a reply to a message can be observed in an example recorded on a discussion list for the project INGREDE, a project organized to develop an on-line instrumental English course involving eight different Federal Universities. The absence

of immediate feedback caused a certain amount of suffering for the interlocutor. The context that produced the message was as follows: on the 12th of August 2000, a Saturday, a member of the project sent the group some teaching material to evaluate. The names of the people and institutions were removed to protect their anonymity.

> *Dear All,*
>
> *I am sending you all an attached file with a sample class lesson that we made here at X-school and we would like to have everyone's opinion on it.*
> *Especially about Y-part and Z-part, PLEASE.*
>
> *Thanks,*
> *XXXX and YYYY*

Two days later, a Monday, there had been no reply. The silence, the absence of feedback, brought about a reaction on the part of the teacher who had sent the message, who proceeded to then contact the group coordinator with this e-mail:

> *Dear Vera,*
>
> *I am sending you this message but not posting it to the mist. What's happening? Wasn't the list supposed to be a place for discussion, especially now that we are developing the units? Without discussion, the work will not be collaborative and will be left lacking because of it. I sent a sample class lesson to the list so we could discuss it, and all go in the same direction but up to now only zzzz who I sent a copy to replied. If you think it would be a good idea, as project coordinator, you could post this to the list.*
>
> *I really hope to construct this course collaboratively.*
> *Love,*
> *XXXX*

The above is a good example of the necessity for immediate feedback in the on-line environment. Even though she sent the message on a Saturday, she expected to receive quick replies. Upon receiving the second message, the coordinator replied immediately, explaining her silence by not having had enough time to study the lesson sent to the group.

In the example quoted, we can see how there was a lack of both types of feedback, evaluative and interactional, that is, the teacher hoped that those who read her

message would have at least confirmed receipt of it, saying that they would read and evaluate the material as soon as they could. In an interview conducted by e-mail, the teacher had this to say about the experience:

> *"It was really very frustrating. I was so excited about having the opportunity to participate in a collaborative assignment, but worried that we were all so far apart and would have to speak the same language. When no one replied to my request for evaluation I felt:*
> *1. incompetent, because I thought our proposal had been rejected;*
> *2. after thinking it over, I realized it couldn't be that, but I was very disappointed at not receiving any replies.*
> *We waited, and in fact we're still waiting now without replies and meanwhile, we've finished the unit without any comments. Only from the two coordinators, which was very good. Nevertheless, the type of group that we are promoting with IngRede is an interactive and participatory one. I still hope we get there."*

4. Feedback in the Classroom

Feedback in the classroom has been studied and categorized by several authors. Lyster & Ranta (1997), quoted in Lightbown & Spada (1999:103-105), describe 5 different types of feedback in foreign language classrooms. All of them refer to the students' performance when learning the language. The teacher gives:

1. *Explicit correction.*
2. *Requests for clarification.*
3. *Metalinguistic feedback.*
4. *Elicitation.*
5. *Repetition.*
6. *Reformulation (recasts).*

Schwartz & White (2000:167) distinguish two types of feedback: formative and summative. According to these authors, formative feedback modifies the thinking or behavior of the student to facilitate learning. The summative evaluates a student's assignment or test with the purpose of giving it a grade. The goal of formative feedback is to maintain the students' motivation and participation, and to keep them from feeling isolated or giving up on the course. In my corpus of data, we can find the following types of formative feedback, which can also be classified into evaluative (examples 1,2, and 3) and interactional (examples 4, 5, and 6)

1. *Telling the students that they are correct;*
2. *Complimenting the student on an insight or for having made a good association with another text;*
3. *Making the students think about a certain statement or conclusion they've made with the goal of persuading them to change their minds;*
4. *Encouraging a student to ask questions;*
5. *Encouraging a student to participate;*
6. *Stopping the students from going off on tangents or abandoning the topic under discussion.*

Regarding summative feedback, most of the examples in my corpus of data refer either to a record of assignments received (each task earned x points) or to the warnings sent to students about their absences and the risk they ran of losing the whole semester. These were designed to avoid the shock students might have received if they suddenly found their registrations cancelled after not participating

5. Feedback in the Virtual Classroom

According to Schwartz & White (2000:169-170), students in virtual classrooms consider feedback to be effective when it is

1. *timely and thorough*
2. *formative and summative*
3. *constructive, supportive and substantive*
4. *specific, objective, and individual*
5. *consistent*

You can also see through my data, collected in asynchronous discussions, that the students expected the teacher to give prompt, detailed answers to their questions and send praise and observations that make them think. There are also explanations about their need to see their errors corrected and to follow the process of registering forwarded assignments. In on-line courses, there is the expectation that the teacher will give encouragement and support to the students, pay attention to the achievements and assignment completion of each individual. Finally, the teacher is expected to be consistent, not demanding constant participation if the teacher herself/himself has shown a long absence from discussions.

Schwartz & White (2000: 167) emphasize that

> *Feedback is even more critical on the on-line environment, where students may feel isolated and detached. More than students in traditional settings, on-line students need appropriate feedback on performance because learning in the on-line medium is complicated by the disconnection of electronic textual communication. Devoid of the environment and nonverbal signals available in face-to-face contact, the on-line classroom requires effective feedback in order to alleviate some of this disconnection and to reduce feelings of isolation in the on-line student.*

When the interaction is virtual, the students cannot see the teacher nodding, or making eye-contact, or backchannelling. It is crucial that the student, in the virtual environment feel the presence of the teacher and that this presence is demonstrated through written messages sent to the group. Bischoff (2000:60) enumerates five types of messages that contribute to the visibility of the teacher, an essential factor in students feeling connected in the on-line classroom.

> *Content-related messages (lectures, handouts, clarifications of points in the text, discussion questions, synthesis of discussion);*
> *Process-related messages (order of assignments, directions for sending assignments, descriptions of the flow of the class, guidance when students become confused);*
> *Technical tips (software tips, information about how to send attachments, discussion of how to format notes, URLs);*
> *Protocol guidelines (code of conduct, plagiarism statement, netiquette, online tone);*
> *Responses (answers to students questions, feedback on work submitted to the meeting).*

Bischoff (2000:62) advocates the frequent and consistent use of on-line feedback. To her,

> *Effective on-line instructors not only write to class meetings regularly but they provide frequent and consistent feedback to the class as well as to individual students. Frequent and consistent feedback in the on-line classroom can stimulate active engagement by techniques such as questioning assumptions, disagreeing with certain points, and pointing out well-analyzed points.*

Students in virtual classes do require feedback as we will see on 5.1.3. Their messages show it is important for them to feel that the teacher is accompanying the discussions and reading all the messages. An examination of the corpora of my courses reveals that my teaching assistants and I attempted to give constant feedback

in order to maintain a certain "visibility" that functions as an indirect speech act – "I'm here and I'm following the whole discussion." The strategies employed were the following:

1. Sending a response to the whole discussion list to the individual questions received in my personal e-mail in order to spread the information and also motivate the students to interact as a group and not individually with only the teacher.
2. Encouraging the group to try to clear up a doubt brought up by one member.
3. Forwarding questions to get a discussion started.
4. Suggesting additional readings.
5. Asking the students to obey certain rules that facilitate interaction.
6. Praising the insights and other contributions of students.
7. Asking the students to avoid digressions from the topic.
8. Criticizing short, undeveloped messages.
9. Passing on technical information.
10. Explaining possible absences of the teacher.

To keep up the students' self-esteem we always avoid sending any feedback that might threaten their faces to the whole discussion list. Thus, cautious comments about poorly written assignments or the consequences of a lack of participation are sent only to the individuals' e-mails.

In our courses, we try to motivate discussions, and mainly, to make the students themselves the center of the interaction. Usually, we do not immediately respond to a question, but wait until another student does so, so that the group will be constantly motivated to try to solve problems sent in by their own classmates. Thus, actions, which are traditionally the responsibility of the teacher, become the students'. It is a common occurrence for a student to solve another's problem, saying that s/he must be mistaken, and suggesting other sources of reading or rules of interaction.

The analyses of the corpora, composed of data being collected since 1997, show the following types of evaluative and interactional feedback.

Evaluative Feedback:

1. The teacher evaluates a student
2. The teacher evaluates the group
3. The student asks for feedback about an assignment
4. The student evaluates the course or the teacher
5. The student evaluates the group
6. The student evaluates herself/himself
7. The student evaluates a classmate

Interactional Feedback:

1. The student encourages another student to stay in the course
2. The teacher encourages the students to stay in the course
3. The student asks for confirmation that a message has been received by a classmate or the teacher
4. The teacher or a student confirms receipt of a message
5. The teacher evaluates an interaction
6. The student evaluates the interaction
7. The teacher sends out guidelines for interaction etiquette
8. The student sends out a suggestion for interaction etiquette

On the following pages I present some examples, using messages collected from three discussion groups: samples of interactions among the participants of the English Language course, "Reading and Writing through the Internet" (1997-2000), in the undergraduate Languages Program at the Federal University of Minas Gerais (UFMG); and samples of interaction among participants of courses offered to Applied Linguistics and another in Discourse Analysis graduate students in 1999 and 2000.

The two examples below are very representative of the students' feelings about feedback in the virtual environment.

Hello Vera and Classmates,

Before anything else, I'd like to apologize for not being present much this week in the discussion room. My provider is really failing to meet my expectations. In fact, I'm only waiting until this class is over to change providers, because I'm afraid the change could make the situation even worse right now.

I haven't been able to read this week's assignment yet. But Juliane said that it would be a discussion of a paragraph of the text.

I would like to comment on the first paragraph of item 1.4.2: Teacher feedback and error treatment:

Teacher feedback on responses given by students is another very important element in classroom interaction. Students need to know whether they have correctly understood the teacher and have provided the appropriate answer. They are likely to feel frustrated if the teacher keeps withholding feedback.

Speaking from the point of view of the student this time, I will compare oral interaction with our virtual interaction. I completely agree with the author who says that the student expects feedback from the teacher. When I receive messages (when I can), I first open those from Vera, because I

want to see what she's written about our assignments and our comments. I notice that I'm not the only one with this expectation, because many times, when someone says, "I'd like someone to help me clarify a point," this someone expects anyone in the group to answer, and obviously, that Vera will read the answer. If Vera has no comment, this leads us to infer that the answer was satisfactory.

I also like it when she comments on my work turned in, and in some way also when she noticed that an assignment got lost along the way. I guess I feel like she looked at me and saw that I am interested in participating.
Hugs to everyone,
Daniela

In the above example we have several types of feedback. The student began her message with interactional feedback when she apologized for being absent, and said that she did not manage to read the weekly assignment, probably due to the technical problems with her Internet provider, as she mentioned at the beginning of that message. Then, she comments on the importance of feedback from the teacher and the expectations of the students to receive this type of response. Interesting is the interpretation given to the teacher's silence on any matter, as an example of a good evaluative feedback. In the last paragraph, the student emphasizes the need to receive individualized feedback from the teacher.

Next, examples of each kind of feedback will be provided.

5.1. EVALUATIVE FEEDBACK

5.1.1. Teacher evaluates student

In the following example, the teaching assistant praises the achievements of a student who commented that she continues interacting with penpals in English, through e-mail.

Paula wrote:
>
>By the way I continue changing e-mail with my penpal.
>
Good job Paula! I hope so does everybody else!
Cheers,
Ricardo.

5.1.2. Teacher evaluates the group

In this message, the teaching assistant sends evaluation of the good achievements of the whole group in the activity involving interaction with other English speakers, and mentions a similar commentary to the group from the teacher.

> *Hi people!*
>
> *Just as Vera mentioned her enthusiasm in an earlier message, I am also amazed at the news you have been sending us! I hope you keep on giving us this preview of the contacts you manage to make.*
>
> *Cheers,*
> *Ricardo.*

5.1.3. Student requests feedback from teachers

In the following messages, the students are demanding feedback. In the first example, despite the student's full awareness that simply completing the assignment is enough to earn him credits, he demands an evaluation of form. In the second example, the student after handing in samples of her interaction with other speakers in chats, a course requirement shows her anxiety to meet the expectations of the teacher, and requests feedback.

a) > *Hi Mário,*
Ricardo or Vera, I´d like to know if I doing the tasks well. I´m waiting for a feedback.

You are doing great. We expect that all the students work autonomously, that is, doing our activities, but going beyond that in order to develop their personal projects.

Cheers,

Vera

b) *Hi everyone,*
Dear Vera I would like to know if you have examined my samples, are they ok??? Do I need to hand in my e-mails samples too.

I am working on my homepage, and I hope I can get it done by the weekend.

When must is be ready??? Vera I would like to know if I have achieved your expectations as a student this term taking this course, would you send me a feedback on my work. I just want you to know that I have learnt a lot. Thank you and to my mates and to Ricardo.

Thanx
Vânia

5.1.4. Student evaluates the course

In the following example a student spontaneously evaluates the course. The student seems to have taken to heart the course's first priority of socially constructing knowledge through interactions with partners and other English speakers.

Dear teachers,

Our subject through Internet is just ***excellent*** *(in the original, the word was emphasized by appearing in red). It encourage us to write a lot, to read a lot to, to know the other's ideas and also to learn how to use effectivaly the e-communication and the resources of Internet.*

It maybe seems ridiculous, but since I started this course, I want to look for my e-mails, at least, twice or three times a day.

When I see my name or ideas in someone's e-mail, I fell very glad, because, as I told the group, I fell that I'm adding something to them, and it is very important for me.

About my penpal: It's a emotional situation to communicate with a native speaker. I never done it before, despite having an eletronic address. I'm trying to do my best!

Short: Go on with your work, because it is very important, interesting and new (for me, of course). I want congratulate you for your work!

Cheers,
Sueli

5.1.5. Student evaluates the group

The same student, as in the previous example, writes here not only about the teachers, but also about her classmates, praising the work of the group. These types of message contributed in a very positive way to the motivation of the teachers and students alike.

> *Dear teachers and virtualmates,*
>
> *I'm very happy about our virtualclass. I am reading ALL the e-mails that I receive and I believe that everybody is doing the same. This attitude joins the group very much and encourage us.*
>
> *My ideas were mencioned in two e-mails of virtualmates, and I fell glad to know that I'm adding something interesting to the group.*
>
> *By the way, I already founded my penpal; better, he founded me. He is Leroy, from Fenix, Arizona, and I hope we can exchange a lot of e mails, even when the semester have finished.*
> *Cheers,*
>
> *Sueli*

5.1.6. Student self-evaluates

In this message, the student also evaluates the course, but what is most eye-catching is the observation he makes about his own learning process – and the awareness this brings of his own difficulties, which he uses to better plan and organize his learning process.

> *Dear classmates!*
>
> *That's great these reading and writing processes*
>
> *Did you read the text and did the exercises?*
>
> *It is instructive and interesting. At least I thought so when I was visiting the site suggested by Vera. I am amazed with the whole course because most of the time I am working in production of texts. It helps me a lot when I have some difficulties.*
>
> *I suppose the text may be recommendable for all graduates students because of its instructive resources for reading and comprehension.*
>
> *I've done all the exercises and after this, I put the sites at bookmarks for future visits. I've still printed the texts and exercises. It is a way for me in*

sense of studying at home. It is because, in computer, it is easy conferring the correct answers. I thing this is not good. So, doing the exercises at home, I am able to just confer the answers after doing the exercises.

Sincerely!

Josué

5.1.7. Student evaluates a classmate

The next messages demonstrate evaluations sent to certain classmates. In the first example an undergrad student compliments a classmate on her format for e-mail and asks for help learning to duplicate it. In the second example, a graduate student shows the importance of participation of one's colleagues in the construction of one's own insights, and gives offers a personal contribution to the discussions.

a) *Hi Valdete,*

I have just read your e-mail about the second activity and I'd like to say that the format of your e-mail is very nice. Could you tell me how did you do that? I'd like to know and I'd thank you if you could tell me. Bye.
Juliana

b) *Danielle,*

I think your observation is so interesting. I had never thought of such a possibility. It combines well with the comments Ana Beatriz and Rogério made that helped me consider what is "innate" or not.

Beside your explanation, which really makes sense, I would also add that students have a tendency to want to understand every single word of a listening activity and when they can't understand one, they miss the rest, and get frustrated at their lack of success. I think it's important to show them that even in our native language, we often fail to understand every detail of speech (the evidence of this is clear when we try to transcribe oral texts) but that doesn't mean we miss the main idea, which is what's really important. A good article to help us develop our students' awareness of factors in listening activities is called "Who is afraid of listening comprehension," by Rosana Lucas. Here is the full bibliographic reference: LUCAS, R. "Quem tem medo de listening comprehension?" in Paiva, V. "Ensino de Língua Inglesa - Reflexões e Experiências". Campinas: Pontes, 1996."

Affectionately,

Viviane

5.2. Interactional Feedback

5.2.1. Student encourages another to stay in the course

Testimonies like the following have two roles. Besides motivating the other students to stay in the course, it builds group morale in the sense that more than one person is facing the same problems, which keeps the recipient from feeling inferior to other participants.

Alda wrote:
>
> Dear Juçara,
>
>As you I have many problems to do my tasks and send e-mails to
>everybody, because I don't have computer at home and sometimes is very
>difficult to get one free at Fale. But we can't desist because this
>subject is very good for improving our English.
>
> BY,
>
Alda

>
Hello, Alda!!!:)
Thank you very much for your friendly words and support. I guess we are not the only ones who are facing such problems: the Computer Lab at Fale is always packed (especially during the breaks between classes) and not everybody has got a computer at home.
The good news is, now I've got my own computer and I will be able to send my e-mails at night and on weekends. I won't drop out of this course, because I'm really enjoying it!
Hope we can be friends,
BYE!
Juçara

5.2.2. Teacher encourages the students to stay in the course

In the following example, a student insists on turning in the assignments after the due date and employs a kind of emotional blackmail. The teacher, while not failing to enforce the rules of the course, which would be unfair to the other students, assures the student that he is welcome to stay, emphasizing the fact through capital letters.

>If you do not accept my task, please let me know before I send you the >second, and doing so I'll not spend my net time with this class if I'm not >welcome.

(...) *Please, try to hurry and catch up with your classmates so*

that you can get all the presences and marks, BE SURE YOU ARE WELCOME.

Regards,

Vera

5.2.3. Student requests confirmation of receipt of a message by classmates and the teacher

Although all the messages sent are visible on the course homepage, the students feel the need to receive confirmation of the teacher or of their classmates that the e-mail arrived, and frequently ask for feedback. When feedback is not forthcoming, the message can be sent a second or even third time to the whole group.

a) *Guys,*

Please, could someone confirm that my messages are getting to you? Because the postmaster keeps on returning them to me...

Ana Paula

b)

> Vera,
>
I would know if my task 4 it was send.

>

It was send before the message thet i send for you about the signature.

>

Rosa

5.2.4. The teacher or a student confirms receipt of a message

Here we see an example confirming the observation made above, that messages are often re-sent in the absence of feedback.

I don't know what happened with my e-mail, so, I'm >sending my task again.
June,It seems your e-mail is working well because we got your three messages with your task.

Vera

5.2.5. Teacher evaluates an interaction

In response to a student who complained of a lack of more active and critical participation on the part of her classmates, the teacher evaluated the complaining student's own participation and suggested that she change the way she interacts.

(...) Disagreeing just to disagree doesn't get you anywhere. You have to say what you disagree with and why. Even now I don't understand what you were disagreeing with. When you say, for example, that classifying strategies only helps the teacher and not the student, I feel frustrated that you didn't elaborate on your ideas.
I'm sure that if you present us with arguments, your classmates will join in the discussion with you. If not, it ends up being a dialogue limited to us two.

Vera

5.2.6. Student evaluates the interaction of the group

In this example, a student evaluates, in a negative way, the interaction of the group that is failing to adequately respond to the questions posed by the teacher.

Just one thing, it seems like we aren't communicating with each other. We don't direct our messages anywhere. To all and to no one. Vera requested that someone send out the different concepts of style and learning strategies. As I have seen that many times one has been confused with another, and she states that they are not the same thing. . . could someone someone take on the responsibility of sending out a text that differentiates them? Academically, please.

5.2.7. Teacher suggests guidelines for interaction

Messages about rules of etiquette in virtual interactions are sent throughout the course, so that discussions can be more effective. Usually, the teacher sends most of these guidelines. One of the most common problems is illustrated in the following example:

I would like to ask everyone to leave only that part of the previous message that is necessary to understand the reply or provide context. Some messages unnecessarily include replies of replies of replies.

Vera

5.2.8. Student suggests a rule for interaction

The students also align themselves in relation to netiquette, (internet etiquette), especially when they feel in some way injured by the failure to observe some common rules, such as the following example illustrates, in which the student reminds the group of the necessity to use anti-virus programs, to avoid infecting everyone on the list.

I had a big problem this week with my computer cause some of our mates sent me e-mails with virus. Especially some who were sending with attachment.
Please tell them again, firts to run a VIRUS SCAN in their

computers and to be more polite as we were seeing about netettiquete on the net.
Thanks
Paulo

6. Conclusion

The literature about feedback in the classroom has focused mainly on actions, which describe learning conditions, with emphasis on errors. If we believe that learning occurs through social interactions among learners and more expert language users, it is important for us to give more attention to interactional feedback.

Automatic responses may help the teacher at least to inform the students that their tasks have been filed or that the teacher has read their messages. Those responses would work in a similar way to those described in section 2, preventing the students from repeating the same actions that is sending the same task twice or more and keeping sending messages asking if the teachers have received their tasks. However, the students and even the teachers demand more personalized participation.

In on-line courses in which interaction via discussion list is expected to have a central role in the learning process, it is feedback that anchors all the interaction and guarantees the success of the course. Students send in their contributions and questions and expect responses from the teacher and their classmates. They feel

rejected by the group and by the teacher when no one takes an interest in the topics they propose. Silence is then a strong feedback that can even have the effect of the student dropping out of the course. In the example below, we can see that the student is about to drop out because of the feeling of being ignored by the group.

> *Good morning teachers and class,*
>
> *(...) I don't know if I'am write correctly, because nobody answered me, so I'm no learning nothing! I thought thar I will learn to write and read but, I don't know if what I read is right, if I write is correct, and everybody knows english very well!*
>
> *I think too that I'm in wrong place! Excuse me for all,*
> *by for everybody!*
> *a hug for you!*

To avoid students feeling ignored in virtual courses, I frequently send messages explaining a lack of reply to a certain message, as can be seen in the following example, which, nevertheless, does not prevent the demand for feedback.

> *Dear colleagues,*
> *I'm going to avoid replying to every student who contributes to the discussion so as not to overload the in-box with messages. I intend to comment each week about the interaction that occurred during that week.*
> *Vera*

Nevertheless, the students do want personal comments on their works. If no feedback is given, students feel insecure about their progress in the course or feel they could get more attention. Some students interpret silence as a meaning they are not on the right track as we can see in example (a); others just request attention – examples (b) and (c) – and others just want feedback as a kind of proof that their tasks were received by the teacher as in example (d).

> *(a)> Am I in the right way? Please, drop me a line.*
>
> *(b)I'm wondering if you could give me a feedback !*
>
> *(c)Teachers and virtual classmates, if you enjoyed reading my text, please give me feedback making a little comment on it. I hope to hearing from you soon.*

> *(d)I haven't got any feedback on my 3rd and 4th tasks and I just wonder what happened. I would really appreciate if you send me some feedback as soon as possible so I can control all of my work in this course.*

In our graduate-level on-line course, we have weekly readings and on-line discussions, without set schedules. The readings generate reactions – comments, questions, criticism, and consultations of other texts – all recorded through e-mail. These messages receive feedback from the students and the teacher. The feedback, also mediated by e-mail, generates reflections, changes in opinion, revised understanding of concepts, and new messages. As the same text is discussed throughout the week, the students have a greater opportunity to make their own comments, and more time than that available in the traditional scholarly context to give feedback, solve problems and doubts, and add information to the readings.

Nevertheless, it is not easy to exchange the culture familiar to us since childhood, for virtual learning communities. In the traditional classroom, the teacher usually is the one to provide feedback. The teacher asks, the student answers, the teacher comments, and the number of topics is usually reduced and controlled. In virtual interaction, everyone can propose questions/topics and everyone can comment or give feedback in reply to a message.

The absence of comments from the teacher and the students is a major complaint among participants, because not all topics, whether proposed by the teacher or by the students, can be taken up for discussion, leaving the person who proposed the topic frustrated. Moreover, many students continue believing in the academic authority and omnipotence of the teacher, as the only source of information, which creates the expectation that the teacher will respond to every single message, even when a classmate has already done so. Such discomfort felt by many students is evidenced by this message from a graduate student:

> *I have this feeling in the pit of my stomach that I'm not prepared to do an on-line course. This is probably one of the reasons I've been so resistent to the class. I feel the lack of feedback from the teacher, and think it's hard when a classmate asks a question and no one replies to it. I'm worried. Every night I feel the computer judging me, like this, there it is over there, full of messages waiting for me. Am I the only one who feels like this?*

Certainly, she's not the only one who is experiencing the discomfort in the transition from the paradigm of teaching concentrated in the limited knowledge of the teacher to a hypertextualized classroom, where not only the words of the teacher, but many other voices with other words combine into a semiotic system made dynamic by feedback. Other students adapted well to the new environment, as can be noted in the message below of one student's interactional feedback provided to the student of the previous example:

I think making a challenge out of working on reducing your anxiety could by a good affective strategy. Don't be discouraged. The feedback could be from all of us, and who knows, maybe by having lived through this experience, we'll be able to do this with our students in a conventional classroom? I mean, who knows, but that we'll be able to truly create student-centered classes and they'll then become more independent?

Don't get discouraged.

There is strong evidence in our data that feedback in the virtual environment is of paramount importance. In the learning environment, no matter what kind of feedback it is, be it evaluative or interactional, the role of feedback is to link together the members of the virtual community, giving them the feeling of belonging

We are all learning and trying to make the best choices. In our constant exchanges, our continuous interaction, we are constructing a collective intelligence that outgrows each one of the participants, that builds something much bigger than each one of us, but that certainly exists only due to the feedback that each one of us, in our own way, gives to the group and to its participants individually.

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Presence in the environment: theories, methodologies and applications to video games

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ABSTRACT

Many authors maintain in their work that the presence feeling in the virtual universe only survives if the player is unaware of the technical interference. The technical system is a mediation between the subject body and the virtual environment. There are many ways to theorise this mediation and therefore many types of explanations given to explain the fact that the user is no longer aware of the technical system. The more common is the "immersion theory". This is a technical theory. We propose a more psychological theory based on activity theories. We think that the transparency of the mediation appears with the subject practise and the increase of it.
We propose a new methodology to assess the feeling of presence to show that this feeling varies during the activity.
We don't find that the more a subject is experienced the more he feels present. We discuss this result and conclude that there's a complex relation between the feeling pf presence and the transparency of the mediation.
We find that the feeling of presence varies according to the activity. This second result can't be explained by the theory of immersion. This result support our proposition but we need more results to conclude.

Keywords: *presence, immersion, activity theories, videogames.*

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1. Introduction

Many authors maintain in their work that the presence feeling in the virtual universe only survives if the player is unaware of the technical interference. For example, if a player is not aware of the fact that the virtual universe is displayed on the screen, he will be able to be present in this universe.

You will notice straight away that we have chosen to use the expression "to be aware of the technical system" rather than "to react", "pay attention" or "perceive." To be aware consists of "having a full and clear knowledge of what one does or feels, of the existence or the reality of something" ("Grand Larousse en 5 volumes" dictionary). This expression does not require a particular explanation: reflex, attentionnal, or perceptive

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mechanisms. Therefore, we can tackle the explanations of this state of awareness or not from the technical system without a presupposed explanation.

Why is the user no longer aware of this technical system? And what should we do to favour the fact that the user is no longer aware if the technical system? We are going to propose some answers to these questions. For this, we will see the different explanations of the fact that the user is no longer aware of this technical system.

2. Explanations of this feeling 'of being elsewhere.

The technical system is a mediation between the subject body and the virtual environment. There are many ways to theorise this mediation and therefore many types of explanations given to explain the fact that the user is no longer aware of the technical system. We will see these different explanations.

2.1 Technical explanations: the immersion theory

This theory aims to make the technical system invisible by allowing the user to behave as if he is used to it. This theory aims to create an ideal interface between the user and the technical system. This interface is ideal in the sense that it would not require any teaching (Rheingold, 1995).

This theory is founded on a distinction between reality and virtuality. For the researchers defending this point of view, there is a reality measurable that it is sufficient to reproduce in order to allow the user to behave 'naturally'.

The synthesis of this universe is realised by means of a technical system that simulates it. The interface works via the peripherals called 'immersive.' The immersion connects the human perceptive and motor 'channels' with entries and exits from the technical system. For example, in the case of office computers, the line of sight is coupled with the screen and the hands to the combination of keyboard and mouse. Nevertheless, our example is a system that is not very immersive. A highly immersive system will consist of a heading in a "Head Mounted Display" (HMD) format and datagloves. So, the visual channel and the hands are totally immersed in the technical system. This allows the user to behave naturally, without any teaching. In order to take an object into the virtual universe, the user seizes with his actual hand, the datagloves are in charge of transmitting the gesture to the technical system that then modifies the attachment on the HMD.

The more the user is immerged by the peripherals that allow him to behave naturally, the less he is aware of the technical system and the more he feels a part of the virtual world (see Coiffet, 1995 for the development that is the most characteristic of this theory).

The limits of this technical theory (for example Cadoz, 1996; Ryan 1994 or Kalawsky 1999) are partly technical. This immersive and invisible technical system does not exist today. It will without a doubt never exist because it implies the disappearance of tools by perfectly copying reality when these tools are not present in reality.

Many questions naturally stem from this technical theory. What classifies as an exact copy of reality? How does perception work? How does action work? What are the links between perception and action? What is natural behaviour for the user? What are your objectives when you use a virtual reality system? What is a feeling of being in a virtual environment?

The study of a person interacting with immersive systems is therefore pertinent and this is what we are going to see next.

1.2 Psychological explanations

From the point of view of the person, many mechanisms are suggested to explain the reason why he is unaware of the technical system and therefore the feeling of being in a world created by the technical system. The field of study of this feeling is that of 'presence'. There is a thin line between this field of study and the immersion theories. If the scientists in this field often reproduce the immersion theory, it distinguishes itself by an approach centred round the person, rather than the conception of the system.

The peripherals as interface between the person and the virtual universe

In this perspective, the person is in the real world and acts in the virtual and distant world. There are different theories to explain the functioning of the person, his interactions with the technical system and the reasons why he places himself in reality or virtuality. These theories lead you to believe that the feeling of presence is like a feeling of being more or less in a virtual world (or acting in a virtual way), a present world (where you are physically) or distant place (where you are acting psychologically).

The people who have written about this perspective agree that the concept of presence has many explanations and that the level of study chosen does not assume that the others are not valid.

This presence approach is based on a separation between environments. It is therefore geographical. We will quote only a few of the most cited authors referring to this approach: Sheridan (1992a), Slater & Usoh (1994), Kim & Biocca (1997), Witmer and Singer (1998), Lombard & Ditton (1997) or Schubert, Friedman & Regenbrecht (1998, 1999).

Whatever the level of study chosen, these authors have their approach of a person as physically present in the real environment and more or less psychologically present in another environment, in common. As a person cannot be geographically present in two places at the same time, you must see to it that he believes that he is physically in an environment that in actual fact he isn't present in.

This approach leads to treat the feeling of presence from a physical point of view, by integrating the perception, the motor capacities, memories and attention of the person and by copying the real world to create an illusion of place in the virtual world. It is important but not sufficient. Nevertheless, few studies look into the activity of the person. What does the person do to define his goals, choose and realise his actions? Does this have an influence on the feeling of presence?

The peripherals as continuity of the body of the person

In this perspective, the person is in his "action world". You don't care about knowing whether it is virtual or real. The real and virtual separation is not pertinent psychologically speaking since undefined in terms of action but uniquely defined in technical terms.

There are also different theories to explain how the person works, his interactions with the technical system and the reasons that place him in a world of action rather than any another. All of them define the world of action according to the person's goals. These theories believe this feeling of presence is like a feeling of being more or less in the world of action.

Flach & Holden (1998) propose using the ecologic theory of Gibson. This approach measures objects and events relative to an actor. In this approach it is the coupling of action and perception that will determine the loyalty of virtual reality. Thus, these are functionalities more than the appearance that determines the reality of the experience. The analysis level of this approach is the perception and action too. But the person is functionally 'linked' to his environment in the approach proposed by Flach & Holden.

Zahoric & Jenison (1998) and Marsh, Wright & Smith (2001) base their theories on the work of Winograd and Flores who bases his on that of Heidegger. For them, the

relation to the world is built. No distinction between the real world and the virtually world is psychologically valid. Zahoric & Jenison (1998) choose to look into a construction in terms of perception and action following Gibson's theory. An individual will feel present if his actions and perceptions are supported with success, in other words if they are the same effects than in the real world. Marsh states that the user must be kept in the flow of his activity in order to increase the presence feeling. This flow is broken if the activity does not happen as expected, there is therefore a breakdown. For Marsh, Wright & Smith (2001) as the attention is not worn in the real world, there is presence in the virtual world even if there is a breakdown in interaction. The transparency limits itself for him to a perceptive and mechanism of attention.

These authors tackle the question of the person interacting with the world in terms of actions. However, they introduce each in their own way a distinction between real and virtual place that is not strongly pertinent from the point of view of the action. We think that the analysis levels used by these authors are not the same. They think that the media is integrated so strongly with the activity that it becomes invisible. This activity is orientated towards a goal. This goal cannot reduce itself to motor and perceptive mechanisms (Zahoric & Jenison) or perceptive and attentionnal mechanisms (Marsh, Wright & Smith 2001). The subject builds this goal actively, consciously and socially. We believe that one must adopt this analysis level in order to be able to free oneself from questions of virtuality or reality what a physical approach stretches to always to bring back. Spagnolli & Gamberini (2002) study the mediation with an activity point of view and show that the feeling of presence is not determined by the perceptibility of the technical medium per se. They based their work on the concept of "breakdown" (Spagnolli, Gamberini & Gasparini, 2002).

McGreevy (1992) studies a precise interaction situation: the work of geologists. It is difficult to say how he thinks the link between the person and his environment. He is interested in the work of geologists in a real situation, with or without the mediation of a camera system coupled with HMD. The environment is therefore the same and is analyse by geologist with and without a technical mediation. It shows that geologists need to have a continue representation from the environment of their work and that this continuity is a condition of presence. McGreevy therefore conditions the presence of the geologist to his goals and to a way he can successfully realise them. The technical mediation does not have to reduce the static continuity and the dynamics of the environment for the geologist. For example the weak field of vision prevents the geologist from having a large view of the environment necessary for his job. The

problem is not that the technology does not reproduce exactly the real environment but that the technology prevents the geologist from working in a way that he is used to. McGreevy shows well that the level of analysis other than the perception and the action is pertinent in the presence study: that of activity.

Jacobson (2001) shows that the users of MUDS are more present in technical activities if they have a technical knowledge and in social activities if they have a social knowledge. Their sensation of presence vary according to their knowledge and their activities. Jacobson (2001) uses interviews to obtain these results.

Reeve (2001) shows that the users of virtual reality system feel more present when they are familiar with the interface. He studies the feeling of presence of actors that use virtual reality to rehearse a play. He found also that the actor feel more present when they are more experienced in acting.

Mantovani and Riva (1999; 2001) think that every experience is culturally and socially mediated. Thus, the reality of the person environment is no longer specific in the case of virtual reality or teleoperation than in other cases. There is always mediation between the person and his environment. For these writers the presence factor is an ecological action via a cultural and social mediation. There is only an environment for the person, that of his possible action via an obligatory social or cultural mediation.

These authors are very close to the perspective presented by Rabardel (1995). For Rabardel, the subject uses an artefact to realise the object of his activity. The subject constructs a mixed psychological entity: the instrument. This entity is constructed at the same time as the artefact and the participants' schemes. It is built according to the object of the participants' activity. It carries out mediation between the subject and the object of the activity. The artefact can become transparent if it enables the subject to build instruments. It is the notion of operative transparency. Once an instrument is built, the artefact psychologically becomes the continuity of the body of the person. It is no longer accessible to the conscience. The transparency is therefore built in the reaching of a goal and no longer an illusion passively received by the subject. Beguin & Rabardel (1997) show in a study on CAD (Computer Assisted Design) that the materiality of the activity's objects is transposed on the file. The file becomes the headquarters of the participants' activity. The authors conclude that in terms of activity, the dematerialization is 'neither really just nor even operating.' This leaves you to strongly believe that the real and virtual distinction is not pertinent from the activity's point of view.

To conclude, we think that this distinction sets out to conceive the presence feeling from a physical point of view, based on an perceptual illusion of non-mediation mechanism (Lombard& Ditton 1997). We propose to consider that the person is also present in his world of action, that integrates but passes the real and virtual distinction and that this world is the fruit of the construction of an instrument.

Thus, we propose to take into consideration the activities' role in the development of the presence feeling of a subject that has built its relationship to the world via mediation of an artefact in order to realise his goals in the given situation.

3. Hypothesis

Basing ones judgement on the literature and on the Rabardel's model, we therefore assume that the presence feeling is dependant on the construction of the mediation by the expert players according to the object of their activity.

We believe that it is pertinent to have a historic approach on the participants' activity in order to understand the presence feeling in a real usage situation.

We try to show what influenced the construction of the operative transparency according to the object of the activity. We believe that the less experienced the user, the more the presence feeling increases with practice. We will see what the users' objects of the activity are and we will check if there are differences in the presence feeling assessments between these. We will compare the assessments of the presence feeling for different parts according to the object of the activity they are not equivalent.

We believe that the persons' presence feeling can vary according to the object of the activity. A number of parameters vary according to the activity's object. If it is completely relevant to study the parameters more precisely, this does not imply for as much as it is not relevant to study the variations of the presence feeling according to the activity's object. It is in fact because the person changes his object of activity that the other parameters change. The change in he object of the activity means that the person will also modify his behaviour and therefore his relationship with the technical system. The mediation construction is in fact linked to the object of the activity.

We will study a real usage situation: games playing. We have therefore created an experimental situation where the players are going to recreate as best they can their game habits on one machine and the will play many rounds in the same conditions. We believe that we will see an increase in the feeling of presence of players as soon as they construct or reconstruct their instruments in the world.

We have developed an original method of assessing the presence feeling in order to conduct our observations. We will firstly present it and then we will develop the experiment properly speaking. Because all construction is steered towards a goal, we will carry out an autoconfrontation with the players in order to distinguish what the objects of the activity are and to compare the presence feeling according to these objects.

4. Methodologies and experimentations

For this research we needed a continuous and subjective method of presence evaluation that is compatible with the games activity. In fact, we needed to obtain the presence feeling of participants at different moments of their activity in order to link the pursued goal and the route that they take to achieve their feeling of presence. We have not found a satisfying method in the literature and have chosen to develop this method ourselves.

We will first present our methodology without results. This is composed of two parts: research into the question of presence and the autoconfrontation of presence.

We will then present the progress and results of the experiment.

4.1 Define the question of presence

Welch, Blackman, Liu, Mellers & Stark, L.W. (1996), Kim & Biocca (1997), Lombard & Ditton (1997), Freeman & Avons (2000) and Jelfs & Whitelock (2001) think that the feeling of presence is strongly subjective and that it is necessary to define it with the participants in order for it to agree on what will be asked.

Theories

We want to determine which questions to ask the participants in order to directly measure their feeling of presence. As Truitt and Ahlstrom (2000) suggested, the assessment of a feeling or an impression goes through a work in real usage situation in order to be as close as possible to the operators. We will try to analyse the feeling of presence of individuals in their activity. We there hypothesise that this feeling will vary from one activity to another by its nature and that it is difficult to qualify it without appealing to the operators.

The works on the sensorial evaluation (especially the taste assessment) inspires us. In order to obtain reliable and accurate results regarding the gustative evaluation of a

product, Urdapilleta, Ton Nu, Saint Denis, Huon de Kermadec, (2001) propose the elaboration of taste descriptors and their group definition. For the taste, there are many descriptors to be evaluated. For the feeling of presence, we want only a single evaluation that represents them all. Our goal is not to evaluate each dimension of the participants feeling of presence but to define a single, common and comprehensible question to all the players.

Interviews with the users in real situation

Leplat and Hoc (1981) note that it is important to know the activity before the signing and analysing of all the methods of verbalization in order to avoid only accessing a formal knowledge. The interviews allow you to therefore familiarise yourself with the activity and to try to 'get closer' to the participants feeling of presence by making it possible to adapt your views and to skip over the general processes towards a more specific knowledge.

Firstly we carried out interviews with the users of virtual game environments in order to determine which terms would best define their presence feeling. There are three objectives; to understand straightaway what creates the presence feeling, what is this feeling of presence and what terms define it the best.

4.2 The game activity

3D video games

We have chosen the computer games playing activity in order to realise our observations. This activity is very standard and the users can be an advanced user. It is therefore possible to observe a real situation of users who have constructed their mediation. What interests us in this paper is a particular category of videogames: the 'First Person Shooter' (FPS).

We have chosen this type of game because it is, as far as we know, the most immersive type of games in the technical sense. Videogames are less immersive than a complete virtual reality system. These games supply a minimum degree of immersion.

- A subjective view for the player (1st person)
- A 3D world with textured surfaces and different lighting and graphical effects (fog, smoke…)
- A sound generally spatialized onto 2 speakers
- Realism research into the interactions

The game that interests us the most is Quake 3

Quake 3

This is a fighting game in a 3D environment displayed in a subjective view. Equipment is laid down: weapons, armour and ammunition. They are always in the same place and reappear a bit after having been taken. You need these pieces of equipment in order to win. They give an advantage to resist and eliminate the others players.

We have chosen Quake 3 for these specific reasons:

- The Quake situations are not real. The places, weapons and characters of Quake are not real. But it is set up to be from the actions and representations point of view. It supplies immersive characteristics in FPS style and other extras:
  - A stereoscopic vision.
  - A joystick (more intuitive than the keyboard or mouse).
  - A 3D sound.

The presence of these immersive technologies allows us to know their real effects. You will notice that the movement are simulated by swinging views when walking or running in order to realise the slight modifications of the position of the head when walking.

- The game is very quick: the action is very rhythmical. The places are generally reduced and players come across them quickly. Also they move a lot quicker than in a lot of similar games. Quake therefore imposes strong temporal constraints: players must act and perceive as quick as possible.
- It is very demanding in terms of processing power. At its release Quake was asking an enormous amount from the machine to such an extent that it became, in many material tests, a point of reference to measure the display abilities of the system.
- It is very adaptable to the players and machines abilities. This game has many configuration layers. The first is at the menu while the last allows you to modify the game via the C++ language. The most interesting is that the user has the possibility to modify the realism and the immersive abilities of this program.

We have seen that Quake imposes temporal constraints and processing constraints. These constraints will force the player to make choices between different characteristics of the technical mediation, and the games adaptation ability will allow him to carry out these choices.

4.3 A first approach of the game activity

Interviews took place during Lan-Party in 2000 and 2001 at Rennes and at Paris (Rétaux forthcoming). There were 11 players interviewed (10 men and 1 woman). Game level was varied. All liking FPS, certain players were passionate for Quake while the others just played it methodically (often preferring Counter-Stricke). We asked them about their playing in a large sense rather than asking the questions that we are particularly preoccupied with.

The players attempt to get the clearest and most fluid display as possible. They try to make the fastest and most precise gestures. They manipulate the graphic parameters of the program; touch associations and buttons to the games function and the sensitivity of the mouse. The sensitivity of the mouse is a criterion that determines the amplitude of the link between a real movement of the mouse and the 'subjective view' movement on the screen. The bigger it is, the more important the view movements for the same real movement of the mouse.

There are many physical laws in the world managing accelerations and speed in movements. The players seek to profit from the many faults in these laws by combining many movements simultaneously in order to profit from multiple accelerations. Amongst these laws there is, for example, gravity. This allows them to move quicker. Nevertheless, so that the gestures have an effect and therefore there is a fault, it is necessary to have more than 24 images per second.

This study of player verbalisations on the transparency of the interface, in a real situation, brought about 3 conclusions concerning the relationship of the player with the technical system:

- The game activity is the object of a construction steered towards a goal
- This construction can provoke a technical system transparency and contribute to the presence
- Players do not feel physically present in the game but rather feel involved in it.

From the interviews carried out, the players teach us that the game is a constructed activity. Historically, players are firstly seduced by the immersive qualities of the game. Little by little, the games ability to adapt the activity and the game to their goals will be more important. Video games are built in order to be known then controlled by the players. The games artefacts must become an extension of the participants' body that

links him to an action space that develops in the rules space. Games each have their own rules, tricks and ways to win. Each game is a free space in which the player can express himself. The game is a world apart created by a game contract (Duflo 1997). The physical illusion of non-mediation only has a fleeting life. The subject will construct the transparency from his activity. It seems to be the construction that straightaway constitutes the game and allows you to feel present within. Whether these artefacts are real or virtual, as long as they are integrated by the subject in a operative way, in other words as long as they allow him to carry out the object of his activity.

4.4 Presence expression

The interviews were analysed. The analysis picks up all the presence-feeling expression in the game used by the users. The expression that occurred the most is used to formalize our question of presence submitted to the definition group. In our situation, the expression 'to be in the game' (or not) appeared often in the verbalizations of one player or another. The term 'presence' did not occur.

4.5 Definition group

Next we carried out a definition group about our question of presence: "to be in the game." A professional must in principle head this group. Not having either the means or the skills to realise this, we opted for an online consultation. We were counting also on attracting a maximum amount of people, more than in the group, and making up for the lack of a professional host. The forum was introduced as:

> "*Hello! I have a bit of a strange question. I am doing a thesis on ergonomics (which I have already posted onto the forum) and I am interested in Quake.*
> *If I was to ask you if 'do you feel like you are in the game?' What would you understand from that question? What does this feeling depend on? More clearly what are the reasons if you do or do not feel in the game?*
> *Xavier*
> *PS: I specify that I am not interested in violence in games or in the fact that the players would be outside reality… it is not my goal. My goal is to know what characteristics does a game have in order for one to be 'in' it?"*

This message allows to be specific straightaway, to arouse interest, to respect the codes and the tone of the forum and finally to take some precautions on the sensitive participants of the community (violence in games).

Sometime, we must to precise our questions:

"Do you think you could give more details? It's not in a one or zero all that is it? You are more or less there, no? Does that depend on what happens outside and in the game? On the machine? On the configuration of the game?"
"Two other little questions:
- *How can these feeling evolve from experience, from installing it for the first time to playing it perfectly a few months later?*
- *Is the first time the same as the umpteenth time? For the same reasons?*

"To come back to Quake and my question, I suppose there are other things that make you feel a part of Quake like 3D or the quality textures? Is there an evolution of the feeling of being in the game? Is it stronger as soon as the game is mastered? Why?"

The group leader carried out the analysis of the verbalizations and the large presence dimensions were subjectively brought together.

For example: *"In order to immerge yourself in whatever it is, an exotic environment is needed, making the work imaginary."* Has been classed "removed somebody from his usual surrounding".

The descriptions of being in the game have been regrouped into a theme in order to be usable in a definition. It was difficult to separate the state of "being in the game" and the causes and effects of this state. For example: *"think of nothing else"* does this allow him to be in the game or does it describe a state of being? We therefore next proposed our definition to the discussion group in order to validate it.

4.6 Results

There have been 45 messages, of which 4 were from me, and 16 contributors during our discussion group set up on the "QuakeFR forum". The choice of forum was lead by the need to test the question of presence with a population of players already aware of this game. This forum brings together the best French players.

If the interpretations that created this feeling of being in the game, were varying from player to another, the term has been immediately understood and interpreted as 'being at the game to nothing else' by most of the players. To be at the game signifies: to be performing, concentrated, involved, disorientated and moved by the game. This stage is indispensable so that the participants all evaluate the same thing and so that this evaluation is as near as possible to their real feeling.

Two players defined this feeling as negative:

State	Occurrence	Category
The opposite of being there is of not being there	1	Conscious of being there
No longer ask if one is there	1	Conscious of being there
Not to be in the reality	2	Conscious of being there

We have not kept this definition because it introduces nothing if it is not to take the opposite. Here are the other definitions given by the players from the fact of 'being in the game.'

State	Occurrence	Category
Not thinking of anything else	4	Concentrated
To be concentrated		Concentrated
To think of the game		Concentrated
To feel removed from our usual surrounding	2	Removed somebody from his usual surrounding / Changing of scenery
To feel emotions	3	Touched
To have taken in the rules of the world or know the universe		Performing
To feel able to do what you want		Performing
Winning	1	Performing
To want to play	2	Implicated
To be interesting in the game	1	Implicated

The created categories are typical of my own subjectivity. A lot of other elements have been collected during this work of definition: These last elements have not been taken into account because they were not describing a state but a factor or an effect of

a feeling of being in the game. The player will evaluate his feeling of being in the game. This feeling is defined as 'performing, concentrating, being implicated, being touched and changing of scenery.'

We next proposed this definition to the discussion group in order to validate it. It has sometimes been judged too large but never (for any player) to restricting. It described the state of the players while they were in the game well. We had therefore a definition of the players feeling of presence in Quake 3 that should be suitable for all the Quake 3 players.

4.7 Conclusion

In terms of these processes, we have a question that the majority of participants understand, precise and exhaustive in the dimensions of the presence evaluated. We demand to evaluate 'the extent to which do you feel to be in the game' and precise that 'feeling to be in the game' is 'performing, concentrating, being implicated, being touched and changing of scenery. 'What remains now is for us to establish a continuous quantitative assessment method of the feeling of presence.

5. Autoconfrontation methodology

It is impossible for the players to continuously and simultaneously assess their feeling of presence. They are too occupied by the game and cannot carry out other actions during certain moments of the game. In the case of simultaneous verbalisation, a double continuous verbal task would unavoidably change the fulfilment of the explained task. It is therefore better to resort to consecutive verbalisations.

We will try to evaluate the presence feeling of participants by using the consecutive explanation and especially the autoconfrontation method. Researchers (Clos, Faïta, Fernandez and Scheller 2000, Bisseret, Sébilotte & Falzon 1999, Rabardel, Carlin, Chesnais, Lang, Lejoliff & Pascal 1998, Hoc 1984, Leplat and Hoc 1981, Theureau 2000) validate the consecutive explanation. The length of the situation that the subject has verbalised and the time that separates the activity from the activity from the verbalisation must not be too long. The nature of the activity is also important: an automatic process will be more difficult to verbalise than a process that is not and will strongly require a reconstruction. It is also necessary to know the activity in order to get the verbalisations on the activity really carried out. They also recommend to use video documents so that the researcher avoid too much of a reconstruction from the subject

and always from the 'general data' to go towards the specific data so that you do not limit the subject.. This is the autoconfrontation methodology. The autoconfrontation is an examination of the dynamics of the structural coupling of the participant and of the situation (including the other participants). This exam is jointly assisted by behaviour reproduction techniques (video) and by the researcher as observer and interlocutor. It allows you to document the immediate comprehension of the participants' real-life experience' at any moment of his activity.

The evaluation can be a reconstruction by the subject because his feeling isn't conscious. The presence feeling model created by the subject must be as near to the truth as possible.

Therefore some precautions are needed:

- The experimenter must familiarise himself with the activity and with the presence feeling of the participants in the studies situation in order to reproduce the most ecological situation as possible. This will allow him to understand what the subject says and to carry out the instructions and an adequate evaluation situation. It is advisable to insure that the participants act naturally during the information collection. The players will face alone the same adversary: a high level 'bot' (computer opponent). The players' goal is to get as many points as possible. This game situation corresponds to a practice that exists already but is not standard. It allows you nevertheless to make the tests easier to compare. The best player will get the prize. We try to favour the optimisation of the player's performance. The players must use their own mouse and are invited to use their own mouse mat. They carry out 6 complete games before starting the proper test in order to retrieve their game habits. Finally, the players will be able to set out the parameters of the game to their liking.
- It is necessary that there are good relations with the participants and that they have good dispositions. The participants that do the task without motivation do not produce good evaluations. It is important that the test develops well and that the task does not put the participants off. To this effect, it is advisable to establish a convivial climate and to not carry out more than one evaluation per session.
- The length of the activity, during which the subject evaluates his feeling of presence, and the time limit between the carrying out of the activity and the evaluation must be short. It will be saved as a video. This recording must last 5

minutes at the most. In our situation, 5 minutes of recording requires 40 to 50 minutes of decoding with the subject.

- The analyst must be independent: he must not talk with the subject. It is necessary to stick to the instructions, explain them if necessary. You must avoid giving these expectations. The recording instructions of the activity must not enable the subject to gather expectations from the researcher. If the subject expresses none or little variation in his feeling of presence, it is advised to stop the recording and to raise the question of presence in terms of variation on a period that comes before. For example, for our situation, we will ask the subject if his feeling of presence increased or decreased since the previous stop? The moment where this question takes place must be fixed in advance (at the end of 30 seconds for example). The autoconfrontation instructions must not enable the subject to gather the expectations of the researcher.

The evaluation of the presence feeling is straightaway quantitative and qualitative. The quantitative evaluation is accompanied by explanatory verbalisations. From the quantitative side, we have opted for a scale in 9 points: from 0 to 8. This scale enables the subject to respond to the question of presence. In the case of video games, the question was to evaluate 'the extent to which do you feel to be in the game'. From the qualitative point of view, we asked the subject to explain the variation causes of the presence feeling.

The use of autoconfrontation supported by a video document seems therefore to be the most adequate methodology for our situation as it respects the usage precautions.

5.1 The presence autoconfrontation

5.1.1 Objectives

We aim to understand the variations of the player's presence feeling according to the object of their activity and their experience.

We want to show that players feel more present when they are more experienced. We want to show that their presence feeling vary according to the object of their activity, especially that this feeling is less important when they are searching for equipment than when they are fighting their enemy because we think that the equipment activity is more automatic and transparent than the fighting activity. In this second activity, a player can't totally anticipated the enemy behaviour. In contrary, the position of the equipment is always the same.

5.1.2 Experimental situation

The test is developed in the laboratory.

It carries out 6 complete games before the actual test-game in order to retrieve their game habits. They came two times and so played two test-games.

5.1.3 The participants

Fifteen males participated to this experience. They will neither speak nor practice with each other. Their game levels are checked by questionnaire and by their performance. Five out of fifteen players have a lot of knowledge of the virtual world. These five players are the most experienced. The "gameplay" concerns the length of the gameplay of Quake and of similar games. The configuration concerns the scale of the configuration tool usage. Finally, the 'map' concerns the knowledge of the virtual environment of the test. This knowledge is important in order to know where the equipment is placed and where the best place to be is and which weapon to use.

Players	Gameplay	Configuration	Map	TOTAL
Player 1	-1	-1	0	-2
Player 2	-1	0	0	-1
Player 3	0	-1	0	-1
Player 4	1	0	0	1
Player 5	1	-1	0	0
Player 6	1	0	0	1
Player 7	1	1	0	2
Player 8	1	1	0	2
Player 9	2	1	0	3
Player 10	1	1	1	3
Player 11	2	1	1	4
Player 12	2	1	1	4
Player 13	2	1	1	4
Player 14	2	1	1	4
Player 15	3	1	1	5

Tab.1: Player experience according to responses to the questionnaire.

The control of the player's experiences will check if there is a link between the initial experience of the players and the increase of their presence feeling.

5.1.4 Materials

A PC Pentium 500 MHz equipped with a TNT graphic card. It is a configuration exactly sufficient for Quake. It makes the most demanding of players carry out adjustments in order to keep fluidity. We use a camera, a video recorder and a screen.

5.1.5 Steps of the test

There are two test sessions that are imperative to be carried out on two distinct days in order to avoid boring. We take a certain number of precautions declared before the tests. In terms of the first session the participants' parameters (in the file config.cfg) is saved and is used in the next one. The test happens in the laboratory.

Steps

The total duration was 2,5 hours.

The players start by configuring the game during the first session. In the two sessions, they play 6 sets of training and one test game. During each training games, the researcher asked to the player if he learned something during this game.

	1	2	3	4	5
Step	Configuration of the game	6 training games	1 testing game	Autocofrontation of presence on the testing game	Autocofrontation of activty on the testing game
Duration	15 min	6 x 5 min	5 min	50 min	30 min

Tab.2 – Steps and duration of the steps of the experiment

To configure the game

We ask the player to firstly optimise the configuration in order to retrieve their habits. Then it asks them to play to win, knowing that only the last game will count towards the competition. The player takes as much time as he wants to regulate the game according to his needs. He can test his configuration, as he likes. It is impossible to adjust Quake from the exterior (for example, on Windows or on the screen) because these adjustments can't be saved. This step is very important and his duration lasts

sometime more than 15 minutes. The configuration continues during the next step: subject training.

Subject training

The training happens in the same environment (Q3Tourney4 card) lasting for 6 parts of 5 minutes. We proceed to the demo recording between each part. All modifications are allowed to take place between the parts. Between each part we ask the subject if he knows the environment, the enemy and where the equipments are being placed after they have been taken, better.

The testing game

The subject will be told that this part is determined by the competition. This is a 5-minutes game. The subject must make the best score possible. We remind the subject that his score will make the difference between his "frags" (the points in this game) and those of the bots.

The autoconfrontations

Half of the players carry out the presence autoconfrontation before the activity autoconfrontation. The other half does the opposite.

Presence autoconfrontation

The player evaluates 'the extent to which do you feel to be in the game and the variation of this feeling'. This feeling is defined at 'performing, concentrating, being implicated, being touched and changing of scenery'. The experimenter who notes the time and the evaluations of presence makes the presence chronogram. The experimenter asks the player to tell him if he remembers the feeling of being in the game increased or decreased during the video viewing. If the player does not signal any variation during thirty seconds, the experimenter asks him if his feeling of being in the game has increased or decreased during the proceeding period and the passage is viewed as new. If the player describes variation cause of his feeling of being in the game, the experimenter will ask the subject if his feeling of being in the game varies each time that this cause will appear during the activity on the screen.

Autoconfrontation on the activity

The experimenter asks the subject to describe what he is doing and what his goals are as the video takes place. The experimenter sometimes pause the video to ask the player if his goals have changed at any point in the game.

5.1.6 Data recording

This methodology enables you to evaluate 2 dimensions of presence:

- Quantitative: a scale of 0 to 8 points to estimate presence
- Qualitative: the participants verbalisations on this presence and in particular the effects and determiners. We will not go back into detail of this data in this article.

The players explain too the object of their activity (their goals).

We record this others data:

- The changes in the game configuration.
- The knowledge of the player on the game environment and enemy between each game.
- The movie of the games.
- The presence chronogram that contains the period in seconds, the level of feeling of being in the game for this particular period and the causes of this variation of feeling being in the game.
- The activity chronogram that contains the period in seconds and the object of the activity in progress.

At the end of a session, the player is reminded not to talk to the other players and to not practice this kind of game. The experimenter makes no commentary concerning the level players in order to avoid a variation in the player's motivations. At best, he will tell the players that he is 'nothing is played yet.'

6. Results

We have kept back two objects from the activity: to fight and equip oneself. There are others but they cannot be used because either they are too rare or we do not have enough data, or that they given by a few players.

When the game crashes, the presence assessment is always 0. In the other situation, the players feel more or less present in the game.

6.1 The difference between the two parties according to the experience

There is no significant difference between presence assessments in the two test parts. The experience of the player has only a significant effect on the variation of the score (ANOVA p<.05) according to the player level. The score do not significantly correlate with the presence feeling.

There is however a certain evolution of player knowledge from one session to another except in the cases of JBB and YAV who already knew the places perfectly. Their knowledge of the game environment and enemy increased.

6.2 Variation of presence according to the object of the activity

We have therefore compared the presence feeling evaluations when the participants say that the finding of equipment is their activity's object to the presence feeling evaluations of when they give battle against the enemy as their activity's object during the second autoconfrontation. We choose this two activity object because they were common.

	Average	Ec-Type	N	Diff.	Ec-Type	t	Dll	p
BATTLE	5.970106	.674636						
EQUIPEMENT	5.173587	.782785	15	.796519	.328833	9.38139	14	.000000

Tab.3 - Matched between the presence estimations when the activity object is the battle or the search for equipment (*Significant differences marked as p < .05000).

The presence feeling evaluations of participants during the equipment or combat phase are significantly different.

7. Discussion and conclusion

Our first result is the design of a new methodology to understand and measure presence. This is a continue methodology to asses presence.

We expect to find an increase of the feeling of presence between the two games test because of the building of a transparent mediation. We therefore do not find any links between the setting up, the acquisition of experience and, we suppose, the building up of the games transparency and the feeling of presence. This experiment only verbally verifies the construction of the relationship of the subject with the object. Reeve (2001) finds a relation between acting ability and the feeling of presence. Our results are not compatible. The transparency of the mediation is perhaps a false cause of feeling of presence. Fontaine (1992, 1995) defines presence as a state of awareness where we

are present in the direct task. Fontaine's approach is interesting because it no longer treats presence in terms of 'real' or 'virtual' but in terms of a task usual or not. The familiarity, attention and automatic reflexes are thus three factors of presence. A lot of activities are unconscious because automatic movements and attention is focussed on a reduced part of the environment. We think that the more a task is familiar, the more it is transparent and the less one feels present. This approach goes against our hypothesis because it would postulates precisely that the mediation awareness is a factor of presence. Perhaps there's a more complex relation between presence, attention, transparency and familiarity.

Perhaps, our experimental procedure was not efficient. It would be advisable to check the activity via the data, in order to see if effectively takes shape. Furthermore, it is very risky to base it solely on the two games. It only needs the first game to go well or the second to go bad so that the statistics no longer speak. Few elements can lead to a part developing well or badly: annoyance, bad luck, errors…

Finally, according to the verbalisations, a lot of players won on efficiency in equipping themselves but without managing to compete with an extremely precise and quick bot. The bot turned out to be too weak for certain players and too strong for a lot of the others. This level of opponent has not enabled many players to finally be efficient against this bot. It seems that it is necessary to leave longer for the players to be able to be truly competitive against the enemy.

We are going to have to create a new faster methodology in order to multiply the comparison games. In fact the autoconfrontation methodology requires 10 times more time than the activity length (a 5 minute part is analysed from the presence point of view in 50 minutes). It is therefore impossible to analyse more games with this methodology.

We find a difference in the players' presence feeling estimation according to goals that they reach in the game. Jacobson (2001) finds a variation in the feeling of presence of MUDS users in their verbalisation. Our measures confirm this result. When players search for equipment, the players are less in the game than when they are fighting the enemy in order to reduce their level of life to zero. The change of the objects of the activity shows that the player is going to change his behaviour and therefore his relationship to the technical system. As the mediation construction is orientated towards the object of the activity, this result shows that the presence feeling analysis from the mediation construction point of view makes you identify the object of

the activity. If this methodological result is important, it is also from the explicative point of view. This result also shows that the feeling of presence varies according to the goals that a person reaches in the virtual world or according to the object of the activity (in the Rabardel's model). We know that the mediation and the construction of the mediation depend on the object of activity too. This result is a first step in explaining presence in terms of presence in an activity built by the subject to achieve his goal rather than spatial or perceptive presence. The immersion theory can't explain this result. There is no technical difference during the game. The players have always used the same technical system. Then, a psychological approach in term of the realism of perception and motor capacity can't explain this result too.. We can say that the player needs more attention during the "fighting activity" than during the "equipment activity". But the attentionnal cost of the activity is only a part of the difference between "fighting" and "equipment". The attention mechanism can explain this results but it's perhaps insufficient to understand the effect of the conscious subjects' activity in context.

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Virtual Reality based tools for the rehabilitation of cognitive and executive functions: the V-STORE.

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ABSTRACT

Cognitive rehabilitation is represented by the application of a lot of procedures in order to enhance development of skills and strategies necessary to overcome cognitive deficits. Computer-based tools can be fruitfully used in the assessment and rehabilitation of cognitive and executive functions. In particular Virtual Reality could play a key role in the rehabilitation of psychological functions due to a creation of synthetic environments where it is possible to carry on tasks very similar to the ones experienced in real contexts. After an analysis of the main characteristics and open issues of the PC and VR based cognitive rehabilitation, the major aim of this paper is to describe: a) the rationale for the use of Virtual Reality in this field and b) some VR tools (V-Store, V-Tol, V-Wcst) used with a particular category of dysfunction, the Dysexecutive Syndrome, typical of the patients with frontal lobe injuries and other neurological diseases. In particular the description of V-Store is provided.

Keywords: *Virtual Reality, Cognitive Rehabilitation, Dysexecutive Syndrome, Frontal Lobe Syndrome, computer-based tools.*

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1. Open issues about computer-based cognitive assessment and rehabilitation.

Cognitive rehabilitation is characterized by the application of a lot of procedures by a different group of professionals such as neuropsychologists, occupational therapists,

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speech pathologists. These procedures aim at enhancing the development of skills and strategies necessary to overcome cognitive deficits (Diller & Gordon, 1981; Ginarte Arias, 2002; Gontkovsky, McDonald, Clark, & Ruwe, 2002; Mickey et al., 1998; Riva, 1998a, 1998b), overall with persons characterized by traumatic brain injuries.

Cognitive rehabilitation techniques have a long history since the ancient Greeks, but only after the World War II they achieved a high level of spread and use in clinical units. According to Gordon, one of the main reasons that could explain the great expansion of cognitive rehabilitation in the latest years is represented by the fruitful technological applications and tools: the potential of computer-based tools could enhance the administration of cognitive rehabilitation (Gordon, Hibbard, & Kreutzer, 1989); (Mickey et al., 1998). Although the potential of computer-based techniques has been underlined (Bracy, 1983); (Gontkovsky et al., 2002), controlled research investigations of computerized interventions have not yet been conducted and concluded (Gordon et al., 1989; Mickey et al., 1998).

Computer-based tools could be fruitfully used in the assessment of cognitive functions too. In particular the Tower of London (TOL) Test (Shallice, 1982) has been studied by Morris et al. (Ager, 1993) in order to obtain a computerized version of TOL, using a touch-screen. The main advantage of this PC version was the possibility to carry on a more detailed analysis of the performance due to the registration of all the movements (and relative times) produced by patients. Also the Wisconsin Carding Sorting Test (WCST) (Berg & Simple, 1948) has been studied in order to obtain different computer-based versions (Grant & Berg, 1984; Nelson, 1976) such as the Bexley-Maudsley Category Sorting Test (Acker, 1982). The advantages of these computerized tests are many: to save time in the scoring step, to simplify all the procedures, to create and show new integrates multi-media scenarios more similar to reality than the traditional pen and pencil approach (Gourlay, Lun, & Liya, 2000).

About rehabilitation, the use of computer-based techniques is now one of the most promising and discussed field of research. There are a lot of open issues related to efficacy, ethics and ecological validity.

First of all the evaluation of the results of computerized rehabilitative techniques is not always univocal due to methodological problems, such as the difficulty to plan comparison between more groups of patients that can differ for a lot of variables very hard to control (such as social, cultural and environmental stimuli, spontaneous retrieval, efficacy of other contemporary treatments, different neurological, cognitive

and behavioural situation before the rehabilitation, etc.). Moreover many studies in rehabilitation fields do not include control groups (Mazzucchi & Maravita, 1993).

Another open issue is represented by ethical problems related to the possibility to experiment not yet validated rehabilitative protocols with patients that could receive more benefits using traditional approaches.

Moreover another point of discussion is about the ecological validity of computer-based rehabilitation procedures (Gourlay, Lun, & Liya, 2000; Riva & Gamberini, 2000). Are these techniques useful for patients' everyday life? Is there a realistic and efficacy transfer of knowledge between the tasks carried out in labs and the life outside the hospital?

There also recognized advantages in the use of computerized techniques in the rehabilitation. First of all many exercises made with a PC could be repeated as homework without the presence of therapists. Secondary, modern software allow "customized" programs that can be built according to single patient's characteristics: the computerized rehabilitative protocols and exercises are flexible and could be adapted on user's needs and features (Skilbeck, 1993).

According to Kurlycheck and Levin (Kurlycheck & Levin, 1987), also in our opinion PC based rehabilitative programs have to follow the indications reported below:

1. Providing tasks of growing difficulty.
2. Selecting a level of difficulty that allows patients to obtain a high percentage of success.
3. Controlling the accuracy and speed of responses.
4. Providing frequent feedback information in order to correct the wrong responses and to confirm the right ones.
5. Reducing gradually the suggestions.
6. Stimulating motivation, continuity and enterprise in patients.

2. The role of Virtual Reality in the cognitive rehabilitation

Among the different computer-based technologies, Virtual Reality plays a key role in the assessment and rehabilitation of psychological functions (Cunningham & Krishack, 1999), (Broeren, Bjorkdahl, Pascher, & Rydmark, 2002; Campbell, 2002; Gourlay, Lun, & Liya, 2000; Grealy & Heffernan, 2000; Jack et al., 2001; Merians et al., 2002; Piron,

Cenni, Tonin, & Dam, 2001; Silva, 2002; Tarr & Warren, 2002; Zhang et al., 2001). According to Tarr, Virtual reality (VR) has finally come of age for fruitful applications in neuroscience, cognitive science and psychology. The VR attractive is due to improvements in computer speed and quality of different tools (head-mounted displays, wide-area tracking systems, etc.)(Tarr & Warren, 2002).

Moreover VR is considered as the most advanced evolution of the relationship between man and computers (Vincelli, 2001). VR is different from other technologies because it offers to users the chance to experience psychological states of *immersion* and *involvement* (A. A. Rizzo, Wiederhold, & Buckwalter, 1998) due to the combination of hardware and software tools with particular interactive interfaces (such as *head-mounted display* and *tracker*). So one of the possible added values of Virtual Reality (with respect to traditional electronic systems of representation and interaction) seems to be the particular level of *presence* that subjects can experience in virtual environments (VEs). With the present and future development of technologies, synthetic environments will be able to re-create situations more and more similar to the ones we experiment in everyday life, therefore we can easily imagine that the possibility to feel presence in virtual environments will increase.

Virtual Reality is a technology used in many applications, from health care to arts, from e-learning to entertainment. Focusing on the health care field, VR finds a role in many areas such as psychotherapy (assessment and treatment of pathologies such as social phobias, eating disorders, sexual disorders, depression, autism, etc.), cognitive rehabilitation (about memory, attention, spatial abilities and superior cognitive functions), motor rehabilitation (about paraplegia, parkinsonism and other disabilities). In particular, in the field of rehabilitation, the possibility to use new technologies has been studied (Gordon et al., 1989) and the potential of virtual reality based applications has been recognized (Pugnetti, 1998; A. A. Rizzo & J. G. Buckwalter, 1997).

According to Rizzo et al. (A. A. Rizzo et al., 1998), it is necessary to carry on a realistic cost/benefit analysis to evaluate which is the added value of VR in different applications comparing with traditional approaches. A key question is *does the objective that is being pursued require the expense and complexity of a VE approach, or can it be done as effectively and efficiently using simpler, less expensive, and currently more available means*? (A. A. Rizzo et al., 1998).

There are different issues to consider in order to evaluate the real costs and benefits of Virtual Reality in mental health applications. One of these important issues, in order to ensure high benefits in the use of VR, is represented by production of functional and

useful environments. Traditionally, as indicated by Waterworth, VR designers typically aim at creating an engaging and convincing environment in which users feel present (Waterworth & Waterworth, 2001). The focus for VR developers seems to be "presence" and all the systems to improve it.

But the concept of presence is very complex because this psychological state is characterized by many factors and so a key issue becomes the choice of the presence factors that have to be considered in the use of VEs in mental health applications. Riva (2000) notes that the substantial challenge for the designers and users of VR is *how* to use immersive environments to support clinical practice (Riva, 2000). It becomes clear that a VE built for entertainment has to be different from a one use in psychotherapy or cognitive rehabilitation. So which are the core characteristics of a virtual environment in order to ensure a kind of presence that is functional and useful for mental health applications?

In Riva's opinion two key characteristics of VR as a clinical oriented tool have to be the *perceptual illusion of non-mediation* and the *sense of community*: in mental health applications, reproducing physical aspects of virtual environments may be less important than the possibility of interaction that a VE could allow. According to Riva, in clinical oriented environments "the criterion of the validity of presence does not consist of simply reproducing the conditions of physical presence but in constructing environments in which actors may function in an ecologically valid way" (p. 356, Riva, 2000). Thus the level of presence, connected with the functional use of VEs in clinical applications, depends also on the level of interaction and possible interactivity (Riva, 2000).

Table 1. Possible issues to consider in designing Virtual Environments in clinical applications.

Key questions	Possible answers	Applications and indications for VR designers
1. Are VEs useful, effective and efficient in clinical applications?	Evaluation of possible advantages and limits Cost/benefit analysis	Development of VEs that have to ensure only the level (and quality) of presence requested by each application.
2. Do VEs reproduce the	Attention on graphics and technical characteristics.	Development of VEs that have to ensure realism and a

physical and perceptual characteristics of real environments?	Focus on realism and technical issues	level of presence as non-mediation and immersion.
3. Do VEs allow users to function in an ecologically valid way?	Attention on cultural and social aspects. Focus on interaction, interactivity Importance of relationships and context	Development of VEs that have to ensure ecological situations of interaction, interactivity

3. The case of executive functions

In the field of disabilities, the category of cognitive dysfunctions can be classified making a distinction between the loss (partial or complete) of the basic *instrumental* cognitive functions (such as attention, memory, language, visual-spatial abilities, etc.) and the loss of *executive* functions (also called *central* or *control* functions). These are generally referred to a group of behavioural skills that includes: the ability of planning a sequence of actions, the ability of maintaining attention in time, the ability of avoiding the interfering stimuli and using the feedback provided by others, the capability of coordinating more activities together at the same time, the cognitive and behavioural flexibility and the other abilities used to cope new situations and stimuli (Crawford, 1998).

Many terms have been used to define this syndrome: *Disorders of Executive Functions*; *Dysexecutive Syndrome*; *Strategy Application Disorder* (SAD); *(Pre)Frontal Syndrome*. Loss of executive functions is primarily a consequence of brain injury located in the prefrontal cortex area, but many different categories of subjects can be characterized by the same syndrome and by similar symptoms, with different levels of severity and various forms of resulting behaviour: patients suffering of different forms of dementia (Alzheimer Disease, Frontal or Frontal-Temporal Dementia, etc.), patients with attention disorders and hyperactivity (i.e. ADD-H), subjects suffering of Schizophrenia.

Usually the problems related with cognitive disabilities are not evident: Thimble (1990) noted that the pathological conditions due to a frontal dysfunction, very often are

not recognized in the clinical practice. This situation could happen, overall in the case of frontal lobe disease, because cognitive performance of subjects may not be significantly reduced and many traditional neuropsychological tests may fail to show significant dysfunctions in the patients' responses (Damasio, 1995; Gourlay, Lun, Lee, & Tay, 2000). For example the traditional version of Wisconsin Card Sorting Test (WCST)(Heaton & Pendleton, 1981) has been usually considered a key measure in the diagnosis of frontal lobe dysfunction (Bornstein, 1986; Braff et al., 1991; Drewe, 1974; Janowsky, Shimamura, Kritchevsky, & Squire, 1989; Milner, 1963, 1964), but recently Stuss et. al noted that "this view of the WCST as a specific measure of impairment in the frontal lobes has also been seriously questioned" (p. 388, (Stuss et al., 2000).

As Damasio brilliantly pointed out, in the complex tasks of everyday life, the same patients may show great limits, decisional problems and inabilities connected with high levels of psychosocial suffering. It has been demonstrated that traditional tests of frontal lobes function may fail to document abnormality: this "diagnostic insensitivity" may cause problems between patients and health care services and can determine incapacity to predict the outcome of treatment.

Damasio's famous patient Elliot not only had normal performances in the standard "frontal" cognitive tests, but in the lab assessment he showed normal responses to the proposed social situations, he planned strategies and he demonstrated to be able to evaluate correctly the consequences of actions in social situations. The same patient showed a severe decisional impairment and emotional deregulation in his real life environment, especially related to social situations. Elliot is described as the prototype of the hi-functioning frontal patient who experiments severe problems in his daily life.

From the point of view of cognitive rehabilitation, if we consider that the traditional protocols used in treatment are centered mainly to protect or recover the basic instrumental cognitive functions, we can understand why, in a clinical or lab setting, superior executive cognitive disabilities are today particularly hard to treat and thus receive a very reduced attention in relation to their dramatic real-life consequences.

From a theoretical point of view, we can try to explain the striking differences in performance and behaviour between lab and life as result of four main failures of the artificial situations to mimic reality: a) choices and decisions are only to be evoked, not to be really performed; b) lack of the normal cascade of events as actions and reactions; c) compressed temporal frame; d) situations are not really presented, but only described through language (Damasio, 1995). Our diagnostic and rehabilitative tools, built to be used in clinical or laboratory settings, fail their goal with executive

functions because they cannot adequately reproduce real situations and the perception of the subject to be really *present* in them. Cognitive assessment and rehabilitation of executive functions faces us with the necessity to transfer our work in real life situations or, as a valid alternative, to be able to build artificial environments who can offer to the subject similar conditions and the same sense of presence.

4. The added value of VR in the treatment of dysexecutive problems

Cognitive rehabilitation has to allow patients to recover their planning, executing and controlling skills by implementing sequences of actions and complex behavioural patterns that are requested in everyday life (A. A. Rizzo & J. G. Buckwalter, 1997; A.A. Rizzo & J.G. Buckwalter, 1997): with these conditions, VR can be specifically indicated to reach this goal (Grealy, Johnson, & Rushton, 1999; A.A. Rizzo, 2000). Moreover VR allows to build realistic spatial and temporal scenarios that can be easily used to increase diagnostic sensitivity of standard paper&pencil tests (Pugnetti, 1995, 1998). For example, in the case of early recognition of Alzheimer's disease, VR may be the most efficient method for a systematic screening of subjects (A. A. Rizzo et al., 1998).

Due to the great flexibility of situations and tasks provided during the virtual sessions, considering both the time, difficulty, interest, and emotional engagement, this new technology allows, besides the diagnostic applications (Zhang et al., 2001), to enhance the restorative and compensatory approaches in the rehabilitation process of cognitive functions inside the traditional clinical protocol.

In our opinion, in general cognitive rehabilitation, the added value of VR compared to the traditional treatment can be summarized according to the following points:

- *customization on user's needs*: each virtual environment can be produced in a specific way focusing on the patient's characteristics and demands;

- *possibility to graduate*: each virtual environment can be modified and enriched with more and more difficult and motivating stimuli and tasks. This last issue shall not be underestimated, because many subjects with cognitive dysfunctions show a low level of motivation and compliance about the traditional rehabilitation iter that is usually repetitive and not stimulating;

- *high level of control*: the possibility of controlling the rehabilitation process in its development is very high. This issue allows to professionals to monitor the level of affordability and complexity of the tasks that can be provided to patients;

- *ecological validity*: a virtual environment allows to stimulate in the subjects emotional and cognitive experiences like in the real life. So the tasks executed during the immersion in the VR can induce the patient to reproduce complex cognitive procedures (such as planning and organizing practical patterns of actions, attention shift, etc…) that are similar in all the aspects to the ones used in the situations of everyday life;

- *costs reduction*: rehabilitation with VR can be cheaper than the traditional one, mostly when it comes to the reconstruction of complex scenarios, also of very complex ones (such as presence of more persons in the same time, particular environmental conditions), which avoids the need to leave the rehabilitation office or building.

Nevertheless, when it comes to the specific needs of rehabilitation of dysexecutive symptoms and frontal lobe syndrome, the employment of virtual environments seems to have another fundamental advantage with respect to traditional non-immersive means.

According to Damasio (Damasio, 1995, see 1st par.) diagnostic and rehabilitative tools used in labs and clinics often fail to assess and treat the frontal patients because they operate within artificial situations, which are far from reproducing the real situations. In this view, immersive virtual environments appear to be the best solution to make lab situations become closer to the natural setting in the subject's perception.

For these reasons, in our work we decided not only to use and implement immersive virtual environments, but also to assess very carefully the key variables that support such choice: subjective sense of presence; qualitative evaluation of virtual experiences; usability level.

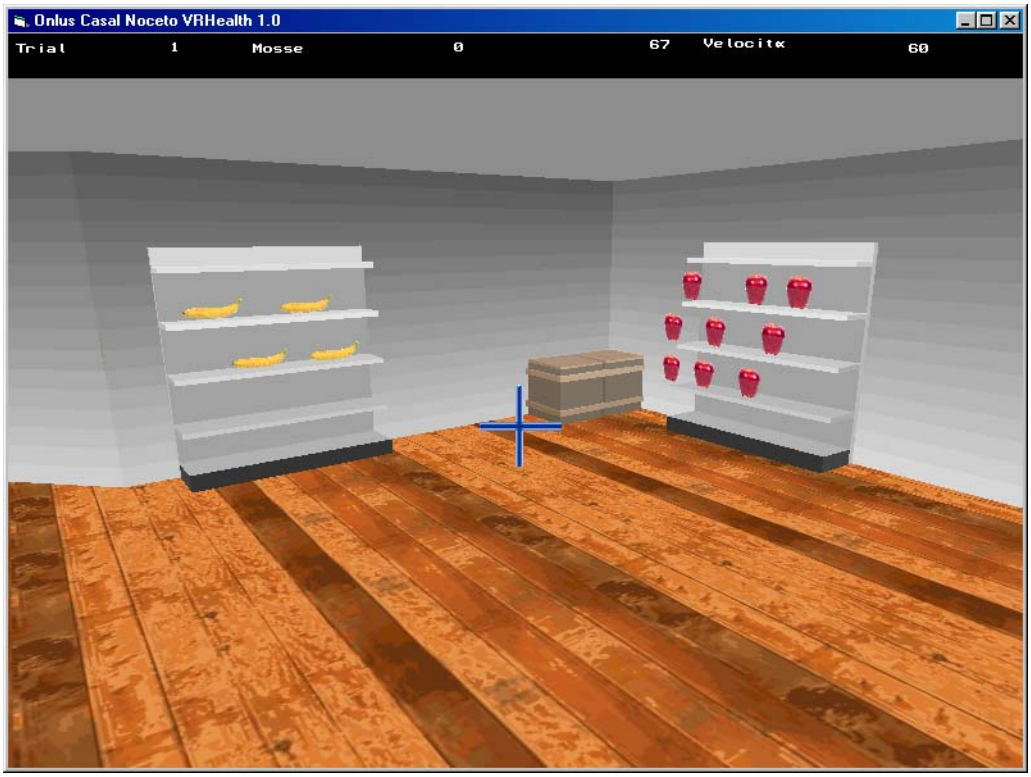
5. A possible VR-based tool for the rehabilitation of executive functions: the V-Store.

In the “Paolo VI Centre of Cognitive Rehabilitation” at Casalnoceto (AL, Italy), the traditional protocol followed in the cognitive rehabilitation has been experimentally integrated with sessions of Virtual Reality.

V-STORE is a virtual environment that consists of a fruit store internal room: the subject (or more correctly his “avatar”, his representation within the virtual world) is set in front of a conveyor belt on which some baskets (from one to three) cross the room. The subjects’ task is to fill up the baskets with pieces of fruit that can be found in four shelves located along the other walls of the room.

At the beginning of each trial, a verbal command is communicated through a loudspeaker, located on the front wall, by which the subject is instructed about what to do: how to fill the baskets and with what kind of fruit. The task has to be completed accurately before the baskets run out of the room on the belt, or else the trial will be repeated from the beginning. It is possible to fix a maximum limit in how many “moves” the subject can execute to solve the trial, forcing him to follow the most efficient and quick strategy.

Figure 1. A screenshot of the first level of V-Store



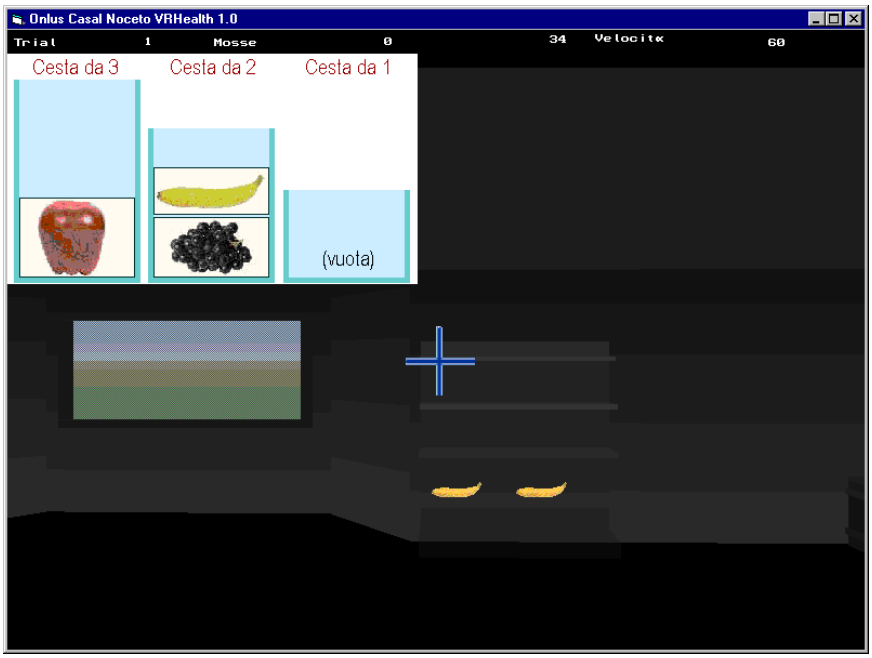
The tasks are ordered according to their complexity, starting from very quick trials that need few fruit moves, up to trials that start with a long and verbally complex command and request special strategies in moving the available fruits from one basket to another. The trials are currently divided in six levels of ten tasks each.

Other elements which are present in the environment are a waste basket, the light switch and a wall telephone, located on the rear wall, through which the subject can receive supplemental orders that integrate the initial verbal command in the most difficult level. The subject can intervene on some additional commands, by which he can stop the belt, end the trial, freeze time.

The supervising examiner can introduce a series of distracting events which increase difficulty and are meant to generate time pressure: room light fainting or progressive dimming, telephone ring, belt speed modification. In these situations, the most interesting focus of performance and rehabilitation consists in the managing steps that the subject will operate and his strategic approach.

For each trial, the system records the following data about the subject's performance for further analysis or research: accuracy, execution time, moves and strategical planning, and furthermore the managing steps taken to face distractors or difficulties, which often constitute the greatest limit for frontal patients.

Figure 2. A screenshot of the last level of V-Store (room lights dimmed)



Ongoing studies in "Paolo VI Centre of Cognitive Rehabilitation" aim at planning, developing and testing a rehabilitation protocol with virtual different virtual tools (see

Table 2) for high-level cognitive dysfunctions that affect patients with brain injures, cerebral diseases, degenerative pathologies and in particular subjects who can be evaluated as “frontal patients” in scientific literature: we also suppose that the developed applications could be useful in a broad spectrum of rehabilitative opportunities.

Table 2. Synthetic description of the V-Store and other tools that ongoing studies are developing in “Paolo VI Centre of Cognitive Rehabilitation” at Casalnoceto (AL, Italy).

Name	*Goal*	*Brief description*
V-Store *Virtual Store*	▪ rehabilitation	Virtual environment (internal store) in which the subject (clinical or experimental) has to solve a series of tasks ordered in six levels of increasing complexity. Tasks are designed to stress executive functions, behavioural control and programming, categorial abstraction, short-term memory and attention. A series of distracting elements are present, aimed to generate time-pressure and to elicit managing strategies. The examiner has full control on all variables, to enhance usability and to increase the number of sessions that a single patient will be administered
V-ToL *Virtual Tower of London*	▪ rehabilitation ▪ diagnosis	A virtual version of the well-known Tower of London Test by Shallice (Shallice, 1982), using the same environment as V-Store. The test is meant to evaluate the executive ability to program behaviors in time. The original paradigm and trial sequence is carefully respected, to grant the clinical and scientific equivalence of results. The task can be used as a one-time assessing test or repeated as a rehabilitative tool (the examiner can intervene on all variables implied).
V-Wcst *Virtual Wisconsin Card Sorting Test*	▪ rehabilitation ▪ diagnosis	A virtual version of the well-known Wisconsin Card Sorting Test (Heaton & Pendleton, 1981), using the same environment as V-Store. The test is meant to evaluate the executive abilities of categorization, abstraction and behavioural flexibility. The original paradigm and trial sequence is carefully respected, to grant the clinical and scientific equivalence of results. The task can be used as a one-time assessing test or repeated as a rehabilitative tool (the examiner can intervene on all variables implied).

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