This thesis focuses on non-formal learning within interactive environments – new technology that has gained increasing importance within different sectors of the society, including that of children with different forms of disabilities. The questions that are discussed in this thesis are: What factors influence action and interaction in interactive environments? What are the characteristics of the engagement that underlies the desire of play in interactive environments? What can we learn from these activities that can assist in designing approaches to formal settings and locations? To address these questions computer-mediated spaces were created that enabled the user to interact freely, intuitively, and without encumbrances in that environment, and to experience a sense of fun and engagement in that environment. The results from seven studies are presented in seven articles. In order to get a deeper understanding, the results of these studies are viewed from a non-formal learning theoretical perspective. This approach assumes that learning and therapy is always situated. The technology is viewed as empowering the user’s active participation in activities to encourage learning. This implies that human action, social and individual, is mediated by tools and signs, which emphasizes mediation of human action through cultural artefacts. Aspects such as play, aesthetics and emotions become important when considering how people engage with technologies in order to learn new skills.

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NON-FORMAL LEARNING THROUGH LUDIC ENGAGEMENT WITHIN INTERACTIVE ENVIRONMENTS
EVA PETERSSON

NON-FORMAL LEARNING THROUGH LUDIC ENGAGEMENT WITHIN INTERACTIVE ENVIRONMENTS

Malmö högskola, 2006
Lärarutbildningen
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Abstract

Adaptive responsive environments that encourage interaction for children with severe disabilities offer a distinct potential for play and learning in rehabilitation. Physical training and therapy for these children is often enduring, tedious, and boring through repetition – and this is often the case for both the child and the facilitator/therapist. Despite this, little is yet known about how the utilization of empowering technology influences the users’ communication and learning. The aim of this thesis is twofold: to contribute to the understanding of the role of action and interaction in the learning involved when people with different abilities are using interactive environments, and to make a contribution to the research field by concluding at tentative generalizations on design for non-formal learning in interactive environments.

The thesis consists of seven studies which analyze different aspects of action and interaction in interactive environments. The first study investigated different interfaces relative to how they encouraged and supported the children’s actions and engagement in activities. The second study investigated the role of the facilitator in creating conditions for participation and its relationship to motivation. The third study tested the potential of utilizing sensor technology to empower control of multimedia feedback across different sample groups of user abilities. The fourth study is a meta-analysis which further investigated the effects of using interactive environments in rehabilitation. The fifth study explored the potentials of interactive environments for people with special needs who were empowered within a volumetric non-invasive interface to actively experience gestural control of sonic events. The sixth study explored how children with severe disabilities used a robotic light system for interactive play. The child’s facial expressions, hand, and head movements, which were synchronous to the robotic device control were the basic unit of analysis. The seventh study investigated children’s dynamic movements when acting, reacting, and interacting in a gameplaying activity.
The seven studies contribute towards an understanding of the encapsulation of learning and design aspects relative to the use of interactive environments in rehabilitation targeting non-formal learning through ludic engagement.

**Key words:** Non-formal learning, interactive environments, activity, action, intuitive interaction, interactive play, rehabilitation, sensor technology, non-intrusive interface, case studies
Dedicated to Karolina, Emma, and David

_Livet skall vara som för en fjärril en sommardag._

(Nesser, 1998)
Preface

During the late 1970s I studied to become a preschool teacher. During the early 1990s I studied to become a social worker. During the mid 1990s I started my PhD studies. Over a ten year period I worked as a preschool teacher and had the privilege to work as a social worker for two years before beginning to work within the academia. My interest has especially been directed towards those who are excluded by political and economical interests.

During my years as a student involved in social work I continuously reflected upon the question of creating conditions as opposed to giving service to. My conclusion from that period was that there is too little space in our society available to what I called “curiosity culture”. My view was that too much in society was incorporated in structures based upon hierarchy and power.

I was, and am still, convinced that the most important learning is created between people and their surrounding. Gregory Bateson’s concept of the “space in between” and also his theories on meta-communication has been influential to my thinking. As well as Michael Halliday’s, Gunther Kress’, and Theo van Leeuwen’s theories on social semiotics.

In the mid 1990s I started to work at Halmstad University and became part of the development of research on toys at the Nordic Centre for Research on Toys and Educational Media. The years at this centre were the most creative, fun, inspiring, and exciting years in my work life so far. We were a fantastic and enthusiastic team who collaborated towards a common goal – to position toy research on the international research map. We were interested in the role of artefacts in children’s learning, how to create conditions to encourage play and
curiosity. I also had a special interest in toys for children with disabilities – for example, how could they be designed in order to meet the needs of the children? I was convinced that the toys especially designed for children with disabilities were applicable to all children.

I have worked in several European research projects, all interdisciplinary (technicians, designers, behaviourists) and in collaboration with the target groups for the research – children, teachers, special pedagogues, therapists – and with the industry. Again – I learnt a lot when being in the space in between different competencies and in the space in between those who knew best about their everyday lives, which we were studying. My conclusion is that the discussion about what can be important can only be defined by those involved. This is why I am interested in the concept of non-formal learning. In order to understand this kind of unintended learning – one must incorporate curiosity of those who are involved in the learning. To trust in them being completely capable to create their own knowledge is also a prerequisite. The most dominant source for non-formal learning is play, a phenomenon that has been my interest for several years. Theoretically I have shifted my choice of position with the winds of time – Piaget in the 1980s, Bowlby in the early 1990s, Mead and Berg in the mid and late 1990s, the social cultural school during the early 2000s. My present track is thus a unique synthesis of these eclectic influences due to the complexities embedded in the concept of the non-formal learning. This unique synthesis is presented in this thesis.

for att kunna lära måste du känna
annars blir din kunskap grå och platt
(Lisa Ekdahl, 1994).

Esbjerg, September 2006
Eva Petersson
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I also want to thank the members of Certec, Lund University's Institute of Technology, for your hospitality and support. You created
physical and mental space for me, through which I found concentration and energy to re-start my writing.

I have appreciated guidance from Bodil Jönsson, her support and valuable comments helped to clarify the content of the thesis. Thank you!

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My grandfather, Gustav, who has shown me that everything is possible – “if I just want to”. Thank you for being such an inspiration!

My large family: my parents, my “bonus” parents – Berit and Leslie, Leif and Berit; my brother Christer and his family; my sister Maria and her family; my sister Malin; Johan and Charlotta and their families; my family in Wales – Joan, Benjamin, Cindy, and Freya. Thank you for always being there.

Last but most, I want to thank my nearest and beloved family, my children Karolina, Emma, and David - you put my life in perspective! Tony – thanks for your love, trust and engagement.

Jag tror, jag tror, jag tror på lek och skratt
jag tror på glädjejnatt
jag tror på sol igen
jag tror på sommaren
jag tror på kärleken
ja det tror jag på
(Jonas Gardell, 2006)
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List of included papers

This thesis is based on the following papers, referred to in the text by their Roman numerals:

I. Virtual and Physical Toys – Open-ended Features towards Non-formal Learning.
Petersson, E. & Brooks, A.
- Presented at the International Workshop on Virtual Rehabilitation, Catalina, USA, September, 2005, and published in the proceedings, pp 47-60.
- Published in the journal of CyberPsychology and Behavior, April 2006, volume 9, issue 2, pp. 196-199.

II. Encouraging co-operation designed as participation – The beginning of a beautiful friendship?
Petersson, E. & Bengtsson, J.

III. Recursive Reflection and Learning in Raw Data Video Analysis of Interactive ‘Play’ Environments for Special Needs Health Care.
Brooks, A. & Petersson, E.
Brooks, A. & Petersson, E.
- Presented at the 11th International Conference on Human-Computer-Interaction, Las Vegas, USA, July 2005, and published in the proceedings by Lawrence and Erlbaum Associates.
- Accepted for full journal length publication in The International Journal of Universal Access in the Information Society (UAIS).

V. Raw emotional signalling, via expressive behaviour.
Brooks, A. & Petersson, E.
- Presented at the 15th International Conference on Artificial Reality and Telexistence, Christchurch, New Zealand, November 2005, and published in the proceedings, pp. 133-141.

VI. Non-formal Therapy and Learning Potentials through Human Gesture Synchronized to Robotic Gesture.
Petersson, E. & Brooks, A.
- Presented at the 3rd Cambridge Workshop on Universal Access and Assistive Technology (CWUAAT), Cambridge, the UK, April 2006, and published in J. Clarkson, P. Langdon, and P. Robinson (Eds), Designing Accessible Technology, pp. 165-174.
VII. **Play Therapy Utilizing the Sony EyeToy®.**

Brooks, A. & Petersson, E.

- Accepted for full journal length publication in *The International Journal of Disability and Rehabilitation*.

All articles have received permission to be published in this thesis.

My contributions to these papers are as follows:

**Paper I** Main author. Planned and performed the empirical study and the analysis. Discussed the results with my co-author. I wrote the paper.

**Paper II** Main author. Planned and performed the empirical study together with project partners, co-author, and editor. Planned the analysis together with my co-author and editor. Carried out the analysis in three of five case studies (presented in chapters 4.2, 4.3, and 4.5) and the editing of two case studies of five (presented in chapters 4.1 and 4.4). Discussed the results with my co-editor. I wrote the paper.

**Paper III** Planned and performed the empirical study and analysis together with my co-author. I wrote the paper in collaboration with my co-author.

**Paper IV** Planned and performed the empirical study and analysis together with my co-author. The paper was a meta-analysis of the results of the empirical work within the Humanics project. This included interviews with physio-therapists
who participated in the project. I wrote the paper in collaboration with my co-author.

Paper V Planned and performed the analysis together with my co-author. I wrote the paper.

Paper VI Main author. Planned and performed the analysis together with my co-author. I wrote the paper.

Paper VII Planned and performed the empirical study and analysis together with my co-author. I wrote the paper together with my co-author.
1 Introduction

New technology has gained increasing importance within different sectors of the society, including that of children with different forms of disabilities. Individuals with disabilities enjoy interaction as much as the next person. This may be more so for those with profound and multiple disabilities, as their social contact is limited (e.g. Clegg et al., 1991). In creating adaptive environments that encourage interaction for these groups of people, I believe new opportunities in improved quality of life is a distinct potential, for them and even so for the staff caring for the people. Having enjoyable experiences together in interactive play scenarios alone – with staff supervision passive-, or with active staff intervention, is in my experience conducive to improving relationships. However, few studies have been conducted to describe how the utilization of empowering technology influences the users’ communication and learning. Additionally, what importance this has for the users with different abilities and the involved staff.

Relative to this is the beginning of the issues that are discussed in this thesis:

- What factors influence action and interaction in interactive environments?
- What are the characteristics of the engagement that underlies the desire of play in interactive environments?
- What can we learn from these activities that can assist in designing approaches to formal settings and locations?
- Does the medium create new potentials or limitations?

To address these questions interactive environments were created that encourage interactions through movement empowered by non-invasive technology to control multimedia feedback; a contemporary phenomenon that can be said to open up new possibilities that change and affect our opportunities in many situations. Intuitive interactions based on temporal and spatial explorations of perceptions rather than memory and symbolic processing are analyzed and reflected upon.
1.1 Creating conditions

Designing interactive environments for learning and therapy implies interactions. The effects of the design of these environments involve the experiences that people have in using them. Experiences from my perspective concern active participation in activities, leading to knowledge or skill (Rogoff, 1990). Optimally, the user of an interactive environment determines the course of actions and interactions and, thereby, experiences autonomy in the form of actions that are selected from a range of possible choices. To select among these choices is to grasp affordances (Gibson, 1979), i.e. to perceive and to act upon something in a particular way. This operation is an immediate and reciprocal action with an iterative character, which relates the user’s actions to the concept of interaction. In this way, communication is initiated as a part of the user’s input in the form of movement (feed-forward) and the response from the system (feedback). This creates an iterative feed-forward-to-feedback loop.

Accordingly, I consider communication within the responsive environment (the term ‘responsive environment’ is used interchangeable with ‘interactive environment’) as a part of the interaction that is defined as the iterative feed-forward-to-feedback loop. This definition of communication is primarily based upon Halliday’s (1985) communication model and his definition of speech acts where he emphasizes that speech acts are dialogic:

An ‘act’ of speaking /.../ might more appropriately be called an ‘interact’: it is an exchange in which giving implies receiving, and demanding implies giving in response (p. 68).

Halliday’s (1985) communication model states that language simultaneously fulfils three broad meta-functions, operating simultaneously in the text, each playing its own part. Kress and van Leeuwen (1996) broadened this hypothesis by assuming that every semiotic mode simultaneously fulfils these three meta-functions. The meta-functions are (1) ideational (enacting “what goes on in the world”); (2) interpersonal (enacting relations between the people involved in a communicative event); and (3) textual (enacting the combined whole – the text). This view on communication implies, as was stated above, that communication is a part of interaction as the interaction also, beside the communication, contains a content, human,
and social functions. These functions are communicated through the interactions and, accordingly, have to be considered. This is in contrast with the communication theorists (e.g. Bateson 1976), who primarily look at the interaction as communication.

The feed-forward and feedback evolving as an iterative loop encourages exploration and development of skills and competence. In terms of Bruner (1973) the competences in question are those involved in the mastery over tools. He describes the exploration as an exercise, through which an infant extends his or her actions to new limits of already achieved skills. When the child becomes absorbed by the exercise, the exploration develops into play. I refer to the intense concentration of the exploration and the play as a basis for non-formal learning (Petersson, 2000; Aderklou et al., 2001; Petersson, 2004). Here, where the conditions are created so that the feed-forward-to-feedback loop provides an invitation to explore and, then, to begin to play and to continue playing. Thus, the use of an interactive environment is considered as active creation of meaning, not just use.

The use and the design of interactive environments for people with different abilities are dependent on idiosyncratic tendencies (i.e. user profile). In therapy and learning situations these kinds of constraints are expected to be recognized by the facilitator, the helper, the family, or the researcher (i.e. outside agents to the situation), in the immediate and/or retrospectively. How to use and overcome these constraints is an important design consideration.

The aim of this thesis is to understand the role of action and interaction in the learning when using interactive environments for people with different abilities. Through this understanding, I conclude at tentative generalizations on design for non-formal learning in interactive environments.

1.2 Learning from action and engagement

For the reader to get a deeper understanding of the cumulative results they can be reflected upon from different theoretical perspectives. The approach taken in this thesis assumes that learning and therapy is always situated. This implies a consideration of the complex relationship between the individual, the activity, and the contextual
environment as mutually integrated (Lave and Wenger, 1991). This implies that human action, social and individual, is mediated by tools and signs, which emphasizes mediation of human action through cultural artefacts (Engeström and Miettinen, 1999). The use of new technology has changed the nature of learning by setting up new scenarios for formal institutions, where the use of the technology is offering new opportunities for the creation of conditions for the learning of new skills. This situation requires that investigations look beyond what traditional education and training systems has to offer in order to consider wider scenarios for learning.

An implication of this is that theoretical perspectives and analysis should reflect a larger set of issues, drawing on a wide range of literatures to guide the design of technologies and environments for learning and therapy. This position is supported in the writing of Jönsson (2006) where she underlines that more is not only more, but potentially augmentative - meaning that reductionism is not necessarily the optimal solution to a scientific problem. It is possible to proceed in the other direction through a constructive work involving different levels of a complex problem. Therefore, both problems and possibilities should be studied on different levels based on their own complexities, but constantly and iteratively coming back to the original context. Aspects such as usability, aesthetics and emotions become important when considering how people engage with technologies in order to learn new skills.

These two standpoints delimit my choice of theories. On the one hand, the position corresponds with the activity theory perspective delimited to, above all, Vygotsky’s (e.g. 1981a), Leont’ev’s (e.g. 1981), and Wertsch’s (e.g. 1998) theories on activity, i.e. the mediation of action through cultural artefacts, and the role of the grown-up in the learning process. These theories have different historical origins and differ in details and name (e.g. cultural historical psychology and socio cultural school). Anyway, they also share basic positions on human activity, and fit together according to the practical consequences presented in this thesis (Papers I-VII).

On the other hand, this perspective is limited when it comes to the understanding of the aesthetics and playfulness issues that are involved. My theoretical perspective has, thereby, been extended with the concept of Aesthetic Resonance. The term ‘aesthetic resonation’ was
coined by Ellis (1997) and described as when a person after a period of intense exploration achieves control over his or her expression. The concept was further developed by Brooks et al. (2002; Brooks and Hasselblad, 2004), which is described in section 3.3. Bruner’s (e.g. 1973) term of exploration and Csikszentmihalyi’s (1991) concept of autotelic activity are the final extensions of my theoretical foundation. These theories and concepts are gathered within a framework, which I have named non-formal learning.

Furthermore, in this thesis “more is different” means that I have included a chapter (chapter 2) where the interactive environment used in this thesis (presented in Paper I-VII) is described in terms of technology and design in order to posit my concern that theoretical perspectives and analysis should reflect a larger set of issues.

It is important to remark, that other different theoretical perspectives could reflect the questions, e.g. a phenomenological approach. But this is also a message that the human not only can be understood in relation to the subjective experienced world, but also relative to the activity and the contextual environment in which the human is engaged.

1.3 Introduction to the papers

The seven peer reviewed empirical studies on which this thesis is based (Papers I-VII), have attempted to conclude at answers to the questions in focus.

The aim of the first study (presented in Paper I) was to explore how different design features of interactive media encouraged collaborative learning. The discussion covers pedagogical issues related to non-formal learning and open-ended features of design. Various interactive media were used in two case studies; physical (non-digital) play- and construction material, digital toys and games, and a prototype of a virtual (digital) toy especially developed to support collaborative learning. Different interfaces were investigated and related to how they encouraged and supported the children’s actions and engagement in activities.

The second study (presented in Paper II) does not involve the use of interactive environments. The study was centred on processes designed to encourage participation in which those involved developed design
ideas into new products. The groups involved in the project were so
called marginal groups, disabled, elderly and people in prison. The
study was realised with an innovative approach through so called
'Integration Workshops'. One of the short term objectives of the study
was to offer the individuals with special needs experiences of
cooperation designed as participation. The design strategy was based
on a treatment with genuine respect, in which those involved developed
design ideas into new products (toys and games). The reason for
including this study was that it was focusing on the role of the
facilitator in the creative process. Also, that the study took aspects of
empowerment into consideration. What was taken into account was the
facilitator’s role in creating conditions for authentic participation, as
well as the factor of inclusiveness and its relationship to motivation.
What was found interesting was that the relationship between the
participant and the facilitator was crucial for the motivation and for
creativity. This was applicable for the different target groups. Co-
operation and participation were two main topics that helped in creating
the sense of empowerment for the participants.

The third study (presented in Paper III) investigated how the use of
sensor technology to empower control of multimedia feedback affected
different sample groups of persons with different abilities. The
background to this study is that the adaptability of the technique as well
as the individualized multimedia feedback offers new opportunities for
health related quality of life. The digital movement information that is
used to control the multimedia feedback is also used for analysis so as
to be a supplementary tool for training progress toward therapeutic and
learning goals. The study investigated how ‘recursive reflection’ and
‘participatory involvement’ can optimize the design of interactive
environments and, also, how it can optimize a mutual understanding
about the user’s engagement with the technology. Whereas in Paper I
the advantages of user interfaces for non-formal learning were studied;
Paper III was concerned with the effects of participatory involvement
towards an optimization of learning and therapeutic goals. Participatory
involvement in this context means to include those who are closest to
the sample, i.e. parents and facilitators. Shared observations of results
in video sessions informed tacit knowledge of an often higher nuance in
respect of personal trait. As pointed out in Paper III recursive reflection
and participatory involvement are factors that influence the interaction with the technology as well as the user interface.

The fourth study (presented in Paper IV) further investigated the effects of using interactive environments in rehabilitation. The study was a critical reflection on results from a project from which the results were considered as non-successful. The discussion covers issues appertaining to the failure of the main project with questions asked of the strategies and decisions of those involved towards a refinement of the protocol. In the light of the previous studies we were interested in the multimodal character of the interaction, which is to say the selected mixture of sound, music, and image controlled by gesture, and in what sense multimodal feedback influenced creativity and motivation. Additionally taken into account in this study, compared to the previous ones, was in questioning in what sense the technique could be used as a supplementary therapeutic aid and home based tele-health system.

The fifth study (presented in Paper V) was an analysis of actions in interactive environments. The discussion covers the bridging between intersubjectivity and individual processes by emphasizing the semiotic interplay, which is to say capacities of action and mediation. This study was an attempt to integrate the findings from the first and the third study, developing the ideas concerning interaction, action, and design in relation to learning on the one hand and to the role of the facilitator on the other hand. What was found particularly interesting in relation to these issues were the shown potentials in using non-intrusive interfaces that were applied in consideration of the user’s specific needs. Furthermore, findings showed that asymmetric interaction and transformative learning increased social interaction in interactive environments.

The aim of the sixth study (presented in Paper VI) was to explore how children with severe disabilities could use a robotic light device for joyful and interactive play. The children participating in the study were encouraged to play utilizing their hands and head. The child’s facial expressions, hands, and head movements were the basic unit of analysis. Whereas in Paper V the emphasis was on the bridging between intersubjectivity and individual processes, Paper VI was concerned with the perception-action cycle. As pointed out in Paper VI the action cycles had a motivating and scaffolding character and
through these the child experienced a sense of control and mastery of
the therapy situation.

The seventh study (presented in Paper VII) investigated children’s
movement dynamic when acting, reacting, and interacting in the
gameplaying activity during play and physical therapeutic sessions.
This study was an attempt to integrate findings from the fifth and sixth
study towards developing the ideas concerning movement analysis
further. Both manually and computer analysis of movements were
carried out. What was found particularly interesting was the
relationship between the intensity and intentionality that was observed
inherent to the interaction. Intensity and intentionality was observed
through the children’s focused concentration and also through their
commitment and enjoyment when playing the game.

On the basis of these empirical studies the use of the technology
provides a way of understanding and describing the interaction between
user and facilitator; interpreted meanings from the interactions (a)
between each other (intersubjectivity), (b) with the system, and (c) self-
system-self (intrasubjectivity).

1.4 Participatory involvement research

This thesis does not attempt to create or to present one truth. The
participatory involvement approach has functioned as a reflective and
creative opportunity for learning, development, and understanding. A
persistent theme that appears throughout all the papers is the offering to
people with different abilities, including those with severe disabilities,
an opportunity to communicate, express and, thereby, describe non-
verbally their experiences when using interactive environments
designed to enhance playful (ludic) engagement. This is especially
exemplified in Papers III, V, and VI, where the participants through
movements, gestures, and facial expressions communicate their desires
and wishes. This position is justified in the Article 27 of the United
Nations’ Universal Declaration of Human Rights that underlines:

Everyone has the right freely to participate in the cultural life of the
community, to enjoy the arts and to share in scientific advancements and
its benefits (Universal Declaration of Human Rights, 1948).
Previous research (Davies, 2005) emphasizes difficulties in regard to traditional strategies of measurement, replicability, and objectivity regarding the sector of the special needs community. Understandably then, in terms of research, this group may be considered too complex and diverse in character to tackle, and in terms of healthcare, not necessarily able to make their voices heard /…/ often overlooked in both research and even healthcare funding (Davies, 2005, p. 285).

The basic idea is that understanding is developed in dialogue and, furthermore, that the view presented in this thesis could be described as unifying the experiencing subject and the experience instead of separating them (Denzin and Lincoln, 2005).

1.5 Structure of the thesis

The thesis is organized so that following this chapter of introduction chapter 2 provides a brief description of computer mediated interactive environments and the inherent technical components. A special focus is upon interactive environments as communicative and expressive medium. This overview also includes a description of potentials and limitations of interactive environments and the related technologies. Chapter 3 covers the relevant theories that contribute to the overall theoretical framework. These theories are discussed within their own terms of reference and applied to the context of this thesis. Chapter 4 presents the qualitative methods used in the included studies (Paper I-VII), which provide the overall methodological framework of this thesis. Chapter 5 presents the aim and research questions of the thesis whereas chapter 6 covers an overview of the papers. Chapter 7 describes the major research findings and provides a general discussion of the results. Finally, chapter 8 presents the conclusions drawn from the research and suggests directions for the further research.

The attentive reader will note my strategy of re-stating specific points of significance throughout this thesis. This is a conscious approach in order to assist the reader in contextualizing my position relevant to the specific concept that is being elaborated. I ascertain that this is pertinent due to the complexities inherent of the problem that is investigated in this thesis, i.e. an enquiry that empirically explores from
my background in pedagogy and design, which is synthesized to question new technology and beneficial application in a child’s development.
2 Interactive environments

Designing interactive environments for learning and therapy in this thesis refers to the creation of a computer-mediated space that is targeted to be accessible by all, no matter ability or limitation, age or creed, preferences or desires. The space should be fun and engaging to be in so as to enhance action and interaction. This formation implies knowledge of the user toward development of personal user profile. Furthermore, understandings of the interactive environment in terms of the technology as such, and the use of the technology in terms of interface and quality of use.

2.1 Interactive environment – what is it?

Interactive environments in general are also referred to as Virtual Reality (VR), Virtual Environments (VE), environments for virtual rehabilitation, and multimedia interactive environments, ranging from desktop VE’s to immersive interactive play and learning environments (Weiss et al., 2003; Kizony et al., 2003; Rose et al., 2005; Slater et al., 2004; Standen and Brown, 2005; Reid, 2002; Sutcliffe, 2003; Camurri, et al., 2003; Roussou and Slater, 2005; Bobick et al., 1999; Penny, 2000).

The term ‘virtual reality’ was coined by Lanier in the late 1980s, but, virtual reality technology has a longer history. The first virtual reality system was developed in the mid 1960s by Sutherland. His presentation of the ‘ultimate display’ (1965) contained the basic idea of an immersive head-mounted display (HMD), which was the starting point of the VR development (Sutcliffe, 2003). The first real example of a multi-sensory simulator was developed by another pioneer in the field of VR technology, Heilig, who developed the cinematic machine Sensorama (1955). However, Sutherland was the first who combined technical components in order to create a computer-generated environment in line with how VR or VE’s are defined today.
Sutherland’s idea was a computer display which could simulate the physical world and with which the user could interact by his or her senses (Gigante, 1993).

In the 1970s Krueger (1977; 1985; 1991) implemented a synthesis of output devices resulting in interactive environments using back-projection and video processing techniques. Unlike Sutherland’s devices, Krueger’s environment was projected onto a wall-sized screen. The user’s images appeared in a two-dimensional computer-generated graphic video world. Krueger explored possibilities for human-computer interaction (i.e. human sourced data capture to video output device) that moved beyond the computer screen and placed the participant inside a virtual environment and allowed the participant to navigate that space through gestures rather than with a mouse. Krueger’s work is referred to as ‘Artificial Reality’, but is commonly under the same genre and interchangeable used with the term ‘Virtual Reality’. In this thesis I use the terms intermittently.

By this, virtual or artificial reality can be seen as a technology and interactive environments as the computer-generated environment which is created by this technology. The standard components constituting the immersive system are commonly described as input and output devices. Input devices imply human sourced data capture while output devices are system elements relating to production of graphics, sound, or haptic user stimulation (Davies, 2000).

2.1.1 Sensor technology

The seven papers on which this thesis is based consist of a technical system based on non-intrusive (non-worn) sensor technologies. The technologies used are in the form of a standard video camera (Paper VII), or an infrared sensor (Papers I, III, IV, V, and VI). The camera enables planar data capture whilst the specific infrared sensor enables natural 3D data capture from movement within a volumetric space.

1) In four of the studies (presented in Papers III, IV, V, VI, and VII) non-wearable infrared (IR) and camera sensor technology was used.

The specific IR sensors used enabled capture of data from natural 3D movement by the user and created a 3D volumetric information space. Movement in the information space generated output signal data from the sensors. This data was routed to a computer and a
sound module/synthesizer. The output of the sound and/or image module was routed to a playback system for the user to audition the sonic/visual response to his or her gestures. This is direct and immediate with latency less than 1ms, which offer the user direct autonomous control.

In one study (presented in Paper VII) the EyeToy® computer game was used. The game necessitates a specific peripheral controller in the form of an EyeToy® USB camera that places the participant’s images on the screen and allows players to control action with their body movements. The camera is connected to the PlayStation2® console via the USB bus on the console. This controller is unique in concept as all interactions to the game are intuitively through the video window rather than through the more common handheld game-pad or joystick device. However, sourcing of data with a camera is planar rather than 3D or linear.

2) In one study (presented in Paper I) IR communication technology was used implemented within a physical toy, a system of interconnecting cubes, with a Light Emitting Diodes (LED) matrix display on one face. The toy had electronic capabilities to form a network with other toys. The output device was visuals, but as the system was implemented in a toy the output was additionally tactile.

In this study traditional play- and construction material was used without implemented interactive technology. The reason in using the interactive toy system and the material without interactive technology was mainly to study how different kinds of interfaces supported or inhibited learning. From that point of view, the play- and construction material was considered as responsive environments that created an exchange between the user and the interface. These are features that are also inherent within the concepts interactive toys and interactive environments. Notable is that in one study (presented in Paper II) there were no sensors or technology used.

However, it is possible to argue that the findings concerning the non-wearable system, the interactive physical toy system, and the traditional play- and construction material cannot be compared since the systems and the toys provided different possibilities for action and interaction. However, on a more generic level, both the systems and the play- and construction material that was used had a strategy of
establishing a real-time responsive play scenario where creative motivated expressions were targeted. By this, the systems and the play-and construction material provided the users with an interactive play space to act and perform within.

To use different interactive systems in order to create more generic knowledge about design for non-formal learning in interactive environments is, however, not all-inclusive, since the definition of the concept 'interactive environments' employed in the different studies delimitate what technologies and interactive environments can be created and studied.

2.2 Interactive environment – user interface

This section tries to characterize interactive environments technology in terms of user interfaces in order to increase the ability to compare and contrast the technology used in this thesis with other technologies. To be able to make a characterization and comparison with other technologies, there is a need to make a general definition of the term ‘technology’. Since I am interested in learning and therapeutic implications of the use of an existing interactive technology and not in the knowledge behind this technology, the definition of ‘technology’ that should be used in this thesis is technology as a tool and ‘use’ as an activity. I adopt Engeström’s (1987) definition of technology as a culturally constituted mediation of the user’s activity.

This definition is broad and has many similarities with other information- and communication technologies. However, instead of simply creating a communicative space between the user and a graphical user interface on a computer screen as other information- and communication technologies do, the technology used in this thesis does so by transforming a physical space into a computer-mediated information space for the user to freely interact with; a form of subliminal graphical user interface which reflects both the user’s input and the desired change of the information space. This free interaction creates potentials for the user to move in the space, which is more or less absent in other media. It is the input and output systems described in the previous section (2.1) that provide these movement potentials.
Technology for the creation of interactive environments, according to the definition used in this thesis should enable the user:

(1) To interact freely in that environment.
(2) To interact intuitively without encumbrances in that environment.
(3) To experience a sense of fun and engagement in that environment.

From that point of view, the technology used for the creation of an interactive environment can be seen as an interface between the user and the environment, extending the user’s senses and enabling interaction (MacLuhan, 2003). This is in line with Latour’s (1991) theories where no difference between the human and the technology is made; the focus is rather on the interaction between them. Latour names the human as well as the technology ‘the actant’. Thus, a situation is created where any mediating technique is invisible, which engages the user in an optimal manner through the direct and immediate responsive content feedback to his or her physiological input.

The technical solution used in the thesis (sensor technology, see section 2.1.1) is targeted to result in the empowerment of the participant. I regard empowerment as a dynamic concept that considers the idiosyncratic possibilities and resources associated with growth and development that is achievable through the concept towards augmenting that person’s everyday interactions. By this, I take on a holistic and process directed view on empowerment (in contrast to considering empowerment as a mental state), where the interaction in the responsive environment serves as a means to enhance the individual’s communication through the feed-forward-to-feedback loop. At a philosophical level, this view enables experiences with an outcome of a more positive self-perception and belief in the own ability and capacity.

The next section will provide a description of qualities of use of the interactive space.
2.3 Interactive environment – qualities of use

The previous section described how the technical systems used in this thesis (presented in Paper I-VII) can be considered as mediators of the user’s activity. To design for mediation requires an understanding and awareness of use qualities.

The way the technology used in this thesis operates, is that it inputs the user’s movements (feed-forward), and outputs sounds and images (feedback) through mapping and processing, which is similar as that utilized in VR technology. The uniqueness lies in the non-intrusive and easy-to-use qualities of the interface and its affordances. These factors together with the cost-effectiveness of the system reduce practical problems such as affordability, high maintenance and usability problems (i.e. expert competence requirements), which impact other products in their potential for interaction and adoption by the community (both clinical and public sectors) (see also Roussou, 2004).

When it comes to the intuitiveness of the interface Bærentsen (2000) assumes that this quality of use puts fewer loads on the user’s cognitive processing by being easy to use. This kind of use quality is adaptable to users with different abilities. Intuitiveness as a use quality provides a seamlessness for interaction since the user is not required to learn new skills, however, this is something that often happens as a result of the seamlessness afforded by the non-intrusive interfaces such as used in the studies presented in this thesis. The study of Human-Computer Interaction and usability most often presumes that transparency is one of the goals of good designs (e.g. Nielsen, 2000). Considering the user interfaces used in this thesis, the invisible quality together with the facilitator as a reflective intervener create what Bolter and Gromala (2003) define as a good design as our system is both transparent and reflective. It reflects the user’s needs and wants in all their complexity (p. 74).

The system data collected from the human has a twofold function. Firstly, it is used as a direct control means to manipulate the environment and the embedded multimedia. Secondly, it is archived as a means to monitor user response and subsequent progress according to patterns that are indicators of system effectiveness, efficiency, and utility. The first function is perceived by the user, the second is the research process that is annotated correspondingly to session video archive. This analysis is unseen by the user who only needs to
experience an enjoyable play environment that is tailored to his or her specific preferences, abilities, limitations, and desires. Thus, with targeted flow a motivational experience is offered.

Usability is subject of a body of work set up in the field of human-computer interaction where usability is a key concept (Dix, et al., 2004; Preece et al., 2002; Nielsen, 1994; Schneiderman, 1998). It originates from the 1970’s and the field of software psychology, which was a related discipline to experimental psychology (Scheiderman in Ehn & Löwgren, 1997).

Preece (et al. 2002) suggests that interactive designs are products that support people in their everyday life and the authors describe usability goals as operationalized through specific criteria. This criteria stakes that the products should be efficient, effective and safe to use in order to meet usability concerns. Further, that the products should have good utility, be easy to learn, and easy to remember how to use. Winnograd and Adler (1992) and Winnograd (2000) take another position by emphasizing the communication dimension of usability and discuss this in terms of usability as a dialogue of change. This dialogue involves the designer and the user, as an assurance for the usability and as a potential to move beyond traditional usability approaches. Brown and Duguid (2000) emphasize the issue of drawing attention to the wider context that surrounds the interactive design, as this is an element that affects the usability the designer tries to create. The authors continue that the consideration of the context involves more than only emphasizing a well-integrated user interface as it also requires the designer to take social aspects carried by the context in consideration. Löwgren and Stolterman (2004) refer to the creation and shaping of use-oriented qualities of an interactive design based on the designer’s highly developed judgment skills. Jönsson (et al., 2006) emphasizes that the design of technical solutions always begins and ends with the human. Furthermore, they consider the design process as a social phenomenon, which needs to be studied in real situations. The designer’s sensitivity to and understanding of the context and how interactions are embodied within these contexts are of core importance for the design of technical solutions. To sum up, the focus in usability research has moved from considering only the human system, to include a consideration of the context, with a focus on users’ expected value (Löwgren, 1993; Ottersten and Berndtsson, 2002).
Usability issues have, in this thesis, been considered as quality assurances based on the facilitator’s judgements *in* and *on* action in a specific situation (Löwgren and Stolterman, 2004), rather than as usability in form of goals and principles. Implicitly, my focus on situated action underlines that the assurance of quality is unique and, thereby, dependent on the individuals involved in the situation. In other words, the participant’s and the facilitator’s competences are unique and goals and principles cannot fully control each of the situated moments as every given situation to a certain degree is unpredictable. Thus, usability is related to the situated action rather than to the usability *per se* and, thereby, the understanding of usability reaches beyond the immediate use (Bødker, 1999).
Theoretical framework

In order to identify learning and design factors that are involved in the shaping of the action and interaction processes, a number of empirical studies have been carried out, which are presented in this thesis (Papers I-VII). The empirical studies each investigate different aspects of the interaction in the interactive environments and do not alone aim at answering the main questions in this thesis:

- What factors influence action and interaction in interactive environments?
- What are the characteristics of the engagement that underlies the desire of play in interactive environments?
- What can we learn from these activities that can assist in designing approaches to formal settings and locations?
- Does the medium create new potentials or limitations?

In order to better understand the findings from the individual empirical studies, but also to be able to take these findings a step further and create a more comprehensive understanding of action and interaction processes in interactive environments, it has been fruitful to further develop theoretical tools for further thought and analysis. Different theories have been considered in order to cover the related issues. These theories form the basis for the tentative conclusion on design for non-formal learning in interactive environments and are presented in the following four sections (3.1-3.3).

This thesis has a particular focus on people’s use of interactive environments, which primarily is viewed as empowering the user’s active participation in activities to encourage learning. Here, the reader can see the following sections (3.1-3.3) presenting the specific theories that form the base for a non-formal learning approach.
However, this thesis does not intend to present what non-formal learning is, but rather to develop a language by which I can point at central aspects of learning in interactive environments. Accordingly, these central aspects are based on theories related to action cycles and interactive play. These theories are important in order to understand the features of an individual’s action and interaction when using interactive play environments and, also, in helping define links between learning and design.

The theories that have been selected in section 3.2 (Action cycles) are based on transformative and explorative aspects of action (Bruner, 1972; Bruner, 1973; Wertsch, 1998). The reason for choosing these theories, rather than others, is that they place the interactive play environment as a mediator of human activity. Through the concept of action it puts forward aspects of human effort, and emphasizes a focus on the context of use instead of reflecting the use of the interactive play environment in isolation.
Learning as a process of competence creation is often not considered as learning in a formal sense by the child, but as play. Hence, play can be viewed as a fundamental factor for non-formal learning. Here, the focus is on the child’s ‘doing’ with enthusiasm and feeling emotively exhibited through being able to achieve, and to be free to create. In section 3.3 (Interactive play) key qualities from theories on flow and aesthetic resonance are elaborated. This includes the issue that play is likely to motivate for learning if it renders complex and challenging experiences and immediate feedback (Csikszentmihalyi, 1991). Further, Vygotsky (1978) emphasizes that play stimulates new shapes of thinking through initiation of function in the zone between what is already mastered and what is to be learnt, i.e. the zone of proximal development – a space where non-formal learning occurs. In addition, free play is self-driven and has a potential of placing the player in a state of concentration and immersion (Csikszentmihalyi, 1997) – a state where non-formal learning occurs.

In the analysis all of the theories mentioned will be taken into consideration, see Figure 3.1. The theories introduced above have, to a certain extent, been elaborated in the analysis of the findings in the studies (presented in Papers I-VII).

The next section details a description of the different theoretical perspectives on which this non-formal learning framework is based.

### 3.1 Introduction to non-formal learning

The use of the term ‘non-formal’ learning is not new. In the 1970s formal learning was viewed as high status knowledge that is possible to generalize in a wide range of contexts, whereas the informal-, everyday-knowledge was thought of as context-specific (Bernstein, 1971; Scribner and Cole, 1973). From socio-cultural and situated perspectives on learning Scribner and Cole (1973) responded to this existing dominance of formal learning by asserting the advantage of the informal and the effectiveness of learning through informal processes. Lave and Wenger (1991) undertook an important rethinking of the conception of learning when they proposed that learning is a process of participation in communities of practice, which involves the whole person, the activity, and the environment as mutually constitutive. They
argued that learning is the process of becoming a full member of the community, *legitimate peripheral participation* (p. 29).

More recent studies on informal or non-formal learning and education have been directed to:

- *Where* the learning takes place, e.g. adult education, the field of lifelong learning, and non-formal location such as museums (e.g. Bentley, 1998; Coffield, 2000; Eraut, 2000; Rousseau, 2004).

- *How* non-formal learning with ICT occurs, e.g. self-teaching or how children organize their own learning (e.g. Willet and Sefton-Green, 2002; Katz, 2000).

- The relationship between the use of interactive technologies and what is valued as learning, which has highlighted the role of the teacher as facilitator in structuring the content (*what*) that is to be taught (Rousseau, 2004). The object in these studies is, however, most often related to formal knowledge.

- How non-formal learning is built upon a high degree of motivation (e.g. Gee, 2003; Harkin, 2003).

In general, studies in this field have been directed to investigating distinctions between formal, informal, and non-formal learning, under strategies that polarizes the concepts against each other or to find boundaries around one of these concepts (Colley et al., 2003).

In this thesis, the concept of non-formal learning constitutes an umbrella that gather corresponding theories on activity (e.g. Vygotsky, 1981a; Leont’ev, 1981; Wertsch, 1998) and inherent concepts related to ludic activities motivated by curiosity, exploration, play and aesthetics rather than externally defined tasks.

In section 3.2 the aspects of action cycles and their bearing on learning will be elaborated.

### 3.2 Action cycles

The motivated processes of action and interaction in interactive environments and their bearing on learning and therapy are key concerns in this thesis. This draws on the writings of Vygotsky (1981a), Leont’ev (1981), and Wertsch (1993) in order to comment on the relationship between mediated action and the situated experience of
learning in the situation; this is exemplified through the following quotation:

Experience does not go on simply inside a person /.../ In a word, we live from birth to death in a world of persons and things which is in large measure what it is because of what has been done and transmitted from previous human activities. When this fact is ignored, experience is treated as if it were something which goes on exclusively inside an individual’s body and mind. It ought not to be necessary to say that experience does not occur in a vacuum. There are sources outside an individual which give rise to experience (Dewey, 1938/1963, p. 39 as cited in Cole, 1995).

Vygotsky (1978) claimed that any human function should be analyzed as a triangulation, consisting of the subject, the object, and the mediating tool or sign, which results in a unit of the mediated action. Leont’ev (1981) argued that the motive of the activity was to be found in its object, where the activity is realized in the form of individual goal-oriented actions. Wertsch (1993) motivated his choice of action as unit of analysis by emphasizing action as a dimension in between the individual and the socio-cultural context, and thereby not limited by a methodological individualism. By this, action may be social and individual as well as external and internal (Vygotsky, 1978; Leont’ev, 1981; Wertsch, 1985; 1998). The analysis of action in this thesis differs from the most common approaches that focus on narrow behavioural, psychological, and idiosyncratic paradigms (e.g. Efron in Ruesch and Kees, 1970; Ekman and Friesen, 1981; Kendon, 1981; Berthoz, 2000; Law et al., 2001).

The social and cultural context referred to and studied here is not extensively focusing on the contextual level, but mainly the immediate environment of each situation (which includes the technical system and the facilitator). The study presented in Paper IV is, however, an exception as the analysis points to the contextual level. However, as has already been suggested in the introduction (section 1.2), events on an individual level are always influenced by structures on a contextual or structural level and vice versa.
3.2.1 Understanding users’ needs

In this thesis the outside agent is an important person when it comes to the understanding of the user’s needs; often tacit knowledge optimizes such understanding. The role of the outside agent is to create conditions for the non-invasive environment to enable the user to control, choose, and develop skills through interaction with multimedia feedback. In that way, the outside agent is an active intervener in the feed-forward-to-feedback loop between the user and the technical system. Implicitly, this involves awareness from the outside agent of his or her own actions in relation to the user and to the system. Thereby, the role of the outside agent is more as an inter- and intra-agent, and a core part in the process of mediation. The outside agent or the inter-agent can be the facilitator, helper, or therapist. The terms are used inter-changeable in the text.

Mediation, in terms of Vygotsky (1981a) provides a link between the actions carried out by the individual, on the one hand, and the institutional context, on the other. Wertsch (1993) expands upon this framework by focusing on artefacts as mediators and essential action shapers. Mediation is seen as a process involving the potential of artefacts to shape action, on the one hand, and the use of these artefacts, on the other. Here, I add the outside agent as mediator in the process of shaping actions where the understanding of the user’s needs is essential. This reflects upon the facilitator’s intervention involving inherent manipulation of the interactive environment (user input/system output), which determines artefact response to the user with subsequent user response to the artefact. Thereby, the understanding of the user’s needs becomes an inherent part in the process of mediation.

In an attempt to extend Vygotsky’s focus on the individual subject in mediated action Leont’ev (1981) developed a three-level model that differentiates between collective activity, individual action, and unconscious operations:

1. Activity

The first level in the activity model generally explains the content and nature of the activity. The motive or object of the activity is the creator of the content and relative to the user’s needs.
2. Action

The second level is the action, which is considered as goal oriented and conscious.

3. Operations

The third level consists of the operation, which constitutes the realization of the action; the ‘way of doing’; these operations are unconscious.

These levels embody dynamic transitions between the different levels; transformation between the different levels in one direction or the other. Observations of these transitions inform the facilitator e.g. when actions have been transformed to operations or if the motive needs to be changed so that new actions can gain progression towards different explorations.

The realizations of the motivated activity require adaptation of the actions to the contextual conditions as well as to the influence of motives and intentions (see Figure 3.2.).

![Figure 3.2. Different aspects of activity are influenced by different factors (from Bærentsen, 2000)](image)

The questions of why, what, and how guide the facilitator in the process, from understanding the user’s needs to deliberated intervention (Bærentsen, 2000).
The components of an individual action are (i) the subject, (ii) the object of action, (iii) the mediating tool, and (iv) the goal (Leont’ev, 1981). Thus, the mediating tool in the activity is representational of the artefact and/or the outside agent, which is an extension of Leont’ev’s model (see Figure 3.3).

![Figure 3.3. The process of mediation in this thesis ©](image)

The model is helpful when it comes to elaborating the role of the facilitator as an intervener that is in between the artefact on the one hand and the subject’s use of the artefact on the other. The motive (object) of the action is twofold; the subject’s and the outside agent’s. On occasions the motives correspond, sometimes not. This depends on whether the outside agent’s intervention is corresponding with the subject’s intention and desired actions, or whether the intervention is challenging the subject to develop his or her actions towards new goals.

Leont’ev (1981) emphasizes that action should be understood through the joint activity which it is part of. This brings us back to section 1.2 where an adopted model compared to Figure 3.3 helps me visualize the three points of mediation; (a) between the subject and the outside agent (intersubjectivity), (b) between the subject and the
system, and (c) self-system-self (intrasubjectivity) into a model of mediated intervention, (see Figure 3.4.).

![Diagram of mediated intervention](Image)

**Figure 3.4.** The process of mediated intervention ©

Vygotsky (1978; 1981a) states that intersubjective experiences and knowledge sharing connects the individual’s internal and external worlds. Wood (et al. 1976) describes this process as a scaffolding performance.

Wertsch (1985) identified four levels of intersubjectivity in the user’s progression towards autonomous performance when he investigated instances of states of intersubjectivity relative to Vygotsky’s (1981a) notion of the Zone of Proximal Development (ZPD). Wertsch emphasized Vygotsky’s (1981a) approach by discussing the transition from inter-psychological to intra-psychological functioning. Wertsch’s (1985) study concerned collaborative puzzle assembling activities with young children and their mothers and showed that:

- at the first level of intersubjectivity no intersubjectivity appeared since the adult and the child differed fundamentally concerning the definition of the objects involved;
- at the second level of intersubjectivity there is still communication problems, since the child did not fully understand the task situation and is still not in agreement with the adult;
- at the third level of intersubjectivity there remain a process on the inter-psychological level where the child is functioning independently and the adult provides reassurances to the child that what he or she is doing is correct;
- at the fourth level of intersubjectivity the child is in charge and has taken over the responsibility for the performance of the goal-directed task. At this fourth level, there is complete intersubjectivity between the adult and the child in the definition of the situation. This shows that the child has mastered the situation where the adult from the start defined the task.

Furthermore, Wertsch (1985) noted that when an increase in the level of shared situation definition occurred, a transfer of responsibility for the task to intra-psychological functioning was accomplished.

Rogoff (1990; 2001) has had an extensive impact on the recent understanding of the term intersubjectivity related to her studies of guided participation in collaborative activities. She defined intersubjectivity as shared understanding based on a common focus of attention. In her studies Rogoff investigates the learning process from the collaborative activity in the form of apprenticeship and guided participation to individual change which she terms as a process of participatory appropriation. This merging into a joint activity, characterized by a simultaneous dialogue where the user’s and the facilitator’s contributions are different but equal, calls up Bakhtin’s dialogic concept of polyphony (Morris, 1994). The jointly created communication can be described as dialogic when there is more than one voice in the communication, i.e. polyphony, and when the user’s and the facilitator’s intentions are mixed. This dialogic feature, thereby, creates conditions for the facilitator to act as a partner in a dialogue (Lotman, 1990). Relatively, Molander (1993) underlines that dialogue is a basic condition for knowledge creation. Through the dialogic form of the jointly created communication within the interactive environment the user, the system, and the facilitator are actively participating in the creation of meaning and in a learning process.

Löwgren and Stolterman (2004) have described this simultaneous dialogue in terms of consideration and exploration with different potentials in a given situation, where solutions and problems are created in parallel, at the same time, in a co-evolving process. Similarly, in his writings comparative to the paradigm of design Schön
resembles a process like this as a conversation between reflection-in-action and reflection-on-action. In this way the facilitator asks questions through exploration based on tacit knowledge, listens to the feedback and adapts the selectable feedback according to the preferences and needs to the user.

Given this as a background, the definition of intersubjectivity in this thesis refers to a joint activity or dialogue where the facilitator intervenes so as to create symmetry as well as asymmetry in the situation. From this perspective, intersubjectivity expands as ambiguities emerge as a result of taking asymmetric interacting elements into account (Gusfield, 1989). The crucial consequence of this definition is relative to the facilitator’s awareness to balance the harmony in the situation towards the challenges so that these interventions are confronted by the user and act as a trans-active motivator. In line with Smolka (et al., 1995) I consider divergent moments that emerge as a result of the user/system interaction as an integral part of intersubjective functioning where a relationship between the subject and the facilitator is apparent.

3.2.2 Transformative actions

The transitions between the different levels in Leont’ev’s three-level model, different modes of interaction, and the process of facilitator-intervention constitute the process of social, individual, and material transformation. In other words, this means that mediated cycles of actions can be identified through the concept of transformation. By this statement I have transcended beyond mere use towards transformative action, which means that I consider every action as new creations (see also chapter 1 – Introduction). This was evident through the participant’s facial expressions and other non-verbal gestures (especially notable in Papers III, V, VI, and VII). Bruner (1973, p. 2) describes the initiation of these action cycles as:

The initial patterns of action that emerge through exercise then become the constituents for new patterns of action directed at more remote or complex objectives.

Wertsch (1998) emphasizes that:

/…/ the general point is that the introduction of a new mediational means creates a kind of imbalance in the systemic organization of mediated
action, an imbalance that sets off changes in other elements such as the agent and changes in mediated action in general. Indeed, in some cases an entirely new form of mediated action appears (p. 43).

In relation to this, Wertsch (1998) accentuates that change through introducing new cultural tools in mediated action is one side of the coin; the other side concerns the skills of the individual. This is highly relevant for this thesis whereby the technical system provides the context and the criterion for assessing the participant’s skills. This can be related to Csikszentmihalyi’s (1991) theory on autotelic activity, which is discussed below (section 3.3).

Every new action in the interactive environment starts with an investigation of the environment; constraints and possibilities are explored by the user alone or with guidance from the facilitator. The following section outlines the property of explorative actions.

3.2.3 Explorative actions

Exploration goes along with play, but is not the same as play. Bruner (1972) describes how play involving manipulation of tools, requires a degree of competence, which is achieved through a learning process starting with exploration of the characteristics of the tools. In Paper I the exploration described takes place as the children are exploring the different toys, and together with the exploration play is apparent. The absence of negative consequences encourages the exploration, which, in turn, can result in the development of unemployed skills (Beach, 1942). Bruner (1973) divides early gained competence into two units, those that regulate interaction with other people and those involved in mastery of tools. Bruner continues by identifying three central themes related to the growth of competence, which is intention, feedback, and the patterns of action (p. 1). Furthermore, he divides the theme of feedback into three aspects. Firstly, internal feedback that signals an intended action within the nervous system, which can be compared to the feed-forward part of the feed-forward-to-feedback loop, as it occurs prior to overt action. The second theme concerns feedback proper from the system during the action and, thirdly, knowledge of results that possibly occur after the action has been completed. This feedback loop can also be described as an extension of the human afferent-efferent
neural loop closure described in Paper VI, which often is called sensorimotor or stimuli-response chain (Scherer, 2000) (Figure 3.5).

Berlyne (1950) refers to interactions as instrumental exploration that is motivated and learned by the cause and effect aspects as well as the surprise exploration that is awaked by pure and simple novelty. This is to say that the instrumental and the surprise exploration achieved from the interactive environment have relations as forms of motivation due to the novelty. However, these statements relate to problems that demand further investigation.

3.3 Interactive play

The theories presented so far in this chapter regarding the role of action cycles in the learning when using interactive environments targeting children and young people with different abilities, have suggested that:

1. Action cycles are mediated and contains subject, object, mediating tools, and goals of action;
2. Mediated intervention by a reflective competent facilitator enhances the interaction;
3. The use of interactive environments are considered as transitional to actions;
4. Explorations are involved in the development of mastery of tools.
For a child with disabilities play situations could be more or less impossible and attached with frustration due to limited access to suitable tools for expression. Consequently, this affects the learning and fun potential for the child. My approach to play is activity driven and based on Aesthetic Resonance (Brooks et al., 2002; Brooks and Hasselblad, 2004). In this section the parts of Vygotsky’s (1978), Leont’ev’s (1982), and Csikszentmihalyi’s (1991) theories which deals with play, autotelic experience and flow will be described in relation to the concept of aesthetic resonance. Before providing these theories, an additional matter has to be clarified, and that is the meaning of ‘having fun’. This clarification will naturally lead us to the phenomenon of play.

3.3.1 Enjoyment

Having enjoyable and fun experiences in the interactive environment is emphasized in this thesis. This means to being engaged (both consciously and unconsciously) and that the individual is offered possible choices of action. The choice in how to do things is in this case closely related to “having fun” (Göncü, 1999; Rogoff, 2001). This is especially significant according to the studies presented in Papers III, V, and VI, where the participants, who had profound multiple disability, were empowered to actively control selected content by body gesture. Initial activities were in establishing an understanding of the interactive space through facilitator guidance. This interaction (facilitator action) means taking the hand of the participant and guiding it through the sound space (this can also be the user’s head, leg, torso, or digit – again, dependent of therapy goals). Tactile response that was exchanged between the facilitator and the participant indicated to the participant’s understanding of the space and subsequently hand and head movement explored without guidance. It is at this stage that the participant uses the mediating tool alone to accomplishing his or her interests. In relation to this, Bruner (1973) points out curiosity, the desire to show oneself and others the ability to act, and the attempt towards common goals together with others as internal motives to learn. This system is characterized by the free interaction within the computer-mediated information space mentioned in section 2.2 (Interactive environment – user interface). The system has the capacity
to awaken and develop enjoyment and curiosity among the participants resulting in an optimized motivation to play and learn.

3.3.2 Autotelic activity and flow

In his writings, Vygotsky (e.g. 1981) states that the play is the source to the child’s development. When the child is playing a potential development zone is created – the Zone of Proximal Development (ZPD). The ZPD is defined as the distance between the actual level of development, which is determined through the child’s own way of solving problems and the potential level of development, which is defined through guidance of the adult (Vygotsky, 1978). Leont’ev (1982) points out the possible conflict between the child’s need for action and the inability to perform this action. The motive for the action is, however, not related to the result, but rather to the content of the action, which is why the child does not need to master the actions or operations that are required. According to Csikszentmihalyi (1991), the balance between the inability and the mastery is crucial relative to curiosity and motivation.

Play is similar to what Csikszentmihalyi (1991) names autotelic activity, which is characterized as being carried out for its own sake by inner goals generating the state of flow. As such play is described as a precondition to flow. In this thesis, this is similar to the way the ‘doings’ or actions are described as prerequisites to playful engagement. According to Csikszentmihalyi (1991) flow experiences consist of seven components that create the conditions that make flow possible. The seven categories can be divided into two groups. The first group of components describes the basic prerequisites of flow:

1. Clear goals and immediate feedback.
2. Challenging activity.
3. The paradox of having control in an uncertain situation.

By this, flow activity is not passively experienced, but requires active engagement. Play seems to be closely related to flow suggesting a goal-oriented nature of the input and a desirable outcome for making meaningful choices. This balance between challenge and sensibility is allowing and encouraging change. In an optimal experience, the participant is able to be in control without completely being in control.
of the situation. If there is no chance of failure, the activity is not
difficult enough and refinement (intervention) to match ability to
challenge is required.

The second group consisting of four components describe the effects
of the flow state:
(4) Merging of action and awareness.
(5) Concentration.
(6) Melting together of doing and self-consciousness.
(7) Transformation of time.

One characteristic of the flow state is that the participant is so absorbed
in the activity that it becomes almost automatic, which allows the
participant’s consciousness to delve deeply into the activity. The
complete focusing of attention on the task is a common effect of flow.
In the state of flow the participant’s experience of self becomes reactive
to the whole of the experience and the sense of time stretches or
shrinks. This holistic mode of operation leads to unification and order
of the participant’s consciousness, in other words, an integration of
physical, emotional and mental functions (Csikszentmihalyi, 1991;
Salen and Zimmerman, 2004).

But, how does an experience like this happen? The answer,
according to Csikszentmihalyi (1991), is that the activities are designed
to make optimal experience possible to achieve. An optimal experience
contains a sense of discovery, which pushes the person to higher levels
of performance. Csikszentmihalyi has developed a general model
which describes how the level of a person’s skill and the challenge can
influence the flow experience in an activity. This is described in Figure
3.6.
3.3.3 Aesthetic resonance

The sense of flow happens when there is a balance between stress and boredom. If somebody is doing something that this person knows how to do it is not engaging, but rather the person becomes bored of doing more of the same. Alternatively, if the person does something that is completely outside his or her competence level, this person may become stressed or anxious. Flow occurs when the experience is targeting the edge of the skills, and stretches the person a little bit beyond his or her limits. By this, the sense of flow contains a total engagement. This is similar to the Zone of Proximal Development (ZPD) (Vygotsky, 1978) and emphasizes the support from peers and/or mediating tools in order for the child to reach beyond his or her limits. Again, the stretching of the user’s potential limits is targeted.

Consider the technical system used in this thesis (presented in Papers I-VII), where the feed-forward-to-feedback loop is autonomously directed by the participant and/or to the goals directed by

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*Figure 3.6. A model of the relation between challenge and skill for the experience of flow (abridged from Csikszentmihalyi, 1991, p. 74)*
the facilitator, who is concerned with overcoming of restrictions and with the emergence of new and improved actions. Thereby, the interactive play environment has the possibility to offer a space, which positions the participant in the midst of the experience, that is to say that the participant becomes absorbed by the ‘here and now’, as in the flow state described by Csikszentmihalyi (1991). This relates flow to the sense of aesthetic resonance. In the study presented in Paper VII it was proposed that the playful aspects of video games have a potential to decrease the physical and cognitive load in a daily physical training regime, i.e. in the children’s rehabilitation world.

The sense of aesthetic resonance in this thesis refers to a situation when the response to intent is so immediate and aesthetically pleasing as to make one forget the physical movement (and often effort) involved in the conveying of the intention (Brooks et al., 2002; Brooks and Hasselblad, 2004).

This situation arises within the space that we all carry around us and which Laban titled our kinesphere (see Laban, 1963, p. 85). Figure 3.7 depicts a participant in his or her own kinesphere, where a gesture is captured and translated by an interface as control data for the technology (usually a personal computer) to interpret and respond with selectable multimedia content manipulation in an immediate and direct manner. In addition to the visuals and sounds feedback content the system has also utilized direct human gesture synchronized to robotic physical feedback movement. This configuration of the system

Figure 3.7. Interactive kinesphere created with sensors to explore aesthetic resonance ©
including the robotic device (presented in Paper VI) may be viewed as a support for the child to reach beyond his or her current level of development. An adjusted support for the child is offered by the interaction with the robotic device, which challenges the child to reach a level of mastery. In the study presented in Paper VII aesthetic resonance was indicated through the increased degree of intensity and intentionality in movements. The increased degree of movements was observed through the range and the shifts in the children’s movements. Thus, aesthetic resonance represents engagement where for example, interaction is such that it subliminally encourages the user to disassociate from pain that may otherwise be present as a result of the physical movement involved in the conveying of the intention in interacting with the system. In this way, aesthetic resonance extends the notion of flow, by adding the interactive and aesthetic dimensions of the experience. This is especially described in Paper I, IV, and VII.

In this chapter I have elaborated the concepts of transition, exploration, engagement, and play. As such these aspects have a bearing on the participant’s experiences of enjoyment and fun in activities.
4 Method

The approach of this work is based mainly on empirical studies in which interpretations of the field work are followed by theoretical reasoning. On the empirical level, action and interaction are examined when individuals with (severe) disabilities are using computer generated interactive environments. Through participatory involvement and recursive reflection, main issues are identified and investigated within a theoretical frame of reference. A qualitative approach was used to determine the use of action and interaction in design issues for non-formal learning utilizing technology. Through unifying the particular a method of understanding the context and situation as a whole developed inductively whilst addressing experiences of individual participants. This development resulted from a process that began with specific observations and interviews with later development toward more generic methods. The warranted strategy of utilizing qualitative research as the methodological paradigm is substantiated by Patton (1990) who offers the four traits (1) the emphasis on individual outcome; (2) the detailed in-depth information about the phenomena under inquiry; (3) the study’s focus on diversity and unique qualities of individuals; and (4) no available standardized, valid, and reliable instrument.

The motivation behind the research carried out (presented in Papers I-VII) is twofold: first, to understand the role of action and interaction in the learning involved when using interactive environments for children and young people with different abilities, and, second, to conclude at tentative generalizations on design for non-formal learning in interactive environments.

A case study methodology was found to be astute as each individual study was rich in information and added to my understanding and in depth learning of the situations, the people, and their actions.
4.1 Case study

The studies in this thesis (presented in Papers I-VII) have used the case study methodology. According to Yin (2003, p. 1):

Case studies are the preferred strategy when "how" or "why" questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context. Case studies can also be used for the answering of "where" and "who" questions and retain the holistic characteristics of real-life situations (Yin, 2003).

This approach is related to Aristotle’s concept of ‘phronesis’, which concerns values and reality, people and actions. From an epistemological point of view phronesis is not scientific as the concept represents knowledge relativism rather than scientific knowledge that is universal, rational, and context independent. However, the term is relevant to consider as it connects the discovery and reflecting knowledge of concrete action in the specific context (Jönsson, 2006). The latter is also emphasized by Engeström (1999), who argues that studies including investigations of transformation and change need to be studied in actual situations.

This approach does not mean that epistemological issues like: systematization; articulation of new questions; openness and transparency in the handling of methods and data; and the capacity to generalize based on the experiences from the different studies, has been neglected in this thesis. The reason for bringing in the concept of phronesis is that it adds the crucial aspect of giving priority to and learning from the particular rather than solely from the general. Striving to be subjective and specific rather than objective and general is to prioritize being situated and interested in what is relevant for a person or a group (Jönsson, 2006). In this thesis, every individual constitutes his or her own reference group, and the generalization of the cases is related to the implementation of a range of different case studies, rather than implementing randomly controlled studies.

The studies presented in this thesis investigate the particular about each case in each study period; they also investigate what is common between the cases within the specific study, which is in line with Stake (2005).
Data has been collected through the use of video, interviews, personal diaries, user drawings, and questionnaires (semi-structured interview forms) supplemented with field notes. Those interviewed were the children, the adult participants, the parents, the institutional staff, the personal helpers, and the specialists. In the studies (presented in Papers I-VII) the institutional staff, parents, and personal helpers were asked to contribute with opinions, appraisals, and interpretations of the specific session situation and of the collected data.

The triangulated data strengthened the analysis and supplement the use of case study method. According to Stake (2005, p. 454):

Triangulation has been generally considered a process of using multiple perceptions to clarify meaning, verifying the repeatability of an observation or interpretation.

Accordingly, all sessions involved in the studies were videotaped, annotated, and analyzed so as to give an opportunity for post session scrutiny of progressive development indicators when compared session to session and study to study.

Through the implementing of these different perceptions and as a result of applying variations to the chosen qualitative method we were able to define meaning relevant to the situation of each case concluding to the validation of the studies (presented in Papers I-VII).

4.2 Participatory recursive reflection

Through reflections and occurrences during the investigations two holistic models emerged that were apparent in their cohesiveness to the different studies included in this thesis and presented in Papers I-VII. Notably is that these models receive incremental emphasis in Papers II and III. The first model concerned participative involvement, which was suggested as a wise strategy to include those who are closest to the sample to review occasional video sessions as they can observe and input with informed tacit knowledge of a suggested higher nuance compared to other observers. The second model, recursive reflection, concerns the videoed sessions, which were archived intact so that a ‘return to view’ in consideration of temporal new findings was possible – in both short term (within the study) or long term (years later) as a “learning” element influential to subsequent investigations, overall
concept development and research/therapist/facilitator “learning” and training. In that way, the emerged approach demands a collaborative arrangement in research with the participants and with their helpers, therapists, and families, that is to say working within this network of people, not externalizing them.

Paper III presented models that support participatory and recursive reflections. A presentation of archived raw video from sessions with the user John was given to his parents who had not previously witnessed the work. By including their knowledge a higher nuance of the analysis was recursively added whereby John (as the experiencing subject) and his experiences of the interactive session were closer to unification than to separation (Denzin and Lincoln, 2005).

The second part of the paper reports on sessions with ostracized children that resulted in an independent report generated by the staff at the school reflecting on the investigation. The report supported the participative involvement model where they had witnessed “special moments” through their knowledge of the children. This inspired a review of the archived session videos from the school which further substantiated the model of recursive reflections.

Thus, the observational work related to case studies is an act of reflective thinking as well as of retrospective reflection, which is relative to what Löwgren and Stoltermann describe as a thoughtful approach to design (2004). This is exemplified by Stake (2005, p. 449):

In being ever-reflective, the researcher is committed to pondering the impressions, deliberating on recollection and records.

Stake (2005) points out that the researcher’s intrinsic interest moves the researcher towards understandings of what is important about the case within its own world. This world is not the same as the world of the researcher and, accordingly, the “case world” is perceived to be an own issue in respect of context, and interpretation. In intrinsic case studies generalizations are done in relation to events of the specific case at times still to come and in other situation (p. 450).

Each child’s personal carer was at all times in attendance at each session to ensure well-being. By this, as well as ensuring the user’s comfort with the situation and with what was confronted we wanted to strengthen the validity of the study by decreasing mistakes like rash and naïve conclusions as well as simplified interpretations. This approach can be considered as participatory research (Starrin, 1993a). Carers
give their knowledgeable input but do not influence the research process as a whole, but merely the interpretation of data and, partly, also the concrete planning of the sessions. However, the inclusive participation approach used in this thesis was intended to involve the carers actively in the creation of specific user knowledge, rather than that they were only being informed or consulted from a distance.

Implicitly, this approach has a divergent nature (Starrin, 1993b) and, thereby, a situated character of understanding. This means that the understanding is defined relative to actional contexts, and not specifically to researcher-self-contained structures (Lave and Wenger, 1991). By this, the creation of knowledge is participative and mediated by the particular differences as reportedly perceived by the children, the adult participants, the parents, the institutional staff, the personal helpers, and the specialists.

4.3 Ethics

Ethical considerations are closely connected to qualitative research and especially to the case study design as these often deal with matters that are of public interest (Stake, 2005).

Qualitative researchers are guests in the private spaces of the world. Their manners should be good and their code of ethics strict (Stake, 2005, p. 459).

The character of the research carried out within the studies presented in this thesis has raised many questions, especially related to the method and analysis as they are closely related to ethical considerations. It is difficult to carry out research that involves individuals; it is more difficult when it concerns individuals with special needs. All in all, this includes a moral responsibility of me as researcher, which has to be in focus and present at all times during the research process. Thus, it is important that ethical questions are taken into consideration.

As research can never be free from values, it is important to make clear which foundations the morality we are dealing with rests upon. Differences can be found in the opinions of the carer or the parent in the study, even though the material appears the same. In all instances we tried as far as it was possible to be aware of biases that could affect the understanding of the sessions and all collected data.
Any research that involves individuals inherently includes sensitivity and integrity issues of those investigating due to their role as primary instrument of the collected data (Merriam, 1998). This fact has its advantages, but also limitations. Throughout the studies (Presented in Papers I-VII), an inclusive participation approach was used so as to decrease the limitations involved in relying on our own instincts and abilities involved in the understanding of the observed interactions involved.

The Ethical Research Practice from the Swedish Government (SOU 1999:4) argues that it is not possible to create knowledge without prerequisites and points out that it is important to increase the consciousness of the fact that research is more or less governed by interests from different instances.

In all instances all participants and responsible staff were approached about the study, informed of the goals, and gave their permission beforehand and informed of their option/right to interrupt. In the cases where the children could not (due to their disability) grant permission themselves, parents and carers were approached and asked to on behalf of their children to agree to involvement and use of material.

The usual method was that parents and the responsible staff were initially informed about the project through an information leaflet that was sent out before the study started. In the leaflet the aims, methods, expected results, dissemination (e.g. how the study should be published and disseminated), and special requirements (e.g. how many times/sessions we wanted to meet with their child) was detailed. The information leaflet was accompanied with information about ethical considerations regarding (1) informed consent; (2) deception; (3) privacy and confidentiality; and (4) accuracy (Christians, 2005). This approach is justified in United Nations’ Standard Rules (1993) concerning the equalization of opportunities for persons with disabilities:

Information and research. States assume the ultimate responsibility for the collection and dissemination of information on the living conditions of persons with disabilities and promote comprehensive research on all aspects, including obstacles that affect the lives of persons with disabilities (UN Standard Rules, 1993:13).
The code of total integrity has been difficult to preserve. We have made efforts to inform the children, parents and responsible staff at the institutions involved where the interview material should be reported and published and how the video material was used. The names were changed and coded in the interviews, but it is however difficult to maintain full anonymity. The involved parties were given the opportunity to make comments on possible consequences, which was taken into consideration.

Video material has to be handled with additional concern. The video tapes in the studies presented in this thesis have been used for the purpose of the specific study and not in other contexts. The video tapes from study III, IV, V, VI, and VII have also been used for educational purposes, and have required additional permission from the persons involved. We had separate permission from the parents to use the photographs used in the studies presented in Paper III, IV, V, VI, and VII. The experiences from the participative involvement approach used in this thesis shows that the involvement of parents, carers, and therapists in a shared reflection and analysis offered wider possibilities for an extended understanding and, sometimes, shared knowledge of the situation. The difficulty, especially apparent in the studies presented in Paper II and IV, was to make the goal of the study/project visible so that both the researchers and the participants and involved staff could see the goal through, as much as possible, comparable spectacles.

The parents, carers, and therapists were by the researchers approached to address questions and possible solutions asked relative to their and their son’s/daughter’s/client’s everyday lives (at home or at the institution). As a result of this interest situated expectations and hope became apparent; more so upon witnessing the potential for their child/client in respect of his or her everyday lives. The institutes involved and many of the parents expressed their interest in the project and they were interested in a continuation of the project after the end of the project period. This has been one of the ethical problems in the studies, which merely have been short-term studies (maximum up to three years) and, consequently, there have not been possibilities within the project funding to cater for the needs of a longer term continuation. This has been experienced as difficult. In the study presented in Paper II, however, the participants took the continuation of the project after the project ended in their own hands and the facilitator expressed the
empowerment of sharing in scientific advancements (Universal Declaration of Human Rights, 1948, Article 27):

We would certainly like to carry on opening the AUSER garden to children in spring 2004 and we are working towards that objective. Even though the T.I.M. project is over I think the ladies will continue to think of themselves as the “T.I.M. Ladies” as being part of a European project is quite a strong part of their identity and motivation (Vittoria Burton, facilitator, Alce Rosso, Italy)

According to ethical rules (Vetenskapsrådet), research should be kept for 10 years after the finishing of the research study. The material within the studies involved in this thesis (presented in Papers I-VII) consist of interviews recorded on tapes, observations recorded on video tapes, questionnaires (semi-structured interview forms), drawings, diaries, field notes. The material has been encoded from names to numbers and no unauthorized persons are able to find the original identity of the participants. Social security numbers have not been used. The diaries were given back to the parents after the study (Paper III).

To summarize, the researchers have met users, parents, heads of institutes, therapists and carers at institutes to assure that all considerations regarding ethics relating to the investigations are addressed. There has been no questioning of integrity; in fact the opposite has been stated. Thus, to all intents and purposes the matter of ethics has been accounted for.
5 Aim and research questions

The aim of this thesis is twofold. First, it aims at contributing to the understanding of the role of action and interaction in the learning involved when people with different abilities are using interactive environments. Second, the thesis also aims at making a contribution to the research field by concluding at tentative generalizations on design for non-formal learning in interactive environments. The insight of these contributions should be able to help developers and users of interactive environments to improve the involved technology and pedagogical issues. Additionally, new training methodologies for a new breed of facilitators are targeted in light of current demographic predictions related to the community of disabled people.

5.1 Research objectives

The research objectives of the seven papers were the following:

I. The aim of Paper I was to explore pedagogical potentials of new technologies and traditional toys integrated into a physical and virtual toy system (integrated toy). In this way, the study concerned how different design features of interactive media encouraged collaborative learning. The discussion covers pedagogical issues related to non-formal learning and open-ended design features.

II. The study aimed at preparing a basis for defining a methodology that encouraged co-operative design under a participatory paradigm in order to achieve greater involvement in product development where the targeted market was related toys and games produced in small and medium sized enterprises (SME).

The main issues involved in the evaluation were defined by addressing the following questions:
- What were the factors that came together and made the methodology what it was?
- What were the strengths and weaknesses of the methodology?
- How were the users and facilitators brought into the activities and how did they participate in the workshops?
- What was the nature of the facilitator-participant and the participant-participant interactions?

III. The main purpose of Paper III was to test the potential of utilizing sensor technology to empower control of multimedia feedback across different sample groups of user abilities and to test the effects of these participants.

IV. Paper IV is a critical meta-analysis of a previous project, titled Humanics 2, which had an aim to produce a home based telehealth training and reporting device for the client that had acquired brain injury. The project ran into detrimental problems in the collaboration with the commercial partner resulting in a curtailed project that did not realize its aim. The issues appertaining to the failure of the project are discussed in context of a reflection on the report with questions asked of the strategies and decisions of those involved towards a refinement of future protocol.

V. The aim of the study reported in Paper V was to explore the potentials of interactive environments for people with special needs and those around them. In the study they were empowered within a volumetric non-invasive interface to actively experience gestural control of sonic events. The unique quality of the interface was the empowerment of natural and intuitive 3D gesture to control and navigate both artefact and environment.

VI. The aim of the sixth study (presented in Paper VI) was to explore how children with severe disabilities could use a robotic light system for joyful and interactive play. The children participating in the study were encouraged to play utilizing whatever physical ability they had. The child’s facial expressions, hand, and head movements, which were
synchronous to the robotic device control were the basic unit of analysis

VII. The focus of this study (presented in Paper VII) was on each child’s dynamic of movements when acting, reacting, and interacting in the gameplaying activity during the sessions. Play was targeted as a strategy for motivating the child in physical therapy participation.
6 Overview of the studies

In this chapter an overview of the studies is provided. Table 6.1 presents each publication study, aim, design, and method. This is followed by a review of each paper where each is detailed as to aim and background, method and results. The conclusion of each paper is also included.

Relatively, in chapters 4 (Method) and 8 (Conclusions) the reader can reference the methods used in the studies which are critically discussed in respect of the studies.
Table 6.1. The theoretical and empirical scope and the methods employed in each study

<table>
<thead>
<tr>
<th>Study</th>
<th>Interactive technology</th>
<th>Methodological approach</th>
<th>Study design</th>
<th>Data collection method</th>
<th>Data analysis method</th>
<th>Number of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper I: Virtual and Physical Toys – Open-ended Features towards Non-formal Learning</td>
<td>Toys, video-game, construction materials, prototypes of an integrated toy (LEGO) with implemented infrared sensor communication technology</td>
<td>Qualitative</td>
<td>Field study</td>
<td>Video observations, semi-structured interviews, written and visual documentation; Focus group interviews</td>
<td>Qualitative analysis</td>
<td>27 children between 4 and 11 years of age (well-functioning and with varying levels of disabilities); 9 adults (teachers, special educators, and therapists)</td>
</tr>
<tr>
<td>Paper II: Encouraging co-operation designed as participation – the beginning of a successful friendship</td>
<td></td>
<td>Qualitative</td>
<td>Case study</td>
<td>Participatory video observation, observation, visual documentation, interviews</td>
<td>Qualitative case analysis</td>
<td>50 adults (healthy, disabled, and personal assistants)</td>
</tr>
<tr>
<td>Paper III: Encouraging Reflection and learning in Home Data Video Analysis of Interactive Play Behaviour for Special Needs Health Care</td>
<td>Computer-generated non-wearable infrared sensor technology</td>
<td>Qualitative</td>
<td>Case study</td>
<td>Video observations, field notes, interviews, diary</td>
<td>Participatory reflective analysis</td>
<td>1 young person (severed multiple disabilities); 23 children between 7-14 years of age (with severe and emotional disabilities); 3 therapists, 2 parents, 2 facilitators</td>
</tr>
<tr>
<td>Paper IV: Human Computer-Interaction in Acquired Brain Injury Rehabilitation</td>
<td>Computer-generated non-wearable infrared sensor technology</td>
<td>Qualitative</td>
<td>Meta study</td>
<td>Written and visual documentation, interviews</td>
<td>Meta-analysis</td>
<td>10 adults - acquired brain injured, 2 facilitators</td>
</tr>
<tr>
<td>Paper V: Raw emotional signifying, via expressive technologies</td>
<td>Computer-generated non-wearable infrared sensor technology</td>
<td>Qualitative</td>
<td>Case study</td>
<td>Video observations, field notes and memory</td>
<td>Qualitative segmented video analysis</td>
<td>4 young children (severed multiple disabilities) who were selected from a sample of 30; 4 therapists, 4 facilitators</td>
</tr>
<tr>
<td>Paper VI: Non-formal Therapy and Learning: Extending through Human Gesture</td>
<td>Computer-generated non-wearable infrared sensor technology and remote light device</td>
<td>Qualitative</td>
<td>Case study</td>
<td>Video observations and questionnaire to facilitators and children</td>
<td>Video analysis</td>
<td>4 children between 4 and 6 years of age; 4 facilitators</td>
</tr>
<tr>
<td>Paper VII: Play Therapy Utilizing the Sony EyeToy 16</td>
<td>PlayStation2® platform, EyeToy® USB camera</td>
<td>Qualitative</td>
<td>Field study</td>
<td>Video observations, interview with children and facilitators, questionnaires to facilitators and children; focus group interviews</td>
<td>Manual and computer analysis of questionnaires (qualitative), and qualitative analysis of questionnaires</td>
<td>16 children between the ages of 5 and 12 years; 5 facilitators</td>
</tr>
</tbody>
</table>


Paper I: Virtual and physical toys – Open-ended features towards non-formal learning

Aim and background

The purpose of Paper I was to explore pedagogical potentials of new technologies and traditional toys integrated into a physical and virtual toy system (integrated toy). The study was concerned on how different design features of interactive media encouraged collaborative learning. The discussion covers pedagogical issues related to non-formal learning and open-ended design features. This learning incorporates rehabilitation, training, and education.

It is well documented that toys play a crucial role in supporting children’s learning and creation of meaning in their everyday life. Children also play with toys out of an interest to interact with others. An open-ended toy is characterized through its multiple opportunities for manipulation and forms of play. The idea of using physical interfaces to support children’s play and learning has been adopted in previous research on computational toys (e.g. Frei et al., 2000) and collaborative environments (e.g. Ananny, 2002). The open-ended features of the integrated toy could be described in terms of alteration, which includes a process of transformation (Wertsch, 1998).

Method

A field study design was used. Three kinds of data collection were used (1) video observations, (2) semi-structured interviews, and (3) written and visual documentation. These different data collections were triangulated in order to strengthen the analysis. 27 children between 4-11 years of age participated in the study. The children were in general well functioning. Furthermore, 51 teachers, special pedagogues, and therapists participated as experts in the study. The material that was used was toys, video-games, construction material, and a prototype of an integrated toy (E-CUBes) with an infrared sensor. A single E-CUB artefact is a six sided cube with a Light Emitting Diodes (LED) matrix display on one face. The cube (E-CUB) has electronic capabilities to sense other E-CUBes in the vicinity and form a network via infrared...
communication with other E-CUBes through determining the other cubes in the area. The display is used as a visual interface to render the alphabet. With an E-CUB the child can initiate a game or play situation by shaking it.

The first case study consisted of three explorative workshops where the children constructed drawings of video games, created sketches of bricks for 3D environments, and played with actual toys and video games. The second case study consisted of two user tests of the E-CUBEs. Additionally, follow up interviews with the experts were conducted.

Findings and conclusions

The results showed a tension between physical and virtual design features through different interfaces. Our findings showed that the interface of an open-ended toy should be alterative and, thereby, offer asymmetric and simultaneous features. The non-formal learning approach contained a change of the traditional perspective on education and rehabilitation, which was characterized by a move from an educational or rehabilitation “service” that someone else provides for the child towards a learning perspective that demands engagement and active participation from teachers, therapists, and children. The materiality in the form of tactile interfaces enhanced collaborative learning through gestures and expressive modalities of play underlining interest and inherent messages. I conclude that open-ended design features evoke children’s motivation to learn and that the physical and virtual explorations optimized a sense of being engaged which has the potential to enhance collaborative play and learning experiences.
Paper II: Encouraging co-operation designed as participation – the beginning of a beautiful friendship?

Aim and background

The paper is an evaluation of a European project, which was centred on processes designed to encourage participation in which those involved developed design ideas into new products. The groups involved in the project were so-called marginal groups, disabled, elderly and people in prison. One of the short term objectives of the study was to offer the participant experiences of cooperation designed as participation based on a treatment with genuine respect. What was taken into account was the facilitator’s role in creating conditions for authentic participation, as well as the factor of inclusiveness and its relation to motivation.

The evaluation aimed at preparing a basis for defining a methodology encouraging co-operation that was designed as participation in order to achieve greater involvement in design- and product development processes, regardless of an individuals’ age, social status or handicap.

The reason for including this study was that it was focusing upon the role of the facilitator in the creative process, and also, that the study took aspects of empowerment into consideration.

Method

The methodological approach to the evaluation of the project consisted of qualitative methods and three kinds of data collection, (1) participatory and video observations, (2) interviews, and (3) written and visual documentation, including project records. The data was collected through participants and facilitators who were associated to the different project groups mentioned above. This approach could be described as inductive as we were concerned about the individual experiences of the participants.

The results and analysis were presented in the form of qualitative descriptions based on case analysis methodology. Each project group
represented one case, which was the basic unit of analysis. The data in question consisted of interview data, observational data, and impressions – in other words – all the information that was possible to accumulate about the particular case in question.

Findings and conclusions
The results showed that the relationship between the participant and the facilitator was crucial for all the participants in respect of their motivation and creativity. This was applicable across the entire sample of the study. Co-operation and participation were the two main topics that helped the participants in realizing a sense of empowerment. The important aspects of the findings were all based on the participant’s trust in the facilitator as well as their own reflections on their own augmented influence, and competence development. It was the participant’s view on the alliance between him- or herself and the facilitator that constituted the most important measurement when it came to predicting a continuous motivation. Related work has shown that the more positive the participant considers the facilitator’s approach, the higher possibility for a successful result of the specific activity (Hubble, Duncan & Miller, 1999; Duncan & Miller, 2000).

Paper III: Recursive reflection and learning in raw data video analysis of interactive ‘play’ environments for special needs health care

Aim and background
The main purpose of this study was to investigate the potential of utilizing sensor technology to empower control of multimedia feedback across different sample groups of abilities and to investigate the effects of these participants.

The technical system used in this study is conceptualized as being adaptable across age groups, abilities, and limitations, so as to be usable for a variety of users in the community. The methodology was to capture movement as digital data that was routed through a computer to
control elements of selectable and immediate multimedia feedback. This was selectable according to the preferences of the individual participant and the goal of the session(s). Through a strategy of adaptable capture technique and content optimization a real-time responsive play scenario was established where creative motivated expression was targeted.

Method

Two investigations that accounted for two different cases were carried out: (1) severe disabled person of age 23, who had been institutionalized since 7 years back; (2) 23 children with social and behavioural problems. The children were between the ages of 7 and 14 years. All sessions were video taped, annotated, and analyzed so as to give an opportunity for post session scrutiny of progressive development indicators when compared session to session. Along with video observations, field notes, interviews with parents and staff from the involved institute and school, and diaries from the institution were supplied.

Findings and conclusions

Each investigation was initiated as an individual case study. However, through our recursive reflection analysis method exhibited corresponding findings elicited a synthesized report.

Findings showed emergent play and learning processes in the form of shared situations, i.e. intersubjectivity. Playful experiences were identified occurring within what we have named the Zone of Optimized Motivation. Moreover, the findings pointed at playful engagement without expectations or rules that resulted in creative achievements that offered exploration and expression, which cumulatively motivated the condition of flow.

Reflections and occurrences inherent to each investigation presented two emergent approaches that we consider as holistic, namely recursive reflection and participatory involvement by including those who are closest to the sample to review occasional video sessions as they can observe and input with informed tacit knowledge of an often higher nuance in respect of personal trait.

Aim and background

Paper IV was a critical analysis of a previous project, Humanics 2, which had the aim to produce a home based tele-health training and reporting device for the client that had acquired brain injury. The project ran into detrimental problems in the collaboration with the commercial partner resulting in a curtailed project that did not realize its aim. The issues appertaining to the failure of the project are discussed in context of a reflection on the report with questions asked of the strategies and decisions of those involved towards a refinement of future protocol.

Method

The method used was a qualitative and critical analysis (meta-analysis) of the findings from the original project. Written and visual documentation and interviews were used. The visual documentation (video observations) was analyzed thoroughly. The written documentation was in the form of research protocols from the project, which were analyzed alongside the video material from each of the sessions and focus group meetings.

Findings and conclusions

The system used in the project, named Personics, was intended to give motivating feedback during free movement sessions and during physiotherapist directed sessions. This was planned to facilitate an increase in the participants’ everyday movements.

In the project, the training situation and the testing were evaluated from a narrow physiological and cognitive perspective. Nevertheless, the findings from the critical analysis point toward possible social and contextual interpretations. This opens up for opportunities to broaden the understanding of the result of the project. Through scaffolding
Wood et al., 1976) the participant could learn and internalize the ‘rules’ of the system in order to make his or her own creative contribution. Thus, the participant achieved clarity of the structure and accessibility of the system. Furthermore, findings showed that the training with the system was not able to adapt to meet the participant’s level of competence (which was a prerequisite of the concept that the study was based upon).

The project investigated the potentials of using the system in a home environment. However, the tests took place at the institution, which affected how the participants viewed the system. Additionally, in a traditional training situation it is probably natural that the facilitator provides and guides the participant through the training (this was also observed in the later session video tapes). In the project protocol or design, the participant was expected to be independent of assistance – yet capable of “training” alone or able to operate the system so as to collaboratively “train” with family or friends.

Paper V: Raw emotional signalling, via expressive behaviour

Aim and background

The purpose of the study reported in Paper V was to explore the potentials of interactive environments for people with special needs and those around them. In the study the users were empowered within a volumetric non-invasive interface to actively experience gestural control of sonic events. This interface enables 3D natural movement from head, limbs, torso or digits to be sourced as data that is generated intuitively.

Persons with disabilities enjoy interaction as much as the next person. This may be more so for those with profound and multiple disabilities, and those challenged developmentally, as their social contact is limited. This has been suggested by Clegg (et al., 1991) as because carers are unsure how to interact with these people.
Method
The paper presented a qualitative study undertaken with institutionalized adults with different levels of ability. Most had profound multiple disability. The individuals were empowered to actively control selected digital multimedia feedback content through body gestures. We selected four case studies from our sample of 18 participants to exemplify the findings.

The technical system used for the study was based on non wearable devices that did not encumber the body of the participant, i.e. wireless. The system consisted of sensors that created an invisible volumetric information space – VIS (Brooks, 1999). The sensors were infrared sensor which enabled natural 3D data capture from movement within a volumetric space. Movement in the information space generated output signal data from the sensor. This data was routed to a computer and a sound module/synthesizer. The output of the sound module was routed to a playback system for the participant to audition the sonic response to the participant’s gestures.

In setting up the system there were two main zones of volumetric information capture available for the facilitator to place the participant. The first zone was defined initially for size and sensitivity. The second zone was enhanced through retro-reflective micro-prism technology which activates an additional zone having a trait of reverse polarity. This information space creates an environment for motion capture to data routing which can extend up to 14 meters. This study did not include content of specific games as in e.g. Paper VII. The content was of a more abstract and artistic form, i.e. sonic expression.

All sessions were video taped. The analysis of the sessions involved rigorous manual observation. The video data was analyzed for defining peaks and lulls of emotive indices and labelled through cross reference to the field notes and memos from the session. The video annotation was focused on the subjective emotional signalling, via expressive behaviour (Scherer, 2000), which was influenced by Efron (1972), Ekman and Oster (1982), and Knapp and Hall (1992). The unit of analysis was the artefact-mediated-action. In particular, the focus was on qualitatively different transformations (Burke, 1969) in action. Basic coding was to look at transformations in form of conflict, shared
situation, reflection, and choice related to the participant’s facial and other nonverbal gestures.

Findings and conclusions
The findings showed the raw unbiased response from the participants who were experiencing the interactive environment that was designed with the clear purpose of enjoyment. Action cycles were identified with an initial ‘pensive anticipation’, where the participant indicated recognition of the interactive space. Following the registration of the sounds the participant then joyfully explored; got a surprise; and then focused feedback – the face and hands expressed a concentrated effort. The final phase of the action cycle was defined head realignment and vocal utterances related to the pitch change of the sound patch that the participant was manipulating. This achievement – accompanied by a relaxation of the hands – was followed by a state of rest. Individual variances in action cycles were noticeable. The transformation between inner to outer processes had temporal variance between the cases. The facilitator’s role of optimizing the situation through adapted intervention was evident.

Paper VI: Non-formal Therapy and Learning Potentials through Human Gesture Synchronized to Robotic Gesture

Aim and background
The aim of this study was to explore how children with severe disabilities could use a robotic light system for joyful and interactive play. The children participating in the study were encouraged to play utilizing hands and head. The child’s facial expressions, hand and head movements were the basic unit of analysis.

Robot therapy is not new. Hogan (2000) details the training of an arm of a person disabled by a stroke. The arm is interacting with a device resembling a robotic arm which could measure the force being exerted by the user. Related work in rehabilitation robotics (Cook et al.,
2002) has shown that the development of a robot manipulator could facilitate learning by young children who were generally unable to grasp objects or speak.

Method

The method used was (1) observation of interaction between children with severe disabilities and responsive ‘synchronous to gesture in real-time’ robotic devices as a virtual coach, to determine learning potentials, and (2) a questionnaire to facilitators. The interaction was tailored to each individual. Inclusive participation and a creative design approach were elements of the methodology.

A basic child assessment coding scale for each session was established by asking the carer (1) how the child was perceived at the start of every session, (2) how the child was perceived during the session, and (3) how the child was perceived following the return to the institute. Sensor selection and set up was logged to a user profile. The set up of the sessions was in a large empty room so that the full range of the robotic moving heads could be programmed to extend beyond the users peripheral field of view so that a head movement was required to observe at full extremities.

Video annotation was central to the analysis. The coding system was established for each child and created with assistance from the carer who was familiar with the child’s profile. As best as possible we generalized common expressions among the children that accounted for the fact that each child had an individual faculty of limitation and ability. Typical features such as a smile, a mouth opening, a quieting, an eye focus, a frown, hand or lower torso movement was noticed.

Findings and conclusions

The results were based on the analysis of three “robotic light interaction” sessions with each of the four children involved in the study and the analysis of questionnaires (semi-structured interview forms) answered by four carers. The child’s facial expressions, hand and head movements were the basic unit of analysis. The findings presented the facts that it was useful to apply an inclusive participative analysis of the video material alongside the systematic researcher’s
annotation to understand critical emerging elements in the children’s actions and interactions.

The user (as subject) action intuitively expressed via the mediating tool develops along continuum; from unintentional to intentional, from unconscious to conscious, and from exploration to play (not necessarily congruent). This mediated action involves operation towards a goal (possibly unconscious).

The results pointed to learning potentials from Human Robotic Interaction within a Virtual Environment. The action cycles had a motivating character and through these the child experienced a sense of control and mastery of the therapy situation. The choice of the MiniMac profile robotic intelligent light devices was astute. The units responded with a latency of around half a second which was acceptable but not optimal as our system has 1 ms latency factor. We tested various light gobos (patterns) and colours but could not ascertain if they were making a difference to the child. This is subject of further studies.

Paper VII: Play Therapy Utilizing the Sony EyeToy®

Aim and background

The investigation was carried out in two hospitals in the child rehabilitation ward. The focus of this study was on each child’s dynamic of movements when acting, reacting, and interacting in the gameplaying activity during the sessions. Play was targeted as a strategy for motivating the child in physical therapy participation. The assumption was that game playing using embodied user interaction has evaluand potentials in therapy. The strategy was to target the same immersive engagement that occurs between a child and a computer game, which is often subject to negatively and reverse the polarity of attitude. If the computer game is positively used, it can empower activities beyond the usual limits of the participant through encouraging an immersed ‘play’ mindset rather than a ‘therapy’ mindset.
Method

A triangulation of qualitative methodologies was used:

- Video observations of children playing with the Keep Up EyeToy® game;
- Interviews with children and facilitators;
- Questionnaires (semi-structured interview forms) to the facilitators involved;
- Diaries/field notes from the facilitators involved.

The subjects in the studies were 18 children (10 females and 8 males) between the ages of 5 and 12 years, in 20 gameplaying sessions. The facilitators involved at the hospital were two play therapists and three doctors who selected the children.

EyeToy® games have ‘tasks’ for the participants to accomplish to proceed the game. The task within this game was to keep a virtual football ‘up’ in the air. The virtual environment and all elements exhibited real-world properties (e.g. gravity, directional and dynamic bounce off body part or environment).

In this game a restriction was established as one game sequence was limited to three balls and three minutes.

After three balls, or alternatively three minutes, the game agent turns up and gives the player negative or positive feedback related to the scores of the game. The player can increase or decrease the scores by hitting monkeys and other animated characters with the ball as the game progresses.

The questionnaires to the facilitators involved were in form of semi-structured interview forms and included questions to the facilitators and to the children. As the studies were carried out in two countries (Sweden and Denmark), at two different hospitals, and with different facilitators involved at the hospitals we wanted, in this way, to assure that the same questions were asked at all instances. The questionnaires were translated into both Swedish and Danish.

The video recordings underwent numerous analyses where the units of analysis were the qualitatively different expressions of movement. Annotation was conducted by two coders. The data was classified into the categories of temporal and spatial movements. Automated movement analysis was computed on the videos utilizing software.
modules from the ‘EyesWeb Gesture Processing Library’ specific to the quantity and contraction aspects of the child’s interaction.

Findings and conclusions

The findings from the video annotation of movements showed that aesthetic resonance was indicated partly through the relationship between the intensity and the intentionality inherent to the interaction. Intensity and intentionality was shown through the children’s concentration and also through their commitment when playing the game.

Aesthetic resonance was indicated by the range and shifts in the children’s movements. The categories of speed and fluency did not have any influence on aesthetic resonance as they did not influence the intensity, intentionality, range, or shifts in movements.

In semi-structured interviews with the children concerning their positive and negative experiences of the EyeToy® game the main part of the children expressed positive experiences. 11 of 18 children thought the EyeToy® game was fun, while 4 of the 18 said that they liked it. One (1) child said that the EyeToy® game was difficult, but he also said that the gameplaying was fun. Concerning positive and negative specifics of the gameplay, 7 of the 18 children answered on the interface attributes and 11 children on the activity attributes of the game. In summary, the children’s experiences of the EyeToy® game indicated that the interface supported the gameplaying activity in a challenging way and we conclude that aesthetic resonance was achieved through this challenge. The findings from field notes and semi-structured interviews with the play therapists and doctors underlined the potential with the EyeToy® system in therapy emphasizing flow and fun aspects of the gameplaying as beneficial for the therapy training. This study is again subject of our further exploration.
7 General results and discussion

In the following two sections (7.1 and 7.2) the results from the seven papers on which this thesis is based will be discussed in relation to the theoretical framework presented in chapter 3. The first section deals with action and interaction influencing learning in interactive environment, merely the effects of the participant’s feed-forward (movements). The second section discusses design features that are influencing learning in interactive environments, merely the prerequisites for the feedback from the system (interface) and the aspect of intersubjectivity. On the basis of the discussion of these aspects, an encapsulation of learning and design will be suggested and presented in section 7.3.

7.1 Action and interaction influencing learning in Interactive Environments

In this section some of the main findings from the seven papers will be discussed. The discussion covers the aspects of action and interaction and their bearing on learning in interactive environments, which are: (i) actions in the form of exploration and transition; (ii) autotelic activity and flow; and (iii) aesthetic resonance.

Basic coding was to identify transitions in the form of conflict, shared situation, and choice. The participant’s movements, gestures, facial expressions associated to the head and limb gesticulations that afforded the interaction with the system were the basic unit of analysis.

The study presented in Paper (VII) conducted a manual analysis of tempostatial movements. The temporal specifics concerned rhythm as a periodic repetition and included dynamic kinetic change as well as structural patterns. Examples of temporal events were the qualities that were in play when the participant affected the ball from one spot to another by swinging the body/hands or arms to and fro. The repetition
of a movement developed a sense of enjoyment and engagement of the activity, which, in turn, motivated the child to continue to experience the movement. More specifically the temporal data was classified into discrete units for analysis by applying the specifics of speed, intensity, and fluency of movements (Laban, 1963; Efron in Ruesch and Kees, 1970). The spatial specifics concerned where the body moves through extended movements towards another situation in the spatial environment. Example of spatial events were the qualities that were in play when the participant sought another situation in the spatial environment, e.g. moving like jumping or leaning the body from one side of the screen to the other whereby the central area of the child’s body was transported to a new position when keeping the virtual game ball up in the air. The spatial data was classified into discrete units for analysis by applying the specifics of range and intentionality of movements (Laban, 1963; Efron in Ruesch and Kees, 1970). Alongside with these tempospatial qualities children’s facial expressions and utterances were analyzed.

**Explorative action through the mastery of tools**

It has been shown in previous research that explorations are involved in the mastery of tools and in the growth of competence (Beach, 1942; Bruner, 1973). This is supported by the content in Papers III and VI. In the study presented in Paper VI, the children were dynamically exploring what was occurring as a result of their empowered control. Their discovery of the interactive space involved range, speed, and directional variation of their gestures. Two of the children especially indicated an early awareness, observed as improved eye-to-hand coordination and concentration, which was a result of the direct correspondence and control to the physical movement of the robotic head and the subsequent movement of the light. Such self-achievement is a rare commodity for these children. Their reaction to the light and the sound (from the physical movement of the robotic head) was an instant exploration followed by cycles of actions (gestures). This phase was followed by more thoughtful exploration of the environment. After a number of gestural cycles additional features came into play, primarily based on the participant’s conscious use of the ‘silent space’.

In the study presented in Paper III the parent informed of the participant’s liking for music which had developed over the years. The
music therapist working with the participant informed that by participating in the interactive sessions the participant had developed skills towards attempting to control a digital drum instrument patch so as to play in the band with his friends. The participant’s mother remarked that his utterances following the musical tones he was playing in the interactive environment through his movements, something his mother had never heard him do. This is relative to Beach (1942) who emphasizes that the absence of negative consequences encourages exploration, which can result in the development of unemployed skills.

This can also be applied to the parallel findings in Paper III, where the children with social and behavioural disabilities felt so safe and relaxed so that, for example, they closed their eyes in front of everybody when they were asked to do so, without any questioning or unwillingness. They were not disturbed that the rest of the children were playing around them, which would normally disturb them. They were engaged in the interactive situation without expectations or rules, which resulted in creative achievements through exploration and expression. Cumulatively, this fact motivated the condition of flow through observed concentration and engagement. The children played within the space for 10 to 15 minutes each, and had to be interrupted so that another child could try. The sense of safety within the environment and the concentrated interaction is exemplified through the following quotation of the therapist:

We have never seen anything like that before, that they have allowed such things with strangers. But the most amazing was, that they entered a meditative state and excluding the arm by which they were guided, their bodies were relaxed and completely calm.

The children involved in the study are characterised having difficulties in managing impulses, which means that they often act out and impulse out without consideration of consequences. They also had limited trust in themselves and others, especially unknown persons. In a written response to the sessions at the school, the children’s teacher said that it was notable that the children broke these patterns when they were within the interactive space.

Through exploring the interactive environment the participant could acquire new abilities, interactions, expressions and emotions, enabling a mastering of tasks and practicing of skills. As such, explorative
actions in the interactive environment, i.e. the feed-forward-feedback-loop, created action cycles that had the potential to evoke the child’s interest in practicing otherwise limited skills, which is vital in facilitation of achieving an optimal experience. Thus, I would like to suggest, that through practicing of skills the participant experienced a sense of control and, thereby, mastery and consciousness of the therapy situation and beyond. Mastery and the sense of control are important prerequisites for the experience of empowerment.

The immediateness of the feed-forward-feedback-loop, i.e. the participant received an immediate response relative to his or her actions, encouraged exploration. This was so in Paper V, where the participant, Beata, once she entered the interactive space immediately signalled recognition that her actions were influencing the sounds and subsequently she physically explored through rocking back and forth in her wheelchair over long extended periods. In the sessions often the wheels of the chair had to be secured because she was so engrossed and physically expressive of the empowerment in the situation.

Transition of actions

As described by Bruner (1973) the initial patterns of actions become the constituents for new patterns of action through exercise. Wertsch (1998) extends this theory by emphasizing that the introduction of mediating tools creates an imbalance in the systemic organization of the action, which enhances changes in the action. This can result in new forms of mediated action. Findings from the studies presented in Paper III, V, VI, and VII demonstrated individual variation in action cycles. The participant John (Paper III) showed through his facial expressions that he went through different phases of interaction where intense concentration was balanced by relaxation, yet all aspects of the physical movements were intentional within his limits. The early sessions with the participant Mats (Paper V) had instances of significance where Mats’ actions signalled his desire to participate more fully with increasingly extended instances of hand gestures. The participants involved in the study presented in Paper VI varied the range, the speed, and the direction of their gestures. The spatial movements by the participants in the study presented in Paper VII demonstrated variations in actions through range, intentionality, and shift of gestures. This is similar to the Zone of Proximal Development (ZPD) (Vygotsky, 1978)
and emphasizes that the support from the system encouraged the
participants to reach beyond their limits; thus, achieving an extenuation
of the participant’s potentials.

These findings show that the transition of actions cannot solely be
explained by the human afferent-efferent neural loop (stimuli-response
chain) as described by Scherer (2000), which is too narrow and
instrumental so as to understand the learning and development that
takes place in interactive environments. Apparently, the application of
Bruner’s model consisting of the patterns of action in connection to the
intention with the action and the feedback (feed-forward-feedback-
loop) offers a more holistic approach to interaction including the aspect
of the individual’s competence growth.

Thus, I suggest that the transition became apparent through the form
of creative actions. I see a differentiation between creative and routine
actions, where the creative actions are connected to the possible and the
routine actions are connected to the existing. The functions of creative
actions are the generation and creation of something new. Creative
actions are not only characterized by motives, goals, and operations,
but also by acts that generate new motives, goals, or operations (see
also Tikhomirov, 1999). By facilitating a safe environment creative
actions are enhanced within the interactive space as an important
prerequisite for non-formal (unintended) learning processes. By this, I
see action cycles as precondition for playful engagement.

Traits of autotelic experience
In his writings Vygotsky (1981) has pointed to play as a source of the
child’s development through the Zone of Proximal Development (ZPD)
which is defined by the distance between the child’s actual level of
development and the potential level of development. Csikszentmihalyi
(1991) characterizes play as a precondition to flow, which means an
integration of physical, emotional, and mental functions. This was
supported by the play activities as described in Papers II, III and VI.

As emphasized by Bruner (1972) exploration goes hand in hand with
play, but is not the same as play, rather explorations serve as a
precondition to play. This is exemplified by the findings presented in
Paper III where the system offered exploratory and expressive
elements, which was defined as an activity in which the participants
were engaged in for fun and for their own sake; just like play situations – without expectations or rules. The participant John was controlling a digital sound patch through movement of his cheek in the volumetric 3D space. Both the parents and the music therapist involved underlined that through the experiences of control John was able to choose by himself, e.g. when to start and stop the music. This fact was motivating and even after the session had been concluded, with the camera still running, the parents noticed that he was still working hard to keep playing. Rogoff (1990) underlines that interest has a motivating character that channels the child’s choices involved in ‘doing’. By this, the interest had an immediate character, which places the participant in the midst of the play experience; that is to say that the participants became absorbed by the ‘here and now’, as in a flow state. As pointed to in Paper III the findings demonstrated play in the form of creative achievements originating from explorations and expressive elements that motivated the sense of flow.

As such the interactive play situations indicated an enhancement of the quality of play and learning, which, in turn, facilitated engaging explorations that were utilized in the therapy. This is to say that play had a motivational potential achieved from the interactive environment, which was apparent through the participant’s concentration when interacting within the interactive environment. The assessment of the contented happiness factor is that it may have been from the empowered activity resulting in achievement of control for the participant whereby the success factor, often unattainable from persons with severe disabilities, was contributing to their emotional self-esteem.

The participants in the study presented in Paper VI showed engagement in every session through an observed concentration and awareness of intent. This awareness was connected to the participant's possibility to experience a sense of control from the interactive play. For example, the participant had the opportunity to control if he wanted to interact or to “rest” within the “silent” space, which was available, i.e. no interaction. This is comparable to the findings presented in Paper III, i.e. the ability to control encouraged play originating from exploration. This is exemplified by one of the participants who was asleep upon entering the interactive space in one session. Slowly he awoke and explored with playful head movements that were mapped to the control of the robotic device. Accordingly, the participant exhibited
a swift understanding of how to best control his movements and gestures in order to meet the challenge involved. The carers noted that the participant enjoyed this challenge as they developed skills in his physical manipulation of the robotic device. The sessions followed a recurring pattern similar to the subject of play, where exploration gave way to play the emphasis changes from the question of “what does this object do?” to “what can I do with this object?” The study (presented in Paper VI) showed that along similar lines the sequence was hereby extended with further emphasis change of “when I move – I hear sounds;”, “when I move – the light patterns move;” “when I stop moving I hear neither sounds or see the light patterns moving!” /…/ "Hey, I am in control here – and it is fun!” Observations further suggested that this emphasis was extended to “well, nobody told what I should do or for how long, so I will just have more fun with what I have learnt I can do with this object!” The sessions were ongoing until the participant signified cessation through a reduced engagement.

Previous research (Csikszentmihalyi, 1991) points to the characteristics of the flow state as being absorption in the activity, i.e. the activity become almost automatic, which allows the participant’s consciousness to melt together with the actions. Leont’ev (1981) describes actions as consciously performed and operations as unconsciously and automatically executed. My definition of the consciousness and the unconsciousness in actions and operations are relative to Csikszentmihalyi’s approach. This is relative to the fact that in my research I distinguish operations not as unconscious in a routine-sense, but rather as an explorative, creative and absorbed act. In this sense, Leont’ev’s (1981) definition is too static. This is exemplified in the study presented in Paper VI where the participant’s action intuitively expressed via the mediating tool developed along a continuum; from unintentional to intentional, from exploration to play, and from unconscious to conscious to unconscious actions (not necessarily congruent).

All in all, these results point to non-formal learning potentials from actions and interactions within interactive environments. I consider play as a crucial foundation for non-formal learning and it was evident in the findings that the interactive play was closely connected to learning aspects exemplified mainly through the effects of the participant’s feed-forward (movements) resulting in self-achievement,
which is commonly rare for individuals with severe disabilities. The findings pointed to the components of (i) the merging of action and awareness (ii) concentration, (iii) and the melting together of actions and consciousness. The fourth component of flow, according to Csikszentmihalyi (1991), concerning the transformation of time was indicated by the facilitators in the form that the participants tended to continue to interact until they were more or less exhausted even after the end of the session.

Traits of aesthetic resonance

Findings from the participant’s exploration and play within the interactive environment pointed towards awareness and enjoyment as the interaction empowered them to manipulate the technical device. The physical relationship of synchronized participant movement within the interactive space reinforced the participant’s actions. This finding was supported by the studies presented in Papers VI and VII. I argue that this reinforcement of actions is directed by the participant or by the facilitator’s concern with overcoming of restrictions and with the development of new and improved actions. In the study presented in Paper VII findings showed that the participants’ use of the body when navigating within the computer game environment as well as the immediate feedback in the form of game content had the potential to reduce the physical load in the daily physical rehabilitation. Findings reported in Paper VI emphasize the immediate feedback that supported the participant to incrementally push their movement limits. These aspects of the physicality and the feedback relative to reducing the physical load in the therapy situation are not fully elaborated in the theories of ZPD (Vygotsky, 1982) and flow (Csikszentmihalyi, 1991). These theories emphasize the distance between what is learnt and what is to be learnt (ZPD) and the balance between the challenge and the individual’s skills (flow) as has been discussed in the previous subsection. This is the reason to why the concept of aesthetic resonance (Brooks et al., 2002; Brooks and Hasselblad, 2004) has been applied within this thesis. As described in section 3.3.3, the sense of aesthetic resonance, as applied in this thesis, refers to a situation when the feedback is immediate and aesthetically pleasing as to make the participant forget the physical movement involved in the conveying of the intention.
The findings from the video annotation of movements presented in Paper VII showed that aesthetic resonance was indicated partly through the relationship between the intensity and the intentionality inherent to the interaction. Intensity and intentionality was shown through the children’s concentration and through their commitment when playing the game. Aesthetic resonance was indicated by the range and shifts in the children’s movements. A general result was the faces of the children giving a defined statement of aesthetic resonance in the interaction with the content of the game, which was mostly pleasing and a challenge for their skills.

In semi-structured interviews with the children concerning their positive and negative experiences of the EyeToy® game the majority of the children expressed it as a positive experience. 11 of 18 children thought the EyeToy® game was fun, while 4 of the 18 said that they liked it. One (1) child said that the EyeToy® game was difficult, but he also said that the gameplaying was fun. Concerning positive and negative specifics of the gameplay, 7 of the 18 children answered on the interface attributes (such as the use of the body, to move, immediate feedback that mirrored the movements made by the participant) and 11 children on the activity attributes of the game. In summary, the children’s experiences of the EyeToy® game indicated that the interface supported the gameplaying activity in a challenging way and it was concluded that aesthetic resonance was achieved through this challenge.

My conclusion from this is that the use of the body in the interaction was motivating and created curiosity among the participants so as to continue their play and to practice their otherwise limited skills. This extends the concept of autotelic activity to also embrace the concept of aesthetic resonance. Berlyne (1950) refers to interactions such as reported in this paper as *instrumental exploration*, motivated and learned by the cause and effect and *surprise exploration* awaked by pure and simple novelty. This is to say that the instrumental and the surprise exploration achieved from the interactive environment are relational as forms of motivation due to the novelty (see also Berlyne 1950).
7.2 Design features influencing learning in Interactive Environments

In this section the main findings from the seven papers are discussed. The discussion covers design features that influence learning in interactive environments. That is: open-ended interfaces; adaptation of the system through facilitator intervention; and situated activity.

Open-ended interface

Previous research has defined the quality of intuitiveness as a crucial usability factor so as to be easy to learn and use (Bærentsen, 2000). This finding is supported by the studies presented in Papers III, V, and VI, where the participants put fewer loads on the participants’ cognitive processing through the immediate and aesthetically adapted feedback from the system used in the studies. The participant John (Paper III) had a very limited range of movement of head, hands, and fingers. The main result from the sessions was that he was enabled to enjoy and express himself with his limited movements. Two of the participants in the study presented in Paper VI indicated an early consciousness relative to the direct correspondence to the movement of the robotic head. This was afforded by the simplicity of the system and setup which enabled the desired short learning curve exhibited by John. This can be exemplified by the description of an action cycle that developed within one session (described in Paper V): Each action cycle lasted on average three to four minutes segmented by a distinct pause. The <Start of action cycle> image, tagged ‘pensive anticipation’, was where the participant indicated recognition that an interactive space was being set up with a sensor for him to manipulate sounds with his head. Following the registration of the sounds he then joyfully explored; got a surprise; and then focused on the feedback – his face and hand expressing a concentrated effort. His final phrase in the initial session phase was defined head realignment where his vocal utterance was recognized by his parents in a video interview as being related to the pitch change of the sound patch he was manipulating via his head movements. This achievement was followed by a state of rest <End of action cycle>. Accordingly, these findings also suggest that the non-intrusive interface of the system used within this thesis influenced the intuitive and easy-
to-use character of the system as the interface enabled the participant to freely interact and explore within the responsive space.

Findings presented in Paper I showed that tactile, visual, and audio feedback encouraged exploration and gestures, which was identified as open-ended features of design through the alternative opportunities in the interaction that was offered through these different modalities. Affordances in the form of shapes and surfaces offered information and creative values for the interaction. The findings presented in the previous paragraph (relative to findings from Papers III, V, and VI) add to the fact that the situation within the kinesphere (Laban, 1963) – augmented as a volumetric information space where the participants’ gestures were mapped, translated by the interface as control data to respond with selectable multimedia content manipulation in an immediate manner – clearly offered invisible affordances for the participant to act upon (feed-forward). This fact was enhanced by the non-intrusive interface, which, according to Bolter and Gromala (2003), offers the qualities of transparency and reflectivity through the mirroring of the participant’s complexity of needs and desires. Thus, I conclude that the invisible affordances of the interface exhibit a tactile character through the manipulation, both direct and immediate, encouraged the participant’s actions within the space. This extends the definition of an open-ended interface to also embrace the invisible gestural modality of the system.

Adaptation of the system through facilitator intervention

The findings presented in the Papers II, III, V, VI, and VII indicate that the implemented intervention strategy has the potential to support the emergence of new and improved forms of actions and interactions in design of therapy. The facilitator facilitated the participant’s optimal experience of the interactive play through the adaptation of the interactive space. This situation empowered the child to meet the challenge (see also Csikszentmihalyi, 1991). Thus, in interactive play there is a fit between the skill level of the child and the challenge offered by the interactive application. Interactive play empowered through the facilitator’s intervention offered a play experience where the children were able to experience an autotelic state that facilitated mastery and growth.
One contradiction became apparent in the study presented in Paper IV where the findings showed that the multimedia feedback from the system (abstract and concrete visuals and sound) was not able to adapt to meet the participant’s level of competence (which was a prerequisite of the concept that the study was based upon). This was due to technical difficulties in registering and processing the movement patterns in real time. This resulted in frustration and boredom through continuously interruptive acts or routine acts among the participants. The system used in the study was intended to give motivating feedback during free movement sessions and during physio-therapist directed sessions. This was planned to facilitate an increase in the participants’ everyday movements. During the free movement sessions the participants were supposed to interact without requirements, rules, or expectations. However, as the participants had not learnt and internalized the “rules” of the system they were not able to contribute and interact on their own due to the lack of clarity related to the system and to the free, non-directive, sessions. In the study presented in Paper II, the findings showed that clarity in terms of creating conditions that are clear, simple, challenging, and emotional created a respectful and creative atmosphere. It was also emphasized that an adaptation to the respective individuals was necessary so as to give them the opportunity to join the activity at any time.

This points to Leont’ev’s (1981) three level model of the activity (activity, action, and operations) and his definition of the components of action: (i) the subject; (ii) the object of action; (iii) the mediating tool; and (iv) the goal, which was extended through a division of the mediating tool into two parts: (i) the outside agent; and (ii) the technology/system. The meta-analysis of the findings presented in Paper IV, showed that the project was performed on the basis of a narrow theoretical and methodological foundation (including merely the first three (i-iii) components of the action in Leont’ev’s model and excluding the contextual dimension of his three level model). This resulted in that social and contextual aspects within the project was foreseen, or at least seen as secondary. I argue that one of the reasons to the failure of the project was the foreseeing of these aspects (the second reason to the failure is emphasized below the next subsection – Situated activity).
Intervention was a necessary prerequisite in the studies presented in Paper III, V, and VI, so as to adapt the feedback content to fit the specific participant. The adaptation was based on idiosyncratic tendencies (user profiles), a necessary approach when working with people with different abilities. This is exemplified in the study presented in Paper VI where a basic child assessment coding scale for each session was established by asking the carer (1) how the child was perceived at the start of every session, (2) how the child was perceived during the session, and (3) how the child was perceived following the return to the institute. Sensor selection and set up was logged to this user profile.

Findings from the study presented in Paper III showed that intervention was necessary in the participant John’s case and was positively commented upon by the parents and the music therapist. The music therapist remarked that the system is just working if you have the right person behind it, as is crucial to notice and capture very small details in the interaction, and as this is what can optimize the use of the technology. The facilitator’s optimization of the situation was shown in the study presented in Paper V, where the facilitator was important as an active inter-agent who actively reflected and interpreted the situation to make conscious choices to overcome constraints and encourage empowerment. Furthermore, the findings show that the interventions performed were adapted to the specific participant. The participant Beate required no intervention at all during the session whereas the participant Hans required intervention in the form of guidance. This guidance is supported by Wertsch’s (1985) theories on intersubjectivity and the transfer of responsibility for the task towards intrapsychological functioning. In the first segment of the session Hans was guided by the facilitator; she actively took his hand and guided him within the interactive space. In the second segment of the session Hans was functioning independently and the facilitator reassured him that what he was doing was correct; he was guiding the facilitators hand as if he had learnt a new thing and wanted confirmation on his understanding. In the third segment of the session Hans has taken over the responsibility for the performance of the task (acting/feed-forward in the responsive space). An intersubjective relationship between Hans and the facilitator was created in the definition of the situation, which I determine as a symmetric intersubjectivity with an inherent intra-
subjective process. He showed that he had mastered the situation. The emphasis in this thesis on intersubjectivity referring to the creation of asymmetri in the situation was supported by the findings from the study presented in Paper III. It was evident that when the participant John started to lose interest a simple change of sound patch or feedback regained and kept his interest for another subsequent period.

The aim of the study presented in Paper II was to support parts of the community from areas traditionally considered as non-productive and dependent on state aid to achieve greater involvement in productive social relations. The project was centered on processes designed to encourage creativity and participation in which those involved developed design ideas into new products. The objectives included the creation of conditions for participants with special needs to experience cooperation designed as participation that was based on a relationship between the participant, the facilitator, and the researcher, so that the participant could develop a trust in themselves and others as partners and experts. The methodological approach that was used was based on participation and involvement as the main elements in the process. The reason for including this study was that it was focusing upon the role of the facilitator in the creative process, and also, that the study took aspects of empowerment into consideration.

My role in the project was to evaluate the project aiming at defining a methodology encouraging co-operation that was designed as participation in order to achieve greater involvement in design- and product development processes, regardless of an individual's age, social status or handicap. The results showed that the relationship between the participant and the facilitator was crucial for all the participants in respect of their motivation and creativity. This was applicable across the entire sample of the study. Co-operation and participation were the two main topics that helped the participants in realizing a sense of empowerment. The important aspects of the findings were all based on the participant’s trust in the facilitator as well as their own reflections on their own augmented influence, and competence development. These findings are relative to the findings presented in Papers III, V, and VI where the participants experienced safety and control when they interacted within the responsive environment, which empowered them to make their own choices. The connection between these studies is supported by Latour’s (1991)
‘actant’ theory, where he emphasizes that other people as well as objects are equivalent as actants from the individual’s perspective.

The main point is that these aspects of intervention, including (i) adaptation of the system, (ii) creation of user profile, (iii) and intersubjectivity, represent different levels of practice and realization. Each of them contributes to the quality assurances based on the facilitator’s judgements in and on action (Löwgren and Stolterman, 2004).

**Situated activity**

As emphasized in the findings presented in Papers II and IV the question of *where* the activity takes place influences the targeted achievements. In line with Lave and Wenger (1991) and considering the study presented in Paper II the “where” implied a consideration of the complex relationship between the individual, the activity, and the contextual environment as mutually integrated. Together these aspects created the basis for the trustful relationship between the participants themselves and between the participants and the facilitators.

The findings presented in Paper IV investigated the potentials of using the interactive system in a home environment. Nevertheless, the tests that were undertaken within the project took place at the rehabilitation institution, which, in consideration of Lave and Wenger’s (1991) theories on the “situated”, influenced the results of the project. Jönsson (2006) discusses how cognitive processes are influenced by cultural and social circumstances concluding that they cannot be studied under simulated conditions. To study a home-based system in an artificial environment influenced the participant’s perceiving of the system and of the activity. The artificial environment (i.e. the rehabilitation institute) created different expectations on the use of the system and different questions due to the situated activity. For example, in a traditional training situation at the rehabilitation institute it was probably natural and in order so that the facilitator provided and guided the participant through the training session. In the project protocol, however, the participant was expected to be independent of any assistance – yet capable of “training” alone or able to operate the system so as to collaboratively “train” with family or friends.
Vygotsky’s (1978; 1981a; 1981b), Leont’ev’s (1981; 1982), and Wertsch’s (1985; 1993; 1998) theories on activity were developed in order to analyze and understand the role of actions and interaction in the learning when using interactive environments for people with different abilities. For mediated interactional actions as described in this thesis, they were helpful. On the other hand, this perspective was limited when it came to the understanding of the aesthetic resonance and playfulness issues that are involved in the interaction, therefore the activity theory has been extended with additional concepts: (1) Brooks’ (et al., 2002; Brooks and Hasselblad, 2004) definition of the concept of aesthetic resonance, (2) Bruner’s (1972; 1973) term of exploration, (3) and Csikszentmihalyi’s (1991) concepts of autotelic activity are the extensions of my theoretical foundation. These theories and concepts are gathered within a framework, which I have named non-formal learning. In order to posit my concern that theoretical perspectives and analysis should reflect a larger set of issues, a chapter (number 2) is included where mainly (4) theories on usability are elaborated (e.g. Löwgren and Stolterman, 2004). In the following section these theories are applied to the results presented in this chapter (number 7), in order to provide an understanding of the encapsulation of learning and design in rehabilitation.

7.3 Encapsulation of learning and design

Previously in this thesis it has been argued that the interactive environments used in this thesis can be seen as a specific accessible technology allowing movement empowered by non-invasive technology. In this section an encapsulation of learning and design features within an interactive environment is presented through a model which, on the basis of the findings presented in the previous sections and the theoretical framework presented in Chapter 3, describes the state and space of optimized motivation.

The model which is proposed describes non-formal learning in interactive environments based on Csikszentmihalyi’s (1991) theory on flow, Leont’ev’s three level model of activity, and Vygotsky’s (1978) theory on the Zone of Proximal Development (ZPD) in learning situations, and modified in order to better describe the processes that
are dealt with here. The model was applied to better understand the findings from the individual empirical studies, but also to be able to take these findings a step further and develop a more comprehensive understanding of design for non-formal learning in interactive environments.

To reiterate my earlier position I again relate that according to Leont’ev the individual action has four components: (i) the subject; (ii) the object of action; (iii) the mediating tool; and (iv) the goal. In section 3.2.1 this model was extended on the one hand by a division of the mediating tool into (a) the outside agent, and (b) the technology/system. On the other hand, the model was extended by the implementation of the three points of mediation into a model of intervention. This was between (1) the subject and the outside agent (intersubjectivity); (2) the subject and the system; and (3) the self-system-self (intrasubjectivity). The model has been further elaborated in order to describe interactions in responsive environments and their bearing on learning and design. This elaboration includes the dimension of aesthetic resonance. The elaborated model (Figure 7.1) describing actions and interactions in interactive environments does not differ much from the modified model based on Leont’ev’s theories on mediated activity (presented in Figure 3.4). This elaboration is achieved through supplementary elements that augment specific composites relative to the action and interaction aspects of the model. These elements are described in the next section. As mentioned earlier in this thesis, the mediated action according to Leont’ev (1981) and Lave and Wenger (1991) are associated with specific situational structures at the activity-level.
Figure 7.1 illustrates the boundary of the zone of optimization by a circle that contains the activity. This zone contains the on-going action cycles (feed-forward-to-feedback loops) between the subject and the system as well as the continuous interventions from the outside agent to the system. These interventions can cause an ambiguity in the situation due to the fact that the goal of the action is equilibrium for a moment.

The outside agent makes on-going judgements in and on the situation, i.e. when to intervene and how to adjust the multimedia feedback to fit the subject’s wishes, desires, and level of competence. In this way the challenge with inherent surprises for the subject becomes optimal. The ambiguity in the situation is in the creating of asymmetry, however, in this thesis is still considered as a part of the intersubjective functioning. Bakhtin’s (1994) dialogic concept of polyphony is representational of what is being approached in this situation. In other words, through the intervention more than one voice in the communication is active, the
outside agent’s through the intervention, the subject through the feed-
forward, and the system, which represents a distinct voice through the
feedback (which is not interrupted in fluency due to the intervention).
This can be thought of as a jointly created dialogue. When an increased
level of shared situation takes place (see Wertsch, 1985) a transfer of
responsibility of the task is accomplished; i.e. the intra-subjective
process. The ZPD is defined as the distance between the actual level of
development, - which is determined through the child’s own way of
solving problems - and the potential level of development, - which is
defined through guidance of the adult (Vygotsky, 1978).

Outside the borderline is a zone representing the aesthetic resonance
grow zone and the edge zone, which is relative to the ZPD (Vygotsky,
1978) in that the support from the outside agent and the system as
mediating tools in order for the subject to reach beyond his or her limits
is emphasized. The zones are also relative to Csikszentmihalyi’s
prerequisites of flow. The results from the subject’s experiences in
these zones are relative to Csikszentmihalyi’s components, as described
previously (section 3.3.2), which describe the effects of the flow state
and the flow characteristic of absorption. In the aesthetic resonance
grow zone the subject’s consciousness is unified, i.e. integration
between physical, emotional, and mental functions is achieved. The
factors of challenge and surprise augment the state of flow into the state
of aesthetic resonance.

The final addition to the original model is the intrasubjective process
according to the outside agent. The outside agent is involved in
multifaceted judgements and responsibilities. He or she is not only
focused on achieving the activity, but also on the minimally required
intervention (adaptation of system and/or guidance – physical or
verbally) so as to best maintain the subject’s interest and engagement in
the situation. An understanding relative to the importance of interest,
curiosity, and enjoyment are inherent as resources for learning. This is
to say that the outside agent is engaged in a gradually learning of the
situation through the reflections in and on the situation.

According to Tikhomirov (1999) the model is representational of
creative processes rather than as a sequential routine as the participant
within the activity situation is involved in exploring and extending their
skills, intentions and ideas. In other words, they are engaged rather than
solely passively receiving; this is relative to the requirements for
human learning. Thus, my preference is to create the conditions and design the activities that most likely will lead to the desired learning I have in mind. In terms of Rogoff (2001) this should be focused upon the qualities as integral to the experience that leads to learning. To do this, activities that encourage actions and interaction are designed. The problems that can occur when designing these activities have been discussed in the previous section (7.2) and are all relative to the need of a more holistic view on the complex situation. This complexity is illustrated in Figure 7.2 below, which is an extension of the model for optimization of the activity (Figure 7.1) so as to point up the composition of learning and design in interactive environments.

![Figure 7.2. The composition of learning and design in interactive environments](image)
The learning within and the design of the interactive environment constitutes a situated activity, with inherent actions and interventions. The goal of action is established according to the user by the facilitator determining a user’s initial profile, which is incrementally refined as a result of session analysis. The profile influences the facilitator’s decisions on how to set up the attributes of the virtual environment relative to the desired learning process and the expected outcome of that process. Once these prerequisites are set, the user is expected to experience as a result of the interaction as well as from the learning. These decisions influence the learning process and the outcome of that process. All in all, this is an iterative process, which supports a holistic view on the design of interactive environments towards learning. The iterative process also supports the prerequisite to meet the user requirements when developing the user profile so as to integrate the knowledge and the expertise from different fields and levels.
8 Conclusions

The aim of this thesis was to understand the role of action and interaction in the learning involved/targeted when using interactive environments for children and young people with different abilities, and to conclude at tentative generalizations on design for non-formal learning in interactive environments. The studies (presented in Papers I-VII) that form the empirical basis of this thesis is based upon the investigation of different aspects of my concept.

A theoretical model is developed to encapsulate the intricacies involved (Figures 7.1. and 7.2.).

The model which is proposed describes non-formal learning in interactive environments based on Csikszentmihalyi’s (1991) theory on flow, Leont’ev’s (1981) three level model of activity, Vygotsky’s (1978) theory on the Zone of Proximal Development (ZPD) in learning situations, and the concept of aesthetic resonance (Brooks et al., 2002; Brooks and Hasselblad, 2004). This model which involves modification to these theories was applied to better understand the findings from the individual empirical studies, but also so as to be able to take these findings a step further with a view to develop an in depth comprehensive understanding of designing for non-formal learning in interactive environments. My expectation is that the model can become a useful analytical tool for further studies in the applied use of interactive environments.

Multimedia feedback was synchronously manipulated from sourced data movement information from each participant. The data was sourced through invisible volumetric non-invasive sensor technology. The results highlighted positive effects of the interaction within the responsive environment by those with severe disabilities and conclude at the potential of the concept as a supplement to traditional therapy techniques. Furthermore, the results highlighted the intervention strategy with the facilitator as a key person and having a prerequisite
for targeting the participant’s motivated engagement and ludic experiences.

The model constitutes a foundation for the contemplation of design issues that have emerged as having a generic outcome that offers opportunities and potential for other interactive environments that have been designed as remedial play environments for children with severe disabilities.

The attributes of the technology and of the interactive environments supported non-formal learning and I reflect on the central principle of learning without expectations or rules: creating interactive environments that build upon and is influenced by the participant’s interest. The inherent learning and therapeutic activities are involved in the session are planned through adaptations so as to meet the individual participant’s competence level, needs, and desires. Interventions create opportunities for the facilitator to learn from his or her own involvement as they support and encourage the participants to learn. The non-formal learning framework used in this thesis emanates characteristics of learning through curiosity and ludic engagement and I posit that these can assist in designing approaches to formal settings and locations by:

- Unintended but adapted learning with clear goals;
- Assessing progress whilst using the body when interacting in the interactive environment;
- Taking responsibility (from inter- to intrasubjectivity);
- Making choices.

The main contribution of this thesis is that through the model and the synthesized factors that influence actions and interaction in interactive environments it is hypothesized as being possible to reveal the complexity in the interactive situation. The revealing process is by iteratively exposing the part from the whole and then to study the parts separately and in relation to each other, and, subsequently to reflect again on them in consideration to the whole. This is an act of iterative reflection and analysis. Using this approach, interpretations and understandings can be made and differences in impact of using different feedback to the user can be examined.

Thus, in closing, I state that it is not possible to capture or describe other peoples’ experiences, nor is it possible to understand the world
exactly like it is for others. However, it is possible to strive from the perspectives of our own lives to understand how the other person experiences something and then to compare it with situations we are aware of from our own experiences.

The short-term studies and the small samples that formed the basis for the studies referred to in this thesis imply a need for extended empirical long-term studies in order to study the potential of using interactive environments for participants with severe disabilities and the lasting value which is currently evaluand. Further, models are also in need of development which I envisage as evolving from those presented in this theses. Supplementing these models will be appropriate techniques to develop models of application. Furthermore, there is a need to develop appropriate techniques of measurements and instruments that are optimized to obtain the needed results wherefrom the total impact of the research will be in evidence.
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Virtual and Physical Toys: Open-Ended Features for Non-Formal Learning

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ABSTRACT

This paper examines the integrated toy—both physical and virtual—as an essential resource for collaborative learning. This learning incorporates rehabilitation, training, and education. The data derived from two different cases. Pedagogical issues related to non-formal learning and open-ended features of design are discussed. Findings suggest that social, material, and expressive affordances constitute a base for an alterative interface to encourage children’s play and learning.

INTRODUCTION

Toys play a crucial role in supporting children’s learning and creation of meaning in their everyday life. Children also play with toys out of an interest to interact with others. Although electronics have been deployed in tools for play and learning, most have facilitated individual learning. Traditional toys, on the other hand have features that encourage both solitary and social play.1,2 In this paper, we explore pedagogical potentials of new technologies and traditional toys integrated into a physical and virtual toy system (hereinafter called integrated toy) with specific focus on the open-ended toy and non-formal learning, to study collaboration among children.

Open-ended toy

An open-ended toy is characterized through its multiple opportunities for manipulation and forms of play. The idea of using tangible interfaces to support children’s play and learning has been adopted in previous research on computational toys3 and collaborative environments.4 The open-ended features of the integrated toy could be described in terms of alteration, which includes a process of transformation,5 i.e., movements across different modalities. The different modalities in this paper are considered as semiotic resources, which are organized as choices based on the child’s interest in the situation.6–10 Consequently, each part of the integrated toy provides different communicative affordances,11 which enable action concerned with the emergence of “new and improved forms of thought.”12

Non-formal learning

This paper focuses on non-formal learning processes that begin from children’s interest and curiosity, that is to say, a non-formal learning perspective based on the child’s sense of being competent in a collaborative environment.10,12 Play motivates learning and training if it offers the children complex and challenging experiences with direct feedback,13 which is similar to autotelic activity that is carried out for its own sake by inner goals.14 Previous research points out curiosity, the desire to show oneself and others the ability to act, and the
attempt towards common goals together with others as internal motives to learn. The integration of the physical and virtual dimensions of the toy carries an adjusted support for the child to reach a level of mastery. The process of support is named “transfer of responsibility.” In view of that, we have coined the name “Zone of Optimized Motivation” (ZOOM), which refers to a state of immersion and concentration within a space where non-formal learning occurs. A main point we would like to make here is that this is an area where rehabilitation and education has an opportunity to expand children’s skills substantially, particularly so, as play is so closely related to intrinsic motivation.

It is argued that mediated action has multiple and simultaneous goals. In the framework of this paper this means that the child’s interest of using the integrated toy system may differ or be in conflict with the interests built into the system. Mediated actions depend on the materiality of mediational means, and by using them, the child develops a mastery of them. The performance into mastery is important for the child’s competence development, and children’s play with toys together with other children implies an important peer interaction and scaffolding performance. Thus, an integrated toy should have inherent opportunities for children to explore and solve problems together with other children.

METHODS

The methodological approach was qualitative, inductive and based on case analysis. Three kinds of data collection were used: (1) video observations, (2) semi-structured interviews, and (3) written and visual documentation. These different data collections were triangulated in order to strengthen the analysis.

Description of the system

In the second case study the first model of an integrated toy, E-CUBes (Fig. 1) was tested. E-CUBE is a cube with a LED matrix display on one face. It has electronic capabilities to sense other E-CUBes in the vicinity and form a network. The display is used as a visual interface to render the alphabet. With an E-CUBE the child can initiate a game or play by shaking it. Using IR communication, a network is established with other E-CUBes that determine the other cubes in the area. This information generates a game that involves all children so that various games can be played in groups and, thereby, encourages collaborative learning.

Description of material and procedure

Two case studies were carried out in Sweden and Italy. The first case study consisted of three explorative workshops where the children (n = 12 [5 female, 7 male], 6–11 years) constructed drawings to video games, created sketches of bricks for three-dimensional environments, and played with toys and video games. Forty-nine experts (teachers, special pedagogues, and therapists) were interviewed. The second case study consisted of two user tests of the E-CUBes, and follow up interviews with the teachers: (1) preschool: n = 15, 4–6 years, and one teacher; and (2) primary school: n = 20, 6–8 years, and one teacher. Video observations of guided and free exploration were used.

RESULTS

Case study 1. Play and construction material

Activities with play and construction material created a collaborative environment among the
children. The context and situation triggered the children’s imagination, kept their attention for a long time and they shared knowledge in an inter-subjective manner. Tactile, visual, and audio feedback encouraged exploration and gestures. Materiality in form of shapes and surfaces carried information and creative values. The interviews with experts indicated potentials of the integrated toy system in training and learning situations.

Case study 2. Integrated toy system

The majority of the children enjoyed the integrated toy, which generated concentrated activity and encouraged social interaction, problem solving, and storytelling. Children’s scaffolding and collaboration was clearly identified in both groups, but with different directions. The bigger groups and older children were keener on forming words. They explored less as they were focused on solving the ‘form a word’ problem. The smaller groups and younger children showed interest in storytelling and social interaction. They explored the cubes by building a story around them. The E-CUBES were useful for children to learn spelling and reading in a playful manner and an alternative to traditional teaching methods. The cubes indicated an increased motivation to learn and had potentials to aid learning in a playful way.

CONCLUSION

The results showed a tension between physical and virtual design features through different interfaces. Our findings show that the interface of an open-ended toy should be alterative and, thereby, offer asymmetric and simultaneous features. The non-formal learning approach contained a change of the traditional perspective on education and rehabilitation, which was characterized by a move from an educational or rehabilitation “service” that someone else provides for the child towards a learning perspective that demands engagement and active participation from teachers, therapists, and children. The materiality in the form of tactile interfaces enhanced collaborative learning through gestures and expressive modalities of play underlining interest and messages. We conclude that open-ended design features evoke children’s motivation to learn and the physical and virtual explorations optimized a sense of being immersed which can enhance collaborative play and learning experiences.

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Encouraging co-operation designed as participation

– The beginning of a beautiful friendship?
Evaluation Report

Encouraging co-operation designed as participation

– The beginning of a beautiful friendship?

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1. Introduction

1.1. Background
The project aimed at helping parts of the community from areas traditionally non-productive and dependent on state aid to achieve greater involvement in productive social relations. The starting point was the conviction that all people, regardless of age, social status or handicap, are capable of finding innovative solutions to problems. The project was centred on processes designed to encourage participation in which those involved developed design ideas into new products. The groups involved in the project were so-called marginal groups, disabled, elderly and people in prison. The project should be realised with an innovative approach within so called Integration Workshops.

The short term objectives of the project were to:
- Offer the persons with special needs experiences of cooperation designed as participation based on a treatment with genuine respect so that they can learn to take themselves seriously as partners and experts.
- Design the workshops so that they not only deal with aspects of productivity and creativity, but simultaneously offer a training and qualification for all involved. The participants should provide elements of continues reflection on one’s own work, planning, and evaluation of the process.
- Develop new product lines within the sheltered workshop (and alike) context.
- Making available a replicable method.

The long term objective of the project was to:
- Create conditions for lifelong learning for all those involved in the organisation.
- Each separate step (workshop modules) should offer increasing knowledge and experience as regards firstly, the general possibilities of structuring technical and creative processes in a participatory way and, Secondly, the resources such processes offer, which is general are frequently underestimated. The project is
intended to help make it increasingly accepted for such approaches to be utilised in everyday social life in future.

1.2. Project groups

1.2.1. Disability context 1 / England

The workshops in the disability context 1 were organised by People Potential, who also developed You 2 Toys as a result of T.I.M. project activities. You 2 Toys are a series of handcrafted toys encouraging role-play, educational and therapeutic activities made by a diverse group of people without jobs in Medstead, UK. The toys were designed, developed and manufactured by the same people, who also tested them with groups of children in the UK and in several African countries. You 2 Toys exhibit their products and sell them to interested teachers and institutions, including low-resource countries, who work with children with different abilities. The experience is that the manufacture is expensive in terms of time and personnel. To introduce the products on the market on the basis of realistic prices is nearly impossible. The initiative however is highly successful in motivating and facilitating people to be productive. It is based on volunteer work of people who have returned to activity and creativity through the T.I.M. project. The group continues to grow in number and output and is developing new toys and expertise in marketing.

1.2.2. Disability context 2 / Germany

The workshops within the disability context were carried out under the guidance of DWfB, a sheltered workshop company, in Potsdam-Babelsberg near Berlin. Participants of the Integration Workshop are those working in DWfB, mostly people with mental handicaps. In several workshop modules they developed or further developed toys or other objects particularly suitable for people with special needs. Finally they decided to further develop a therapeutic toy named “Dynamik”, originally developed by Pablo Baquero. The participants were assisted throughout these processes by externals with expertise in design, therapy, economy and other supporting fields.
The objective for this part of the project was to:
- Establish a new line of products in the company
- Obtain a new level of qualification for disabled and non-disabled employees in the company supported by a creative process characterised by participation and involvement.

The methodological approach related to realisation of the Integration Workshops was based on:
- Participation and involvement as the main elements in the process
- Interdisciplinary teams of tutors with external expertise.
- Cooperation with toy distributors as business partners from the beginning.

In a third workshop module new designs and technology were supposed to be adapted to the production process. The manufacturing conditions should be optimised according to the new tasks.

Workshops consisting of different modules were realised.

The milestones of the work within the disability context were:
- Exhibition of the newly developed item.
- ‘Opening’ of new product line in the sheltered workshop company.

The long term milestone was to present the new product at a fair or exhibition beyond the project duration.

1.2.3. Age context 1 / Germany
The workshop within the age context number one in Germany was carried out at Miteinander, an initiative for leisure facilities particularly for elderly people.

The objectives to be realised within this context was to:
- Allow elderly people to be partners and experts in a creative process characterised by participation, involvement, equality and partnership.
- Make use of the creative potentials of elderly people in a social and productive activity.

The methodological approach that was used should be based on:
- Participation and involvement as the main elements in the process.
- Interdisciplinary teams of tutors with external expertise.

The work that should be carried out within this context was intended to be in form of a series of meetings instead of one workshop. The series of meetings should be continuous over a fixed period and continuity related to the personnel question was considered as important.

1.2.4. Age context 2 / Italy

The workshop within the age context number two in Italy was carried out in cooperation between Alce Rosso and Auser (an organisation for elderly). Alce Rosso, a toy library, have collected experiences in this field before and have many links to the community of Ivrea and to other initiatives and experts, was the coordinator of the work in Italy. A lot of effort was put into bringing different age groups, children and elderly, together.

The objectives within the age context two were to:
- Allow elderly people to be partners and experts in a creative process characterised by participation, involvement, equality and partnership.
- Make use of the creative potentials of elderly people in a social and productive activity.
- Involve and join people belonging to different generations in one process.

The methodological approach was based on:
- Participation and involvement as the main elements in the process of the Integration Workshop.
A series of continuous meetings over a certain period of time were proposed instead of one workshop. The participants developed or further developed activities especially suitable for this context. They were assisted throughout the process by facilitators.

The milestone within the age context two was:
- Presentation of the newly developed items at a presentation session.

1.2.5. Prison context
The workshop within the prison context was carried out at Jugendanstalt in Hameln with the help of LEB who offer education services for the prison. In two modules of the Integration Workshop participants developed a computer game, which was considered as suitable in this context. They were assisted throughout these processes by externals with expertise in design, therapy or other helpful fields.

The objectives to be realised within this context was to:
- Allow imprisoned people to participate in a creative and productive social process that offered interesting and challenging tasks of public benefit.
- Support future reintegration into society after imprisonment, e.g. through particular features like take-over of personal responsibility, partnership and involvement.

The methodological approach was based on:
- Participation and involvement as the main elements in the process.
- Interdisciplinary teams of tutors with external expertise.

Workshops consisting of different modules were realised.

The long-term milestone was to present the new product at a suitable fair or exhibition, probably beyond the project duration.
1.3. Aim and questions
The evaluation aimed at preparing a basis for defining a methodology encouraging cooperation designed as participation in order to achieve greater involvement in design- and product development processes, regardless individuals’ age, social status or handicap.

The main issues of the evaluation were defined by following questions:
- What were the factors that came together and made the methodology what it was?
- What were the strengths and weaknesses of the methodology?
- How were the participants and facilitators brought into the activities and how did they move through the workshops once they were participants?
- What was the nature of the facilitator-participant and the participant-participant interactions?

2. Methodological framework
The methodological approach to the evaluation of T.I.M. project consisted of qualitative methods and three kinds of data collection, (1) participatory and video observations, (2) in-depth interviews, and (3) written and visual documentation, including project records. These different data collections were a type of triangulation in order to strengthen the analysis. The data was collected through participants and facilitators of the different project groups described above. The evaluation approach began with specific observations and interviews and was built toward general patterns. This approach could be described as inductive as we concerned about the individual experiences of participants. Between the project groups we were also interested in institutional characteristics that made each setting a case unto itself. This meant that results from the evaluation findings were grounded in specific contexts. As evaluators we strived to understand each context and the situations as a whole by unifying the particular contexts.

The results and analysis are presented in form of qualitative descriptions based on case analysis. Each project group represented one case, which was the basic unit of analysis.
Within each case we have pulled together relevant data and written a holistic case study. The relevant data in question consisted of interview data, observational data, impressions, in effect all the information that was accumulated about the particular case in question. After the individual presentations of each case study, the analysis moved to looking for patterns across cases, which is presented in Chapter 5, Discussion. When looking for patterns we realised a content analysis, which involved identifying coherent and important themes, patterns, examples in the data. We used themes developed by the T.I.M. project group (Workshop parameters / Techniques, strategies and attitudes / Indicators of success, see annex 1). We were also aware of patterns for which we did not have pre-formulated terms. The chapter ends with a conclusion.

2.1. Case study
The depth and detail of our qualitative methodological approach derived from the five different project groups, each one too small for confident generalisations. Therefore the project groups served as case studies for the evaluation purpose. Considering the project groups as case studies were useful as we needed to understand the situation in depth and as each case was rich in information in the sense that a great deal could be learned from this few groups in question.

We also used process evaluation as a strategy as we were aiming at understanding the internal dynamics of the different workshop operations. The process focus implied an emphasis on looking at how the outcome was produced rather than looking at the outcome itself.

2.2. Participatory observation
On two occasions participatory observation has been used in the T.I.M. project as ethnographic method. The first time was when the evaluator participated in the first workshop held at Plum Cottage in England and the second time was when participating in the activities together with the Berlin based seniors organization Miteinander when they had a workshop in youth hostel outside Berlin. Participatory observation signifies that the
 evaluator participates in the activities on the same basis as the other participants and observes, chat, associate and note to understand what is going on. At Plum Cottage focus group interview also was made as complement to the participatory observation. A focus group interview signifies that all the participants, since the group was small, and a given theme was discussed connected to the accomplished activities.

Participatory observation is a method to produce ethnographic knowledge and get closer to an understanding of the activities from the participants’ point of view. This is especially crucial when the time is finite as in these workshops. The workshop in England lasted for days and the workshop in Germany was during three days. Participating in the activities did not only provide the evaluation with a deeper understanding of the activities but also made it possible to get a closer relationship to the informants. Although it was not the experience of taking part in the activities that are of interest but to get closer to how the participants might experience the activities.

The participatory observation also was helpful in relation to formulating further questions and to design other ethnographic methods necessary to get closer to the participants feeling of involvement in the TIM-project.

2.3. Participatory video observation
In the T.I.M. project we have used an ethnographic method called participatory video as a tool for evaluation and for producing ethnographic knowledge. The use of participatory video was initiated by the evaluator, in discussion with the organizing groups, as a solution to adapt the research-design to the specific circumstances within the project. Since most of the workshops were to be run as occasions once a week or month during a prolonged time instead of being dense occasions it impeded the ability to follow the workshops. Participatory video then became a useful tool. It did not only solve the logistic problem since the participants would do the shooting themselves, but also corresponded to the overall aim of the T.I.M.-project. This is particularly important since research methods play a role in how identities are constructed and interpreted. It was thus
appropriate to use a research method that contributed to the empowering theme of the project.

The evaluator visited four of the groups and delivered a camcorder, gave a short instruction on how to handle it, and a brief introduction to image-telling as well as emphasizing the importance of being distinct in what you chose to do with the camera. Due to various reasons we decided the Hamlin group could manage themselves and they also had all the necessary equipment. The idea was that one person should be responsible for the shooting or at least the same individual during one entire workshop session. The reason to this was to avoid snapshots of the activities and to inspire the person behind the camera to tell a story. After each session they were also promoted to orally in front of the camera give their impressions of the day. This did not work out though. The material that was collected was impressions of the workshops without any obvious idea from the person behind the camera. In one of the groups two persons had been responsible while the shooting in the other groups had been done more or less by everyone. When the workshops had come to an end or when we decided they should stop filming the evaluator received the material and made edited versions of ten minutes. The evaluator returned to the groups to show the films and to interview them both about the workshop and the research method. The editing enabled analysis of the material and through this work, combined with interviews and participatory observations, the ethnographic knowledge was produced. Even though these short movies need to be presented in a wider informative context, to be more meaningful, they turned out to be useful products for the groups to present there activities and to inspire the other groups within the T.I.M.-project.

2.4. Visual documentation
In the workshop held at a sheltered workshop in Bornemouth, the activities were followed with a small camcorder. A draft manuscript was written of the film that was intended to be made. Since extensive case research was not possible to do in advance and since the evaluator only saw the place and met the participants some days before the workshop was to be held this manuscript could not be followed. The film that was made
of the footage was rather growing out of the relationship with the protagonists than from an idea on what was wanted to represent with the film. However, by keeping the manuscript in mind the shooting close ups and other images that would be possible to use made the narration clearer and the editing easier. This was particular important in relationship to the short amount of time the workshop was running. The main method during the workshop was to follow the activities and trying to interfere in and disturb the activities as little as possible. A small amateur DV camcorder that was easy to handle and easy to keep away was used. No external microphone or extra light was used. Even if the technical quality suffered by using such spare equipment the positive effects on the ability to get close to the participants by using a small camera was in advantage. From the four days I got about nine hours of material of which I made a ten minutes long film.

2.5. Interviewing
After the ending of each project group workshop activities qualitative data was collected through interviewing of workshop participants and facilitators. By this we wanted to find out how the specific person viewed the workshop activity. The interviews also helped us in understanding and learning about things we did not observe, e.g. feelings, thoughts and intentions. In other words, the purpose of the interviewing was to enter the participants and facilitators perspective. The interviewing was realised at each project group’s workshop place as we wanted to provide a framework within which the people could respond comfortably to our questions. The interviewing of participants were realised either one by one or in smaller groups, i.e. two or three persons. The facilitators were interviewed together at all contexts, which meant two or three persons at the time. During the interviewing at Miteinander, the Jugendanstalt, and Auster/Villa Girelli, interpreters were used. The selection of participants for the interviewing was done by the facilitators, but was realised on a voluntary basis.

When collecting the data we used an interview guide approach by preparing a list of questions and issues (see annex 2) that was explored in course of the interview. The list was based on the Workshop parameters / Techniques, strategies and attitudes / Indicators of success lists that were developed among the T.I.M. project partners in the beginning of the project period (see annex 1). This approach appeared to be fruitful as it made sure that
essentially the same information was obtained from the different project groups by covering the same material. The questions was not taken in any particular order, they simply served as a checklist during the interviews to make sure that all topics was covered. The interview guide approach was not as controlled as a standardised interview where the interviewer can obtain data that are systematic for each respondent. However we found that the flexibility and spontaneity that our chosen approach offered was an important ingredient in our ambition to provide a comfortable environment in order to obtain qualitatively good data. Our ambition was to create conditions for an interview in form of an interaction. We learned that it was especially important that we as interviewers undertook the task to make it possible for the person or persons being interviewed to bring us into his or her world. Our own sensitivity to how the person being interviewed was affected by different questions or order of questions was important.

The raw data of the interviews that was realised was the actual words spoken by the participants and the facilitators. There are, of course, no substitutes for these data. Therefore all interviews were recorded by a MiniDisc and a digital video projector. The video projector was merely used as an auditory back-up. The recorders permitted us as interviewers to be more attentive to the persons. Each person was asked for permission before we used the recorders and also informed about how we should use the recorded material afterwards.

All interviews were fully transcribed, which we think was a useful part in the data analysis process. It was essential that we were two persons realising the transcription as it was critical to the validity of the method. We went over the material, our notes and experiences from the interview situations over and over again, which helped us to identify areas of uncertainty and to review the quality of information we had received from the participants and facilitators during the interviews. By this the interviews also became a kind of reflective observation. This was an important process that helped us making sense out of the interviews. We also reflected upon our own approach and how it could have affected the interview.
3. Theoretical framework

In the work with developing a theoretical framework for the T.I.M. project a thorough literacy research and/or article survey was conducted in order to search the field of previous research. To enabling the capture of the essence of the T.I.M. method, the phrases empowerment, innovation and creativity were emphasised in the search for relevant articles. The evaluation team believes that the concepts that these three phrases stand for are highly relevant in describing the T.I.M. project. A great range of variety of texts was found, were some of them served as explanatory as to find the meaning and uses of the concepts. As the evaluation work proceeded, a forth concept became central for the theoretical base; participation. The idea of participation is one of the foundations of the T.I.M. project and without it the method would clearly fail.

3.1. Empowerment

The inclusion of persons within marginalised groups in the mainstream of economic and social life constitutes an important issue for today’s policymakers and politicians. Polloway, Patton, Smith and Smith (1996) showed how four key paradigms of historical changes have shifted over the past few centuries.

Table 1. Historical change from the 19th to the 20th century (Renblad, 2003, p. 10)

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<td>Institutionalisation</td>
<td>Deinstitutionalisation</td>
<td>Mainstream in social life</td>
<td>Influence, participation and control</td>
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<td>Segregation</td>
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The normalisation principle was established in 1959 in Denmark (Grunewald, 1994), which marked the beginning of the normalisation and integration period. Normalisation firstly concerned how to improve conditions within institutions, and after that it developed to a model for integration within society based on values of equality (Tideman, 2000). The inclusion and participation period meant having the ability and right to participate and to be treated as an ordinary citizen (Polloway, Patton, Smith and Smith,
1996). The United Nations (UN) Convention on Basic Human Rights from 1948 provided the basis for the self-determination and empowerment period, which can be considered as a consequence of civil rights movements in the U.S. during the sixties and seventies (Renblad, 2003).

In the T.I.M. project empowerment is regarded as a dynamic concept that concerns individuals' possibilities and resources associated with growth and development in practice-based settings in everyday interactions. By this we focus on a person’s ability to participate in everyday life and thereby expand his or her possibilities to make choices and have influence. Renblad (2003) underlines that empowerment could be seen as the capacity to act and participate and a feeling that one has the right and ability to do so. Furthermore Bendz (2002) states that empowerment could be seen as a process and a mental state and analysed at different levels, an individual as well as an organisational and political level. These levels might also refer to interactions between the different levels. Empowerment is thereby to be regarded as both a psychological and a sociological term.

Weissberg (2000) argues that there has been too much focus on empowerment as a mental state. A holistic view is of importance, which underlines the necessity of understanding empowerment as a process (Bendz, 2002). In a T.I.M project view empowerment could be seen partly as a philosophy about equality enabling experiences and collaborations, with an outcome of a more positive self-perception and belief in one’s own ability and capacity. Empowerment could also be seen as a process where participatory activities including collaborating partnership are of importance. The workshop activities could be regarded as means to help one where the interpersonal communication influences and is influenced by personal experiences. Partnership means trust, respect, shared responsibility and cooperation.

3.2. Creativity
Creativity is generally regarded as an individualistic process, a sort of mental activity inside the heads of people. Csikszentmihalyi (1996) points out that this assumption is
misleading. Creativity happens in the interaction between people’s thoughts within a sociocultural context. In line with Csikszentmihalyi (a.a.) Daniels (2000) underlines that creativity is behaviour, not a brain thing, and as such it can be explained.

In the T.I.M. project creativity is considered as contextual, which implies induction of the participants and facilitators into a specific context. Consequently our main focus on creativity is not only related to an individual, psychological dimension that is developmental relative, at first place. Rather creativity is firstly considered from a societal perspective, which includes a historical dimension and is cultural relative. From that perspective the focus on creativity should not be concerning what it is, but rather where it is. A behavioural understanding of creativity and change as part of a sociocultural context demystifies the processes and makes them manageable (Daniels, 2000).

Csikszentmihalyi (1996) analysis model points out three main categories, namely domain, field, and the individual person. The domain consists of a set of symbolic rules and procedures. The working conditions at the project groups’ places could be considered as a domain and the characteristic is that the conditions are nested in a sociocultural context, an institution (Douglas, 1986; Selander, 1998), which is symbolised by that the overall symbolic knowledge is shared by the members of the specific institution. The second category of creativity is in terms of Csikszentmihalyi (A.A.) the field, which in this case includes an organisational management level who acts as gatekeepers to the domain. It is their task to consider whether a new idea, e.g. the new T.I.M. methodological approach, should be included in the domain or not. It is in this field that selects what deserves to be considered and developed. Finally, the third category of a creative system is the individual person. Creativity takes place when people, in this case the participants and facilitators, using the symbols of a given domain, such as the T.I.M. method, experience new patterns, acting, ideas, etc. and includes it into the domain. From this perspective creativity is any act, product or idea that changes an existing domain. A creative person could by this be defined as someone whose actions change a domain.
However, it is important to notice that a domain can not be changed without the consent of a field responsible for it (ibid). Csikszentmihalyi (A.A.) underlines the following:

“Because creativity is jointly constituted by the interaction among domain, field, and person, the trait of personal creativity may help generate the novelty that will change a domain, but it is neither a sufficient nor a necessary condition for it.” (p. 29.)

In line with Csikszentmihalyi (1996) thoughts there could be three major reasons that could support or hinder the implementation of the T.I.M methodology: the **clarity of structure**, the **centrality** within the culture, and **accessibility** (p. 38). Furthermore, a person has to learn the rules of the domain and also the criteria of selection, the preferences of the field in order to make a creative contribution. In other word the domain has to offer possibilities for individuals to internalise the fundamental knowledge of the domain.

Daniels (2000) also points out that change and creativity are similar as they require old behaviours to be replaced by new ones. The question concerns how to make change easy and efficient. Positive reinforcement is one of the most important factors that must be planned for when a change is going to happen. People need to experience benefits of the change on the first day, not six months later. Frequent social reinforcement should therefore be a priority for facilitators, supervisors, team leaders, etc. If positive reinforcement is lacking emotional behaviour is a natural response to the change.

An aspect of positive reinforcement at a personal level could be cultivation of curiosity and interest, in other words, the allocation of attention to things is important in order to enhance creativity. When creative energy is awakened a need to protect it emerges, a protection against distractions so that energy can flow more freely. If it is not done there is a danger that the concentration breaks down and the attention returns to its baseline state (Csikszentmihalyi, 1996). If the time is shorten that it takes for someone, e.g. a facilitator, to acknowledge an idea, it will increase participation. Following this thoughts participants and facilitators have to be both open and receptive as well as focused and
hard-driving, which not need to be a contradiction, but probably need time for reflection and relaxation in order to enhance a shifting from one of these poles to the other. Daniels (2000) underlines that in fact all ideas should be reinforced, nothing should be as trivial as to be ignored. Another important aspect is to look to unlikely people as a source of ideas.

Zoels (2002) suggests the term of *inclusive creativity* in order to underline that involvement in creative processes are dependent on trust and a social atmosphere where all members are respected with their individual skills and abilities no matter their position or role. By this inclusiveness is not adaptation, but the best possible development situation of every individual.

Creative activities could encourage new needs and new motives as, in turn, could become important sources for the creativity of ongoing activities. Motivation to participate can change during the ongoing activity as well as hierarchical relations between initial motives to participate may change. Motives are factors that could influence productivity and structure as motivation could be characterised not only by the content in question, but also by the intersubjective dynamics (Tikhomirov in Engeström et al., 1999).

### 3.3. Innovation

Creativity and innovation may overlap in some regards. Nevertheless innovation is more widely considered as an activity that offers promise of economic advantage, e.g. in the shape of new products or processes. Innovation has had a tendency to be presented as if it were only associated with technological changes. An example of this is that fewer references could be found to different kinds of innovation where the focus is on environmental or social enhancements (Rickards, 1999).

Innovation concerns the realisation of something new, which implies the conception of change. As innovation is new it also implies that one carves out entirely new lines, in other words there are no same old formula related to innovation. If so it would not have been any surprises, changes or any new. We consider the T.I.M. project as an innovation
activity instead of regarding it as an innovation process. We think that behind every successfully realised idea a unique composition of activities could be found, which, consequently, points out that it does not exist any given innovation process. Ideas are created and pushed by individuals within a social context. Previous research (SOU 1993:84) has shown that successfully implemented ideas often derive from a specific combination of individuals, more than from structures or systems. As there is no single and simple innovation process, there is either no clear rule for how innovation activities could increase in efficiency. As it is an activity that is part of a social, cultural and economical wholeness, it can either not be considered or described independently of these factors.

Richards (1999) presents two different ways of treating the complexity of innovation. One way is to emphasise the ambiguities of the innovation activity, which leads to a formulation of strategic responses appropriate to conditions of uncertainty. Another strategy in managing ambiguity is to break down communication and cultural barriers by setting up cross-disciplinary teams. Another approach is to develop skills of reflection and learning.

“Innovation is particularly about learning, both in the sense of acquiring and deploying knowledge in strategic fashion and also in acquiring and reinforcing patterns of behaviour which help this competence-building to happen.” (Tidd et al. 1997, p. 19).

The second way to handle the complexity of innovation is by adapting the contingency perspective, which implies that outcomes of a given situation depend on various factors. The task for e.g. an evaluator is to indicate these factors by collecting empirical examples on how contingencies operate in different cases. To understand the importance or significance of a particular factor the evaluator has to remember that ‘it all depends’ (Rickards, 1999, p. 48).
3.4. Participation

In a T.I.M. project context participation is an essential conception in relation to the act of collaborative activities. Participation is considered as an active and functional form of activity grounded in collaboration. Participation in an activity like a T.I.M. workshop involves interpersonal as well as practical goals. In other words, participation in an activity is, as in the case of creativity, both purposeful (focused) and involving exploring properties of an idea (open). This kind of approach could be considered as active, rather than simply acquires perceptions and skills, and focus on people’s attempts to transform problems that emerges at work or in life in general. In line with Rogoff (1990) we do not separate cognitive, affective, and social processes as we believe that human goals involve other people and carry feelings with them. Considering this the conception of intersubjectivity defined as sharing of purpose and focus among individuals is a central aspect of participation (a.a.).

Rogoff (1990; in Wertsch et al., 1995) has developed Vygotsky’s (1978; 1999) conception of guided participation and internalisation, and she suggests an internalisation of three levels of ongoing processes in a social and cultural embedded activity; cultural, interpersonal and personal. In her model she defines the levels as apprenticeship, guided participation and participatory appropriation (Rogoff, 1990; Rogoff in Wertsch et al., 1995). Apprenticeship foregrounds the institutional organisation of an activity and focus the nature of the activity and its relation to practices and institutions. Guided participation refers to the interpersonal level, i.e. to the processes of involvement between people as they communicate while participating in the activity. Finally, participatory appropriation refers to how individuals change through their involvement in an activity; in terms of Rogoff (A.A.) it is a process of becoming. This approach should in a T.I.M. context include studies of actual processes that people are participating in together with other people in activities. The difference in view between Vygotsky’s conception of internalisation and Rogoff’s participatory appropriation is related to the matter of time. While time in relation to internalisation is sequenced and separated to events, merely looked upon as external and internal, and, thereby, development becomes accumulated. Participatory appropriation focuses upon events as dynamic and changing and where
people participates with other in coherent events, and development will by this be seen as transformation. Bruner (1983) uses the conception of *scaffolding*, which is further developed by Wertsch (1985) that underlines a clarification of the conditions necessary for internalisation, which include active participation in specific tasks with the help of a facilitator who provides appropriate commentary and who transfers responsibility to the participant at an accurate rate.

4. Results and analysis

4.1. The England case – Disability context 1

In England the T.I.M. method were carried out on three occasions with diverse participants. In these workshops the aim was to create toys for children with special needs, with the purpose to encourage participants to develop and use their own creative abilities and skills in developing design-ideas of toys into new products. The first workshop was held at the home of the organizers, Plum Cottage, in a small village on the countryside. A variety of people from the neighbourhood was participating. The second was held at a centre for adults with learning disabilities. This workshop was not in the initial plan but an outcome of a visit made to the centre to get participants to the first workshop. The third workshop was held at a Toy factory and sheltered workshop in Bournemouth, with their employees as participants. The non-governmental organisation “People Potential” was in charge of all the workshops.

4.1.1. Creating conditions

In the first workshop getting participants was a difficult task. The reason for having a community based workshop is to reach people that are interested in making toys but who are living on their own or being left to their own devices. People was invited to attend the workshop through organisations of disabled people and by advertising in the magazines published by the Coalition of Disabled People. The Social Services was also contacted in order to get participants. Being part of the religious community in the village the organizers had a network to pick up people from. The participants in the first workshop
were a diverse group of people. Some with a history of mental illness, like agoraphobic or schizophrenia, some with disabilities, others just retired who would like to do something. In Bournemouth the difficulties to get participants were not the same since it is an institution with employees. Instead it becomes a question of motivation and trust to attract people to do something different from the usual.

In the first workshop it was important to emphasise the aim of producing toy for children with special needs rather than an empowerment theme. It was also important to have a diverse group so everybody felt they could fit. In both the workshops the group-process was a crucial thing. At Plum Cottage the participants did not knew each other from previous occasions and it was thus important to create a feeling of security among the participants. In Bournemouth the participants knew each other but instead it was important to overcome internal group structures and hierarchies that could be devastating for the creativity. In Bournemouth it was also important to work towards the facilitators at the sheltered factory to change their attitude towards the workers.

4.1.2. Disposition
The dispositions of the workshops were rather similar. Each workshop was run during four days. The first night we were introduced to the prototypes from Foerdern. These products we were supposed to develop further. The idea was to visit a special-school and a pre-school the day after to let children play with the toys to find out ways to develop them. We divided in groups of two that choose a toy to keep under observation. The children at the pre-school played with the toys and we filled out our observation forms. Back at Plum Cottage we shared our observations and if we had came up with some ideas of approval. The purpose was not to see if the toys were good enough but to inspire us to design new products. After the testing of the toys the actual approval and adaptation-phase started. Each one found a position where they could feel secure. Some mainly went on by their own while others depended on each other. Two ladies started to materialise their idea by sewing. One man who is a trained engineer started to make some drawings. Another group gathered in the greenhouse, brainstorming on what to do. From speech to
action the group continued in the workshop starting the toy-making by learning how to use the jigsaw. After two days of hard work the workshop was summarized and we presented the different toys we had produced to each other.

4.1.3. Inclusiveness and motivation
In these two workshops the reason for motivation was different. In Bournemouth it was out of curiosity and a will to try something different. Most of the participants had been more or less voluntarily offered to take part in the workshop by the manager. The participants that were chosen were those who could be spared without reduction in the production. But by giving this unneeded force attention a greater effect on the final result was achieved. The feeling among the participants was that they were taking part in an important activity for the benefit of the company. At Plum Cottage it was important that the reason of the workshop was something else than disability. The salient reason for motivation of the participants was to make toys for children with special needs. Then everybody felt they could attend. The diverse group also draw attention from the hidden agenda of empowering the participants. The social aspect, to work together with other people was also an important reason to motivation.

4.1.4. Achievements and further development
The new designs resulting from the workshop at Plum Cottage can be used by the participants themselves in setting up small business or be passed on to and used commercially by, for example, sheltered workshops or small and medium sized companies. It is however not likely that any of the participants are going to set up a small business and start producing toys, since a lot of other things have to come in work then. The prototypes resulting from the Bournemouth workshop might be put into production since they already have the structure necessary. For most of the participants it was the feeling of being able to come up with new ideas and realise these into a product that was the most important achievement. At Plum Cottage they are carrying on with toy-working days twice a week. The first Toy workshop day was held for two persons who wished to continue with others and a possibility for the organizers to continue. Invitations were going out for others from the community to 'drop in' and join. These Toy-working days
differs from the workshops in that the aim was to improve the new ideas further rather than coming up with a lot of new ideas. Than things as safety and regulations for Toy makers must be taken into consideration as well as which material is most appropriate to put the design into production, and of course continued testing on those for whom the toys are designed to get the ultimate solution. The work has been proceeding well and more people have attended the group. They have set up a small business called U2TOY, attended a toy fair with their products and got in contact with the Toy makers guild to get further help on how to set their products into production. Except the organizer one of the participants from the first workshop is still in the group.

4.2. **The Potsdam Case – Disability context 2**

In Potsdam the T.I.M. method were carried out among a working group at Diakonie-Werkstätten or DWfB; a sheltered workshop company. Participants of the Integration Workshop were those working in DWfB, mostly people with mental handicaps. Many of the mentally handicapped workers have extensive experience and working skills. In several workshop activities they developed or further developed toys or other objects particularly suitable for people with special needs, before they finally decided to further develop the *Dynamik* toy. They were assisted throughout these processes by facilitators with expertise in technique, design, therapy, and economy. Through DWfB’s participation in the T.I.M.-project, these people were able to both take part in a rehabilitating activity and develop a product suitable to mass-production.

4.2.1. **Creating conditions**

The starting point of the DWfB’s participation in the T.I.M. project was the conviction that all people, regardless of age, social status or handicap have an ability to find creative solutions to problems. The purpose of the project was to try and develop a new method of work based on an altered view of the human being, in which the individual was equally participating in the work process, which lead to the awakening of the individual’s creativity and motivation.
The group of individuals that participated in the workshops was in the ages between 21 and 49. They were 10 men and one (1) woman. All of them were suffering from some sort of mental disability (psychoses, neuroses and personality disturbances in the social and communicative area). They all lived by themselves but were in need of a certain support in their everyday life. They all had some form of education or working experience from before, though neither of them was (yet) capable again to meet the demands the individual has to face in working life. At DWfB these people are offered work with a suitable amount of support and assistance. The group of people was selected on a voluntary basis, i.e. each one decided by themselves whether they wanted to participate or not. During the process they were supported by the two main facilitators.

In a previous Innovation project (Production of Innovative Play Products in Sheltered Workshops, IN301058I, and DWfB successfully gathered experience with a comparable type of workshop, which made DWfB a good model site for the T.I.M.-method. The participants of the Potsdam case decided to fulfil the task to find a usable solution for the elaboration of an existing therapeutic toy prototype called Dynamik. To gain empowerment, both participants and leaders underlined that they showed each other trust in the work process. The facilitators showed the participants patience and faith enough in trusting them and their abilities, and the participants, on their hand, took part in the activities and showed responsibility for their work. There was no difference in rank; the leaders were aware of that they should not give the directions; they worked together with the participants in a team.

4.2.2. Disposition
The different workshop activities were carried out in the workshop facilities, were the Dynamik were further developed and built. Different solutions and prototypes were conducted before the toy was finished. This process was filled with elements of problem solving, co-operation, teamwork and involvement, both from participants and facilitators. During the process the participants expressed social aspects related to their expectations, fears and further developments of the Dynamik. Their expectations were related to a great interest in taking part of an international project, to help others, i.e. the toy would be used
by children and also by children with disabilities, as well as a wish to learn more about new techniques. Some felt afraid of working together with others so intensive. Beside social aspects the participant had a lot of ideas concerning the design and technical development of Dynamik.

Methods used to evaluate these workshops varied in some ways. In one aspect video observations and participatory observations were used. In another aspect interviews were carried out with the participants and the facilitators. The activities first recorded with video camera took place within the workshop facilities at the start of the T.I.M.-project and they were filmed by the participants. The filming took place when the participants were working with the toy Dynamik. The other video observation was carried out at the end of the project, and it showed the finished toy Dynamik and its usage. The use of video was an overall positive experience among the group; they found it thrilling and fun. These video takings have been analysed by the evaluation group. Edda Kraenzmer carried out the interviews with both participants and facilitators, with the soul purpose to reveal the participant’s experience of their involvement in the T.I.M. project.

4.2.3. Inclusiveness and motivation
The videotapes were analysed according to a list of guidelines, called Indicators of success, put together by the entire T.I.M. group. The analyses of the videotapes were able to enlighten two indicators from that list: “Involvement of participants” and “Co-operation”. Through the working method that was carried out in T.I.M., creativity has been awakened on varied levels among the individuals in this group. Their resources have been mobilised. By observing the participants there was a great deal of co-operation between the participants going on. At numerous occasions two or more persons were helping each other out by e.g. holding and sawing material. It also appeared, by watching the interaction between the participants, that there was a joined sense of wanting to help out among the participants. The atmosphere in the room seemed to be quite calm and nice. After working sessions a follow up session was taking place where the facilitators and participants talked about their experiences and problems to solve. The discussions included all the participants, and one person from each of the (voluntarily formed)
smaller groups tended to speak for the rest of the group members. The participants actively showed the results from their work during the day, which, together with the high frequency of activity at the working sessions, indicated that, the involvement of the participants as a whole was high. At the same time it was possible to uphold a positive attitude towards the co-operation among the participants, which was based on the fact that they, on numerous occasions, showed co-operation through interaction, communication, and basically helping each other out work wise.

4.2.4. Achievements and further development

The interviews with the participants showed that most of them had positive experiences of taking part in the T.I.M. project. There was a preconceived notion among the mentally disabled workers that there were some elements of support and inspiration within the method, which gave them a sense of faith in what they actually know to trust themselves to be competent rather than to be incompetent. This was the essence which increased their self-confidence. The emotionally support they received during the outcome of the project seems to have awakened their creativity along with the achievement to abolish their fear of committing a mistake. After a relatively short time the participants independently formed three teams, which was not in line with their previous group formations. The teams were a source for development of ideas in order to find a possible technical solution for the Dynamik coupling. Notable was also that one participant taken on a leader role of one of the teams. Normally this person was reserved, but in this context, he managed to convince the team to believe in his ideas for solutions. A lot of ideas were developed in parallel. Nobody said that something was “impossible” to do, there were an inbuilt trust upon each others ideas and creativity. They felt that they were committed to an important task in a significant context and they worked to achieve a specific goal. With this specific goal, to create something that could be of use for other disabled persons; they also expressed a sense of coherence during the project, in seeing their work as being filled with meaning and value, something well worth being committed to. They felt that the final product was “theirs” and they were proud to be part of this project. The fact that they were parts of an international project with partners all over Europe made their feeling of being special even more present.
4.3. The Miteinander case – Age context 1

Within the Miteinander organisation the T.I.M. project was carried out among a group of elderly people. During daily events and social meetings the group worked with the method together with the facilitators from the organisation. They named their T.I.M. activities Altweibersommer project. Initially the participant and facilitators created a banner and they gave themselves names of animals. All these together aimed at creating a feeling of belonging together as a special group. The idea was originally initiated by the facilitators. When the project started two of the leaders of the organisation actively planned the realising of T.I.M. method and started the group of senior participants as well. But when the T.I.M. facilitator was employed by the organisation, which was when the project has been going on for about a year (including the definition phase), they stepped back and put forward the facilitator. The facilitator considered his role in the project as a trainer of the group, which, from his point of view, was an agreement with the persons in charge of the organisation as well as with representatives for the T.I.M. project coordinators, Fördern durch Spielmittel. The staff of the Miteinander organisation spent some time to find out the kind of activities they should focus on within the project. Finally they decided to work together with the “Grass-Roots Church” community and in collaboration develop a mobilisation course with the topic of “Perceiving the body”.

4.3.1. Creating conditions

When the group of senior participants was chosen (August-September) they went away for an excursion where they spent the night in the nature and played outdoor games, which was the occasion when the idea of establishing the Altweibersommer came up. It was related to this event they created the banner, as a symbol for themselves as a group, and they always brought the banner along at every T.I.M. activity. Alongside with the banner they also read a book together, which became a kind of bible for the facilitators and the participants. During the mobility sessions one important issue have been to create a secure environment for the participants, as much as a good climate among the people attending these events. The intentions from the mobility sessions facilitators was to create
conditions related to how to move in a group – structure vs. chaos, playing with Hengstenberg devices (special wooden equipment developed for physical exercises for young and old people), and self-perception – perceiving the outside world. To be able to work with their bodies and the good support shown from the facilitators, have made the participants confident of themselves. Key elements for an allowing atmosphere regarding all activities were to give space and time and not pushing and forcing, trust and simplicity. One thing to keep in mind when it comes to working with elderly people is that some of them may pass away due to sickness and/or age. The group have experienced this while working with the T.I.M. method, which caused the original group to shrink.

4.3.2. Disposition
The participants were elderly people living in the near area of the facilities used by the organisation in Berlin. They frequently met for social events such as musical sessions, handicrafts and discussions. They also had meals together. The facilitators decided not to send out information about Altweibersommer to the general elderly public in the area. The choice of participants was internally and was just introduced to some who was especially picked by the organisation, some seniors from the charity and some that they knew from former projects. Regularly the members of the organisation who had decided to join the T.I.M. project activities had mobility sessions with a team facilitator from the Church community and the facilitator from Miteinander. In addition, as a follow up of each mobility session, the T.I.M. group has had Round Table discussions, which mostly was realised in an undirected form. It has been during these events that the T.I.M. method has been carried out for most of the time. Occasionally they have also gone to seminars with themes related to mobility, active life and well being at old age.

4.3.3. Inclusiveness and motivation
There have been some slight problems when it comes to inclusiveness on the participant level as well as on the organisational level. One is that in the group there were some strong personalities, and sometimes not all got along with each other. This may have had
an effect on whereas some of the members of the group chose not to attend the mobility sessions, due to the fact that there was some/someone attending that they did not get along with. However, the participants expressed a strong support towards the facilitator. In interviews with the participants they all underlined their likings towards the facilitator and the way the T.I.M project worked. One reason for this could be that the Miteinander organisation, and thereby the senior activities in general, was threatened by a closing down due to structural, i.e. financial, matters. It seemed like the seniors included a defence for the organisation as a whole within their answering of questions concerning T.I.M. activities. From that point of view it probably was important for the seniors to underline their likings of the activities as if their opinions might influence any kind of decisions for the future existence of the organisation as a whole. On organisational level there were some discrepancies expressed as well, especially from the facilitator’s point of view, which concerned his feeling of inclusiveness within the project as facilitator. The facilitator thought that the initial planning of the project to a certain extent went to far until they first talked to the seniors. And when they talked to them, the question to them was not in form of an offer to participate in a joint project. Merely like “you are the group, now we introduce what we have as a surprise to you”, but in a subtle way, which, also, was one of the main reasons to why he thought that the activity level, especially at the round table sessions, was rather low. Based on this it was difficult for him to re-direct the development of project activities into another direction, which, from his point of view, should have been more inclusive on the participant level. To some extent he did not feel comfortable with the way the project developed and it influenced his own feeling of inclusiveness in the project.

4.3.4. Achievements and further development
The participants of the mobilisation sessions especially underlined the social aspects of the course, and that they enjoyed the togetherness. Several times the participants underlined that they appreciated the togetherness with the facilitator, who also expressed that he thought they liked the time spent together with him. In other words it seemed as the facilitator did play an important role for the motivation of participation among the seniors. Now and then the sessions did not include working with Hengstenberg
equipment, which seemed not to be as important as the social experiences together with the others. The visiting of different seminars were important for the self-esteem within the group. At these occasions they gained positive feedback on what they had learned and what they had done together; “This is what we do all the time!”

4.4. The Italian case – Age context 2
In Italy the T.I.M. method were carried out in cooperation between Alce Rosso and Auser. Alce Rosso is a cooperative that organizes summer camps and other spare time activities for children as well as providing educational services for children and adolescents. Auser is a national organization run by volunteers that works to promote the wellbeing of older adults. The reasons for these two organisations to cooperate with each other were many. Alce Rosso, who arranges all kind of activities at their premise Villa Girelli, experienced a lack of facilities in the centre of Ivrea, while Auser’s premise is situated just in the middle of town and it is filled with seniors with plenty of time and wishes to do something. Also Auser already had the experience to organise activities for children since they had been organising a day of festivities called Giocca con i Nonni in the summer for the local children to attend.

4.4.1. Creating conditions
Alce Rosso and Auser had a long period of uncertainties in what to do. At first they were paralyzed by the demand to produce toys; a task they thought would have been difficult to realize. This phase of uncertainty also led to problems in establishing a working relationship. After getting rid of the burden to produce toys things really progressed; the two organizations started to understand each other. An important cause for that development was that the Auser ladies started to come to Alce Rosso’s place, Villa Girelli, and thus got a clearer idea of what Alce Rosso were doing with children. With the guidance of Alce Rosso the Auser ladies created an occasion once a week when children can come and play at the Auser premise. To make it more attractive for the children and to allow the ladies to supply with standards they found important as well as games from
their childhood. The Auser ladies got more confident and it became easier for Alce Rosso to contribute with their skills and experiences in working with children.

4.4.2. Disposition
The work has been done on a regular basis in workshops held at either Alce Rosso or Auser once a month. Initially when the two groups had understood that the requirement with the TIM-project was to come up with a prototype, they tried to do that. They studied some toys and games that were available and how children used them, and they looked at Foerderns prototypes as inspiration. But the two organizations realized they did not have the necessary abilities to think of an innovative toy and build it up. So instead of fulfilling the assumed demand to produce a toy, the two organizations built on their expertise and improved the cooperation into a network of collaboration between Alce Rosso and Auser. They started from the Auser initiative *Giocca con I Nonni* and brought in the work Alce Rosso does with children throughout the year. The idea was to take some elements from *Giocca con I Nonni* and give it the continuity that Alce Rosso gives to its services. This new perspective was successful and it resulted in afternoon occasions for children called *Castelazzo*. It also changed the meetings in that everybody contributed and there was a more like balance between all the members of the group.

4.4.3. Inclusiveness and motivation
The participants in this project are all persons that regularly attend the Auser premises. Initially there were only women attending the workshops but towards the end when things progressed and results could be seen, some men also participated in the work. The persons from Alce Rosso were experts and did it as a part of their job. For the Auser ladies it was something new to come together to plan and organize activities as in a project like this. The Auser ladies have been very enthusiastic and after the initial obstacles they have been active and participated in the project with a lot of energy. All the ladies felt they have been involved in the project and able to contribute to the work with their skills and ideas. The salient factor for motivation has been the reaction and response from the children. All the ladies are aware of the idea behind the local project,
i.e. to include elderly and to bring together two generations. But they are not fully aware of the overall theme of the TIM, i.e. to transfer innovative methods to people on the threshold of society. The main reason for this is that they have difficulties in identifying the marginalized group that are supposed to be empowered in this local project since they do not consider them selves being that marginalized.

4.4.4. Achievements and further development
For Alce Rosso one of the major contributions in this project has been to allow them selves to step out of the routine and see what they do with a fresh outlook. The project has made them discover the energy and enthusiasm in doing certain things with the children due to the ladies being so involved in their relationship towards the children. As professionals the Alce Rosso representatives had a distance towards the children, whereas the ladies were more involved. For the Auser ladies the project has had a positive outcome in that it allowed them to rediscover the child within them. The cooperation between Alce Rosso and Auser has been good when the two organizations managed to value each other skills. The Auser ladies said it has been of great help to cooperate with Alce Rosso since they are experts and see how they work with children at Villa Girelli. At the same time the Auser ladies felt they have been free to discover themselves on how to work with children. The most valuable things were the relationships the two organizations established and that the children have had fun. The two organizations have applied for patronage from the council in order for Auser to be able to open its space to children since it is the local council that owns the Auser building. The plan is to reopen the garden to the children as have been done during this project. The Auser premises is situated in the city centre and can thus be a complement for these children living in this area that are having problems going to Villa Girelli since it is isolated from the city centre.

4.5. The Hameln case - Prison context
In Hameln the T.I.M. project was carried out in a youth prison with a group of facilitators from LEB and prison interns. The interns were offered an opportunity to take part of the
project by working together with the creation of a computer game. They were involved from the beginning with writing the storyline, designing the game and then further on with actually making the real computer game. This process especially involved them to learn computer skills, work together in a group and to come up with creative ideas.

4.5.1. Creating conditions
The facilitators in Hameln working with the project faced some problems when it came to the getting participants. The problems were mostly due to the conditions of being an intern. One aspect was that interns who started working with the project were released from the prison and therefore unable to continue with the project. Another aspect was the strong hierarchical system in the prison between the interns, which affected the interns’ involvement in the project to some extent. The interns also had different agendas to be part of the project; some of them were not really interested in the workshop, they were merely there to have something different to do or to kill time. Most of the participants though where genuinely interesting in making the computer game and be part of the project.

4.5.2. Disposition
The workshops have been carried out on a somewhat regular basis, even though the working group has changed during time (due to reasons mentioned above). The work started out with the decision to make a computer game that was to be the focus of the workshop activities. The activities were divided into doing both known and unknown things. After an introduction they started the first session with playing computer games, and after that they should evaluate them according to their graphic, design, language, action, content, etc. This activity had both entertaining and hard working conditions. At another occasion they were brainstorming and came up with spontaneous ideas for a game, and afterwards they arranged and discussed all ideas. This activity was both opened and focused.
4.5.3. Inclusiveness and motivation
In the beginning of the project it was crucial to motivate the interns to come and take part of the workshops; some of them were sceptical at first not knowing really what the project was about and their role in it. The facilitators of the project started to have Saturday breakfasts in addition to the following workshops. In total there were 13 prisoners who participated in the workshop activities. In this way the facilitators and the interns could sit down for some time and talk about what they were about to do while eating breakfast together, feeling at ease. It was also important to choose a theme for the activities that was attractive for the prisoners to take part in. Therefore a lot of time was spent on creating a meaningful starting point for the workshop activities. When the workshops started the facilitators had three suggestions on what they could do together. With this approach to the workshop the facilitators created a good atmosphere for the forthcoming workshops, based on no pressure for achievements or alike.

4.5.4. Achievements and further development
The interns have said that they enjoyed taking part of the project and want to continue the work. They believe that their self-esteem have increased as a result of their involvement in working together in a group and feeling competent in developing a computer game. The competence was related to its usefulness for the future, for example when they return to a working life outside the prison. The experience of working together in a group was compared to this valued secondary by the participants, but was nevertheless expressed in relation to that the reason to why they learned more about computers, was by working together with others. The participants underlined that they felt good to be part of a group who had a common task to achieve and that the process of working together with others for them was a continuously learning. In line with this achievement the facilitators said that the task, developing computer games, was not the most important, it rather was that the participants wanted to be a part of something. And the ‘something’ happened to be developing a computer game. The participants liked to be a part of the group and expressed that a main reason to this was that they felt no pressure being in the group, which was an open and allowing atmosphere. Both participants and facilitators
underlined that they had a positive experience of mutual motivation to realize a common project.

5. Discussion and conclusion

The evaluation aimed at preparing a basis for defining a methodology encouraging cooperation designed as participation in order to achieve greater involvement in design- and product development processes, regardless individuals’ age, social status or handicap. By developing trust in the abilities of the participants as a base for the working conditions, a source for an innovative, creative and participatory approach including a belief in other people’s ability to come up with suitable solutions to problems, was created. All of the groups that have participated in the T.I.M. project consisted of participants that belonged to marginalized groups of people in society. People in general tend to view marginalized people as “them” and “us”. The T.I.M. method was created in order to get away from that notion and to commit a process of change in people’s way of thinking in these terms.

Through the approach mentioned above there is a thought of re-integration of these groups into the society as competent and equal citizens. A Swedish researcher Kjellman (2003), who has studied marginalized peoples conditions and changes in everyday life, believes that intellectually disabled, criminals, and people being marginalized by their age; all are exposed to political, economical and social marginalization to a certain extent. This obviously have effect on their everyday life and their self esteem. Thus, it is important to mention that not all participants within the project thought themselves individually to be marginalized, mere as a group. To be part of a group or a context is valuable for everyone. Kjellman (A.A.) also speaks of the concepts of being an insider or an outsider, i.e. being part of a group or not being part of a group; to belong to a context. So, what was the nature of the facilitator-participant and the participant-participant interactions? In the T.I.M. project emphasis was put on participation as of one of the most important goals. Co-operation and participation were two main topics that helped creating the sense of empowerment for the participants, which, in turn, was one of the bases for the positive outcome of the project. Within the work carried out with the
method, facilitators and participants worked on the same level both as professionals and as human beings; there were no us and them, just us.

*How were the participants and facilitators brought into the activities and how did they move through the workshops once they were participants?* To create a trustworthy “us” context and by that create “insiders” specifically the way participants are committed to the engagement plays a role in how successful the method will turn out. The essence of this is that it should be clear not only to the facilitators / organisers, but also to the participants why they are participating and where they are heading. Motivation for spending time on something is that you get something out of it in the end, e.g. the possibility of influencing your daily working environments. In future full-scale use of the methodological approach T.I.M offers it should be considered setting up an initial workshop with the participants before the start of the implementation period. This workshop should focus on the projects overall goals and methods, and letting the participants have an understanding of this as part of the process of engaging participants. Otherwise we risk ending up in a situation where participants just play the role as ‘participants’ in a politically correct process of inclusion. In other words, motivation is a matter that includes apprenticeship, guided participation and participatory appropriation.

Furthermore Kjellman (2003) underlines the difference between *taking* and *getting* (receiving) place. In the T.I.M. project the participants were getting space, both physically and mentally, which made them feel competent about themselves. Some of the participants expressed anxiousness and worries about the ending of the project and that it would mean that they were to go back to their former way of being. Their concerns could be related to how the participants have taken part in a social and cultural activity and how this participation might have changed their sense of movement from taking place, i.e. being peripheral, observing and secondary, to getting place, i.e. being responsible for managing further activities. The essence of this discussion concerns the question of what will happen when the project period ends, will there be a continuation or will the daily activities return to the way they were before? The uncertainty also highlights one *weakness of the methodology*, namely that if not the domain, field, and the individual
person are considered as integrated when implementing a methodology like T.I.M., there
is a risk that uncertainty will be created among participants as well as facilitators. This, in
turn, according to Csikszentmihalyi (1996) will influence the degree of creativity. All
facilitators from the project are concerned about following up the T.I.M. project, and to
keep up the work they believe in; a way of working together they trust to make a
difference in the marginalized people’s lives.

Getting place is an issue that could be seen as a learning process towards self-
determination and empowerment, including influence, participation and control, which
need necessary conditions on domain, field as well as personal level. The conditions
include a unique composition of coherent activities as well as a specific combination of
individuals, who are parts of a social and cultural context. From this point of view
learning and development is considered as transformation, and not as accumulated
sequences. Traditional approaches towards learning and development is most often
considered as sequences that occur by transfer and repetition, in other words, a stimulus-
response situation, despite all talk of individual development and the right to self-
determination. Our assumption is that people learn by asking, seeking out, generating and
finding support in the external world and inside themselves, i.e. as in guided participation
and participatory appropriation.

People within “marginalised groups” really have no basic special needs, what is suitable
for them is that they perhaps have specific difficulties and, consequently, needs for
special solutions. But sometimes, these solutions are of more general value – for all.
We can never really generalise from one person or group of people to another. What we
can do is that through the individual example, the particular case study; see something
that can be expressed on a more general level, for example, as a methodological
principle. If this principle, which has no statistical basis but instead is more of an eye-
 opener based on work carried out under specific circumstances, has any general value is
determined by its ability to help us see new phenomena that we have never seen before,
or our case studies could by this serve as examples of eye-openers.
A main strength of the methodology and an important basis for the methodological approach in general is to consider domain, field and personal levels as well as apprenticeship, guided participation and participatory appropriation, in other words, the methodology as forming a whole. The factors that came together and made the methodology what it was could be summarised through Senge (1995), who underlines a systems thinking in relation to organisational learning. Systems thinking are an overall approach offering a view of a whole. Nevertheless, systems thinking should be supplemented with building of shared visions, mental models, team learning, and personal mastery, in order to be successful. Shared visions secure engagement in the long term. Mental models provide domain and field with the needed openness in order to find out weaknesses in our approach to the surrounding world. Team learning activates the possibilities within the group to find common aims that are of more importance than participants’ individual aims. Personal mastery increases the motivation to a continual learning about how our own actions influence the surrounding world. Without personal mastery we could get caught in a negative approach in which development constitutes a threat.

Creativity should not only be considered related to an individual dimension, but also as interpersonal and cultural dimensions. From that perspective it is not relevant to focus on what creativity is, rather on where it is. (Csikszentmihalyi, 1996; Daniels, 2000). In line with these assumptions, as well as with the empirical results, we suggest that the focus in general should not be on the methodology as such, i.e. on the content ‘what’, but rather on where and, as important, on whom. This assumption implicates that the relation between facilitators and participants (whom), within a social and cultural context (where), could better predict the result of a specific method, than “what”. It also seems like it is the participant’s view on the alliance between him- or herself and the facilitator that constitutes the most important measure when it comes to predicting a continuous motivation and a successful result of a specific method. An alliance based on equality could be described as a stool with three legs, which all need to be stable if the alliance should be steady. Agreement about aims and where the method/workshop activities are heading is the first. The second constitutes the participant’s experience of the relation
between him- or herself and the facilitator. The third leg stands for the methods and means used in specific activities and which the participant and facilitator are agreed upon. The more positive the participant considers the facilitator’s approach, the higher possibility for a successful result of the specific activity (see also Hubble, Duncan & Miller, 1999; Duncan & Miller, 2000).

Strength of the methodology is that the methodology is suitable for different target groups.

The perspectives and important aspects of the methodology given above are all based on the possibilities and degree of trust, influence, and competence development. The primary aspect of the methodology to consider concerns the matters of whom and where, the matter of what is secondary. In the light of this following assumptions could be formulated based on a properly functioning interpersonal relation and inspired of Critchley & Casey (2004):

- people care for each other;
- people are open and truthful;
- there is a high level of trust;
- decisions are made by consensus;
- there is strong team commitment;
- people listen to ideas and to feelings;
- Process issues (task, relations, and feelings) are dealt with.

Furthermore another dimension of strengthens and weaknesses of the methodology are related to the following re-formulated issues:

- The work of participants-facilitator team (in terms of specific modes).
- Processes that are needed.
- Skills that is required.
- The function of the facilitator.
The issues are illustrated in the model (modified from Critchley and Casey, 2004) below.

**Figure 1: Processes, intersubjectivity and facilitator role.**

**Processes**
To start with the horizontal axis – processes. In line with Critchley and Casey (2004) we distinguish three levels of process in the workshop group. At the most basic there are *trustworthy social processes*. It is important to sustain the social trust of the group. The work accomplished basically via *task processes*, i.e. the way the workshop is organised, distributed, ideas generated and shared, decisions made and so forth. The third level of processes concerns people’s feelings and how these are handled within the group. The figure shows that as the mode of working become more difficult, climbing the vertical axis, from unshared certainty towards shared uncertainty, the processes needed to accomplish this more difficult work, also become more difficult, as the group moves
along the horizontal axis from simple social processes, through task processes, towards the more difficult processes of working with people’s feelings. To reach the top mode of shared uncertainty, where people’s feelings are part of the work, enthusiasm and trust is needed. The shaded areas should be avoided. The top shaded area indicates that there is no need to share deeply when only the two lower levels of processes (social processes and task processes) are operating. An alliance of participants-facilitator team faced with the need to tackle uncertainty can either stay safely behind the barriers, which is not unusual, or it can have the courage to break through both barriers simultaneously, arriving in the top right-hand corner where the mode of working is shared uncertainty and the necessary processes are task and feelings processes together, which stress a trustworthy based group constellation. Attempts to push only one barrier will probably fail and make things worse for the group, e.g. trying to handle uncertainty without sharing, or sharing for the sake of sharing.

**Intersubjective skills**

The diagonal variable – ‘intersubjective skills’ – indicates that there is an order of skill from the lowest (but not least important) level of trustworthy social skills to the highest possible level of intersubjective skills required in the atmosphere of highest uncertainty and real group work. But, for the middle mode, a push of straightforward intersubjective skills is needed by all facilitators and participants, i.e. empathy, co-operation, communication, listening, and many more.

**The facilitator’s role**

The facilitator is hardly needed in the unshared certainty mode. The facilitator’s role in the centre, co-operation, mode is of a traditional co-coordinating base, e.g. to co-ordinate a specific task. The facilitator’s role in a mode of shared uncertainty includes working with feelings, which could be described, more of a ‘catalyst’, or an equal partner, than a leader. The role of a facilitator and a catalyst at the same time is complex and attempt a high degree of intersubjective skills.
References


Annex


Annex 2.

Inclusion and empowerment as resources for creativity, learning and development

Interview guide

- How would you describe the activities within the project that you have been taken part of? (An overall description).
- Have you participated in projects like this before?
- As a participant/project leader, what do you think was positive and negative about the project activities?
- Why did you decide to take part in the project?
- What was especially important for you to take part in the project?
- How would you describe your involvement in the project?
- How have your ideas/solutions been taken into account?
- What factors are important to you in order to experience involvement?
- What factors are important to you in order to experience creativity?
- What factors are important to you in order to experience motivation?
- What factors are important to you in order to experience self-confidence?
- What factors are important to you in order to experience satisfaction?
- How would you describe your motivation to take part in this project?
- Are you satisfied with your participation? How and why?
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Recursive Reflection and Learning in Raw Data Video Analysis of Interactive ‘Play’ Environments for Special Needs Health Care

Abstract—Technology influences the situation of people’s every day life and this, in turn, has an impact on opportunities for health related quality of life. This paper presents how findings from two separate and distinct feasibility investigations under the SoundScapes body of research corroborate an important aspect of the original methodology of the concept such as to have influenced its future design and application in its health field context. The primary purpose of the independent studies was to test the potential of utilizing sensor technology to empower control of multimedia feedback across different sample groups of abilities and to test the effects on these participants.

I. INTRODUCTION

Two investigations were established where exploration of the genesis of breaking patterns on limitations and abilities in the form of emergent play and learning processes in an intersubjective manner. Playful experiences were identified occurring within what we have named the Zone of Optimized Motivation (ZOOM), “unpublished” [1]. Moreover, the findings pointed at play, without immediate goals or material reward (autotelic) and which was offering exploration and expressive elements that motivated the condition flow [2].

Moreover, the findings are in part that: (i) when using video tape analysis it is optimal to preserve the original raw tape for review at a later date as additional findings are probable, (ii) Participative involvement is a wise strategy to include those who are closest to the sample to review occasional video sessions as they can observe and input with informed tacit knowledge of a higher nuance.

II. SOUNDSCAPES

The research has long-term goals of offering new opportunities for health related quality of life and analysis in human performance, play and creativity. The SoundScapes technology is conceptualized as being adaptable across age groups, abilities and limitations, cultures and creeds, so as to be usable for a variety of users in the community.

The methodology is to capture movement as digital data that is routed through a computer to control elements of selectable and immediate multimedia feedback. This is selectable according to the preferences of the individual participant.

Through a strategy of adaptable capture technique and content optimization a real-time responsive play scenario is established where creative motivated expression is targeted.

III. PEDAGOGICAL ASPECTS AND THERAPEUTIC ANALYSIS

The digital movement information that is used to control the multimedia feedback is available for analysis so as to be a supplementary tool for training progress toward a therapeutic and learning goal. This analysis is unseen by the participant as he/she only needs to experience an enjoyable play environment that is tailored to his/her specific preferences, abilities, limitations and desires.

Furthermore the content is adaptable so as to continuously challenge improved ability which is motivational and sustains interest. This aspect takes inspiration from known game design and strategies, [3], [4]; theories on flow [2]; and the notion Zone of Proximal Developmental (ZPD) in learning situations [5].

IV. OPTIMISED LEARNING AND TRAINING

Two investigations that accounted for two different sample groups were initiated in Denmark: (i) Severe disabled adults, (ii) Socially ostracized children through behavioral problems.

All sessions were video taped, annotated, and analyzed so as to give an opportunity for post session scrutiny of progressive development indicators when compared session to session.

Along with video observations, field notes, interviews with parents and staff from the involved institute and school, diaries from the institution were supplied. Multimodal transcription (in visual and written form) of correlated data was archived.

This process is towards an iterative post session inductive qualitative reflection on observation and findings with subsequent hypothesis construct, followed by system parameter change, and another applied session into the cyclic sequence.

This approach combines the strategies involved in grounded theory methodology [6], and action research [7]. It also involves the assumption that learning and training always is situated. In order to consider the complex relationship between the individual, the activity, and the environment as mutually constitutive we refer to [8].
Through reflections and occurrences during the investigation inductively two secondary more holistic theories emerged that were apparent in their cohesiveness. These findings are suggested as being pertinent across disciplines:

(i) When using video tape analysis it is optimal to preserve the original raw tape for review at a later date as additional findings are probable.

(ii) Participative involvement is a wise strategy (a) to include the participants as they are engaged in the (inter)activity as to achieve design relevant information, and (b) to include those who are closest to the sample to review occasional video sessions as they can observe and input with informed tacit knowledge of an often higher nuance in respect of personal trait.

In that way, the emerged approach demands a collaborative arrangement in research with the participants and with their helpers, therapists and families, that is to say working with this network of people, not on them. SoundScapes practices archiving of source material in its entirety and encourages a limited input from helpers, families or therapists. However, the findings presented in this contribution point to the fact that an even more concentrated effort of inclusion of those close to the participant are optimal to interpret video sessions to a higher level. In the cases presented in this paper we refer to the parents and teachers. These finding are currently being implemented within related international collaborative studies between Universities and hospitals in Scandinavia.

V. RECURSIVE REFLECTIONS

The videoed sessions were archived intact so that a ‘return to view’ (hereafter termed Recursive Reflection) in consideration of new findings is possible. This is a different strategy than that as in [9] where a slightly different grounded theory model is adopted. We question this model of hypothesis building under a grounded theory doctrine when a return to the source data is not available due to selectively edited source material.

In our study a presentation of archived raw video from sessions with John was given to his parents who had not previously witnessed the work. This gave interesting insight and supports finding (i) and (ii).

In a similar way the sessions with the children resulted in an independent report generated by the staff at the school reflecting on the investigation with the children. Their comments supported (ii) where they had witnessed special moments through their knowledge of the children. This inspired a recursive reflection of the session videos from the school which further substantiated (i).

VI. PARTICIPATIVE INVOLVEMENT

Interacting with SoundScapes includes specifics to interaction as well as user interface, which, iteratively, became part of the responsive system. This form of dialogue was created by the correlated exchange between the users and the user interfaces, and constituted a critical part of this exchange. Previous studies indicate that an interaction mode offered through a user interface influenced how children played and learned with toys, traditional games, and computer games [10]. Consequently, the interface can support and/or inhibit certain learning and therapeutic strategies.

Furthermore, Peterson (a.a.) underlines that input from different people in the design of interactive tools for play and learning, is crucial and that this input should express the relationship between design and learning needs at one hand and the technological potential at the other.

Reference [11] underlines that by developing trust in the abilities of ‘participants’ in a process like this, include a creation of belief in other people’s ability to come up with suitable solutions to problems.

The findings from the studies presented in this paper points to the additional participative involvement including the participants themselves and also the people that are closest to them. This involvement is partly to optimize the design of interactive responsive environments and partly to optimize a mutual understanding about the participant’s engagement with the SoundScapes. This also serves as a validity check for the data reported in the case studies.

A. Case study 1

The first case study was with a young adult who was severely disabled from a young age and who undertook SoundScapes sessions at a day care centre for handicapped adults. In sessions in a quiet room John was empowered to “motion control” sonic events with a near-field Virtual Interactive Space. Observable and obvious delight as a result of the control resulted in a motivated interactive ‘play’ scenario. Previously in his life John had not had such expressive stimulus opportunities due to his disability. This form of nonverbal communication was seen as positive in interviews. A video tape was shown to John’s parents and his music therapist at the parent’s home. The parents had never witnessed any of the sessions and were apprehensive and nervous of their emotive reaction as John had died five years before this meeting in 2005.

Peterson conducted the interview as an independent third party who had not been involved in the sessions. In the interview before viewing of the archived video the parents disclosed as to the positive benefits they believed happened to John as a result of SoundScapes. They also subsequently obtained John’s diary from the period which constituted an input to the study.

The raw footage on the video tape was of a session where the near-field sensor was placed adjacent to John’s head to control the sounds of a digital synthesizer. The parents noted many indicators accumuluating to a new input for the research team. His preference for loosing attention to nearby windows and how it was possible to put hands over his eyes to regain his focus is one example of this input.
In Fig. 1, John is controlling a digital sound patch through movement of his cheek in the volumetric 3D infrared beam. In discussions following the parents and music therapist viewing the video the facilitator/researcher told about a desire to edit the ‘cheek control’ element out of the video due to the sensor being ‘in his face’ and a consideration for the parents distress. However, the reaction of the parents was that this “section” was a highlight of the video as it showed a distinct focus from John on the changing sensor LED light as a result from his attempts to control the sensor from his cheek muscle. Other sections of the video were commented on with similar enthusiasm, many of which could only be seen through the eye of someone with such a close relationship to John.

These enthusiastic positive comments of response to visual stimuli corroborate findings in the study Twi-aayi [12] where tests of synchronous image and sound were reported as preferred over segmentation (i.e. sound alone or image alone).

John’s parents described his severe disability in the interview and the case where for two years following the accident when he became disabled there was no expression, movement or communication at all from him. At age four a limited communication became possible such that for the remainder of his life (he died March 2008) he was able to smile for “yes” or frown for “no.” He developed a liking for music and when institutionalized in 1996 he established a friendship with others more able that could play some music and had a band.

When introduced to SoundScapes in 1998 he had a very limited range of movement of head, hands and fingers. The main results from the sessions were that John enjoyed expressing ‘himself’ with his limited movement. Usually the therapist, parent or helper was doing everything for him. The music therapist commented that by participating in the SoundScapes sessions John developed skills towards attempting to control a digital drum instrument patch so as to play in the band with his friends. This increased John’s quality of life.

Both the parents and the music therapist underlined that through the experiences with SoundScapes John developed skills in making choices himself. He could, for example, choose by himself when to start and stop the music.

His mother remarked on the video showed his utterances following the musical tones he was playing through movement, something she had never heard him do. Furthermore, one of the helpers observed that when John after one of his sessions played in the room while another young man participated in a session, he communicated with him through joyful sounds and shouting.

It was noticeable that when John started to lose interest a simple change of patch regained and kept his interest for another subsequent period. Even after the session had been concluded, with the camera still running, the parents noticed that John was still working hard to keep playing.

The sessions with John were intense and emotionally charged as his facial expressions indicated that he went through different phases of interaction where intense concentration was balanced by relaxation, yet all aspects of the physical movements were intentional within his limits. His phase of attention is of interest as is his phrasing within each phase. This is the focus of subsequent investigation.

Intervention was necessary in John’s case and was positively commented upon by the parents and the music therapist as a form of guidance for his explorations. The music therapist remarked that “the system is just working if you have the right person behind it,” as is crucial to notice and capture very small details in the interaction, and as this is what can optimize the use of the technology.

B. Case study 2

The second case study is with a class of children at a special school for those with behavioural, contact, and well being problems (classified as AKT children in Danish) – previously described as “children with social and emotional problems.”

Characteristics for these children are difficulties in managing impulses, which means that they often act the impulse out, without consideration of consequences. They also have limited trust in themselves and others, especially unknown persons. In a written response to the sessions at the school, the children’s teacher said that it was notable that the children broke these patterns when they were within the virtual interactive space (V.I.S.) of SoundScapes [13].

The sessions with the SoundScapes system took place at the school. Each session had duration of two hours with one (1) week in between sessions. Participants were one group (n = 14) of younger children (7-10 years old) and one group (n = 9) of older children (10-14 years old).

The Virtual Interactive Space was created as an active single zone of 6 meters. The mapping of the data was to a drum or piano sound. The data was also mapped external from the computer to an intelligent robotic light which could be controlled by movement in the zone.

The first time they were all present at the same time. Everyone tested the system shortly and was reported as being fascinated by the teacher.
The results showed that in spite of their difficulties in relaxing and their need for control, they felt safe and relaxed, so much so that, for example, they closed their eyes in front of everybody when they were asked to do so, without any questioning or unwillingness. They were not disturbed that the rest of the children were playing around them, which would normally disturb them (teacher letter extract).

First the group of younger children (7-10 years old) had a short try with the system. Even though the time was short and other children were present, they were described as experiencing that the room was out of the ordinary. The special teacher noticed that the children expressed themselves through their body language easily. This was once again remarked upon as a rarity.

In one session the older children, with their eyes closed, “blindly” allowed a SoundScapes visitor - a female therapist from New York - to guide them. The special pedagogue said that:

“We have never seen anything like that before, that they have allowed such things with strangers. But the most amazing was, that they entered a meditative state and excluding the arm by which they were guided, their bodies were relaxed and completely calm.

The children played within the space for 10 – 15 minutes each, and had to be interrupted so that another child could try. The special teacher stated her amazement at the length of time that the children were engaged and that: “The children had a smile on their lips and had a remarkable positive experience.”

The condition for children which is something that the special pedagogy they traditionally use strive to do, but has difficulties to target.

Extracts from the long letter from the school exemplifies the impression made by the experimental sessions: “This vital condition is particularly important for them to develop, in order to be able to find trust in themselves and others, and to be able to handle their own and others impulses.” However, she underlined, “…the speciality of your virtual interactive space is that it is a fun experience that creates space for the child, and where the interactivity supports the child to experience and control what happens.”

VIII. BREAKING PATTERNS ON LIMITATIONS AND ABILITIES

As stated in the start of the paper, technology influences the situation of people’s every day life and this, in turn, has an impact on opportunities for health related quality of life. The results from the involved studies showed that the participants’ experiences with SoundScapes changed a complexity of patterns, doings, and perceptions, which arise from a semiotic interplay between the participant’s ‘inner’ and ‘outer’ world, into new and emergent learning processes in a continually ongoing process [14], [5].

These ‘doings’ and ‘interactions’ are, in this context, characterised as non-formal learning processes in the form of exploration and curiosity, as in [15], rather than traditional formal learning and therapy. A kind of shared situation was identified within the SoundScapes sessions, which indicated a level of intersubjectivity among the participants and facilitators, which was unusual in their ordinary everyday life.

Intersubjectivity is characterized as shared situations and joint participation. Reference [5] states that intersubjective experiences and knowledge sharing connects the child’s internal and external worlds. Within the SoundScapes sessions the shared situations was negotiated through semiotic mediation, as in [16], including gestures, sounds, and language. This flexibility in modes is important for sharing experiences. Reference [16] underlines that the semiotic challenges that adults provide in their communication with children are particularly important for the child’s possibility to redefine an on-going situation. Reference [17] describes this process as a “scaffolding” performance.

VIII. PLAYFUL EXPLORATIONS

New technologies empower and change our ways to act and perform despite limitations and abilities. Children more than others live in a world of exploration and this is where the learning and creation occur, as in [18].

The immediate feedback from the SoundScapes system enhanced and frustrated on-going processes of learning and development in an immediate situation, dependant upon a direct sense. Through this the SoundScapes system seemed to operate within the participants’ self-representations and provided a virtual interactive space like SoundScapes can support these children. She remarked that the concept targeted a crucial, relaxing and safe condition for children. As a result the special pedagogue pointed to something that the special pedagogy they traditionally use strive to do, but has difficulties to target.

As stated in the start of the paper, technology influences the situation of people’s’ every day life and this, in turn, has an impact on opportunities for health related quality of life. The results from the involved studies showed that the participants’ experiences with SoundScapes changed a complexity of patterns, doings, and perceptions, which arise from a semiotic interplay between the participant’s ‘inner’ and ‘outer’ world, into new and emergent learning processes in a continually ongoing process [14], [5].

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IX. CONCLUSIONS

The investigations are detailed as individual cases yet they exhibit corresponding findings in respect of the actual session findings, and additionally in respect of the reflections on the SoundScapes evolving methodology: an entry open for improvement which in itself is a core element of the SoundScapes concept.

In respect of the contents of this paper the insight gained in respect of findings (i) substantiated concept design (of archiving raw material) and thus improved the methodology (by highlighting the potential from a “Recursive Reflection” of the raw material exemplified in gaining new insight and learning to the process and design of the interactive play environments), and in respect of findings (ii) that the presentation for parents interview and comment and the teachers input presented the case away from an insular, perhaps somewhat positivist attitude, towards a design where closer dialogues are encouraged with those who are close to the participants so as to share nuances of knowledgeable insight to personality traits which would indicate to process refinement in the iteration cycle.

Furthermore, we explored the genesis of breaking patterns on limitations and abilities in form of emergent play and learning processes, and as shared situations and joint participation, that is to say intersubjectivity. Playful experiences were identified occurring within what we have named the Zone of Optimized Motivation. Moreover, the findings pointed at play, without immediate goals, and creative achievements offering exploration and expressive elements that motivate the condition of flow.

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www.soundscapes.dk for further images and material related to this study (and others) under the SoundScapes platform.
Humanics 2: Human Computer Interaction in Acquired Brain Injury Rehabilitation

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Abstract

The Humanics project goal was to produce a home based telehealth training and reporting device for the client that had an acquired brain injury. Initial feasibility testing was successfully undertaken at the Centre for Rehabilitation of Brain Injury (CRBI), Copenhagen and this led to the creation of a research protocol that centered on key issues of creativity and resulting motivation for implementation in a full project. The core body of research utilized for the feasibility study was applied as a new supplementary therapeutic aid. The subsequent full project, which is the subject of this paper, however, ran into detrimental problems in the collaboration with the commercial partner resulting in a curtailed project that did not realize its goal. The issues appertaining to the failure of the main project are discussed in context of a reflection on the report with questions asked of the strategies and decisions of those involved towards a refinement of future protocol.

1 Introduction

Interactions through movement empowered by technology to control multimedia feedback opens up new possibilities in rehabilitation to optimize training potentials, and thereby offering new opportunities to improve the patient’s quality of life in different ways depending on their needs and desires. The multimodal character of the interaction – i.e. a selected mixture of sounds, music, image, vibration, etc., controlled by gesture - center on key issues of creativity and resulting motivation. The body of research is founded upon an earlier research system design titled SoundScapes (Brooks, 1999), used together with handicapped, elderly, and in rehabilitation, so as to offer accessibility to appealing technology for improvement of their physical and cognitive skills (Brooks & Hasselblad, 2004). Furthermore, SoundScapes has inherent design aspects to specifically accommodate adaptation as an Interactive Home Telehealth system1, based on utilizing the Internet for observed training progress and reporting. As an iteration of the SoundScapes system being successfully facilitated in the feasibility investigation (Brooks, 2004b) the research presented in this paper2 was dedicated to the production of the concept as a marketable product. It is important to note that the eventual system that was developed as a prototype in the main project research differed from SoundScapes which was used in the earlier successful study. A commercial company, titled Personics attained the contract for the production.

2 Background

2.1 Personics: Baseline, Prototype, and Promises

The company Personics was created in the year 2000 as a result of the successful bid for the contract with Centre for Rehabilitation of Brain Injury (CRBI). The company were contracted to create a system to fulfill aspects of the

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1 In 1999 the author Brooks won a top European prize for his design of this system at the Brokerage Event on Applied Multimedia (B.A.M.) held in Stockholm, Sweden.

2 The research presented in this paper is founded upon collaboration with the Centre for Rehabilitation for Brain Injury (CRBI) in Copenhagen, Denmark.
feasibility study and to extend the results from that investigation into a product for the home and clinic where communication of patient progress was monitored and reported by an internet connection. The product was to be used in home training of rehabilitation for acquired brain injury. The training was to be enjoyable, fun and creative so that motivation was optimized. This design (see footnote 1; and Brooks, 2004b), based on using an adaptation to the common home theatre system, was to give direct multimedia feedback – sound and image – that was controlled through movement within an activated air space.

In the feasibility study the space of capture was achieved through volumetric 3D sensors and this was to be the baseline for the new system. The requirement to establish test bed sites through a network of recognized training research establishments was included in the design. This was instigated in cooperation with CRBI in the early stages of the project with key centers ‘standing by’ awaiting the prototype development.

The Personics prototype system consisted of three low cost infrared movement sensors connected by telephone wire to a small plastic computer interface box. The sensors registered movements obtained from the physical training. The data was routed to various animated basic child-like games created in the software Flash3 that visibly responded to the input from the patient. Sounds, which had been instrumental in the earlier studies and used as a reinforcement of patient awareness to proprioception were promised to be responsive - if not an improvement - as the original system.

The aim of the research was to obtain increased motivation and creativity in connection with physical training, but also to affect the motivation and creativity in the everyday life of brain injured people. Thus, it was hoped that brain injured people would initiate more activities, together with family and friends as well as alone. At the same time it was hoped that they would increase their creativity in everyday life. The subject of this paper is to critically reflect upon the results from this research, which is to say a meta-analysis on the fact that the Personics system did not fulfill the aim of developing a new, different, and motivating rehabilitation aid.

2.2 SoundScapes: A unique phenomenon

The core of the SoundScapes phenomenon was to create a space that was fun and enjoyable to be in, and that it was a place where the participant’s creativity and motivation was stimulated through a form of play and enjoyment. Furthermore it was to be adaptable so as to be accessible by all, no matter ability or limitation, preferences or desires, gender or creed. Beneath this fun “user-perceived accessed-by-all” layer, the information captured from the participant that is empowered to have control of the environmental feedback stimuli is the analytical data which gives an indication of training progress and session presence.

This concept and methodology is applied as a new supplementary therapeutic concept and methodology across distinct borders in the field and as such has been stated by neuropsychologist Lyon (2002, p.7) as being unique: “Der er mange andre metoder til fysisk rehabilitering. Men det umikke ved Soundscapes så ud til at være, at de kunne vække – og udvikle – en høj grad af motivation, glæde og kreativitet hos patienterne” [There are many other methods for physical rehabilitation available. But the uniqueness with SoundScapes, it seems to be, that it could awaken - and develop - a high degree of motivation, enjoyment and creativity among the patients].

From its initial seeding around the mid eighties SoundScapes was developed throughout the nineties finally evolving into an open platform for new inter-disciplinary investigations into various human performance aspects. Throughout these years the research has been applied at various disability institutes and special centers in respect of those who may benefit within special needs. Tri-weekly sessions at these centers led to the establishment of inductive grounded theories being developed where the parameter of human movement, communication and expression became the main focus and indicator. These theories developed into a phenomenon called Aesthetic Resonance (see next page).

These theories are the topic of ongoing inquiry in the field through various research initiatives which have resulted in a number of publications (see Brooks, 1999 – present), degrees based on the design and concept (e.g. Lyon, 2002) and research citations in studies (e.g. Kjær 1999, p. 11-12).

3 http://www.macromedia.com
2.3 Aesthetic Resonance

![Interactive Kinesphere](image)

**Figure 1**: Interactive Kinesphere created with sensors to explore Aesthetic Resonance.

Aesthetic Resonance refers to a situation when the response to intent is so immediate and aesthetically pleasing as to make one forget the physical movement (and often effort) involved in the conveying of the intention (Brooks et al 2002, Brooks 2003; 2004c, 2004d, 2004e). This situation arises within the space that we all carry around with us and which Laban titled our Kinesphere (see Laban, 1963, p. 85). Figure 1 depicts a participant in their own Kinesphere where a gesture is captured and translated by an interface as control data for the technology (usually a personal computer) to interpret and respond with selectable multimedia content manipulation in an immediate and direct manner.

Aesthetic Resonance was targeted in the Humanics 2 project such as in Figure 2 which illustrates a 3D animated dolphin that navigates through human body/limb movement in the Kinesphere to catch fish. In this training exercise in Humanics 2 the participants also generated a chart with scores so as to compete from day to day. In hindsight this is suggested as to substantiate the social bonding that is discussed later in the paper and which is suggested as a main positive outcome as far as the actual participants were concerned.

![Immediate and aesthetically pleasing response](image)

**Figure 2**: Immediate and aesthetically pleasing response.

In a similar way an earlier European funded future probe titled Twi-aysi6 based upon this interpretation of the term aesthetic resonance presented the findings, relative to the investigation of (1) control of robots through gesture and (2) control of animated 3D artifacts in a Virtual Reality (VR) environment with children between the ages of three and six years and having a severe disability. The research with the robots (Brooks, 2004c) presented similar findings to the VR (Brooks, et al 2002) in so much that the children were totally absorbed by the empowered control through their bodies and reaching an aesthetic resonant state.

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6 Animated dolphin game credit Pete Stromberg: [http://www.stromberglarsen.dk/](http://www.stromberglarsen.dk/)
6 [www.bris.ac.uk/Twi-aysi.html](http://www.bris.ac.uk/Twi-aysi.html)
3 Method

The objective of the project was to develop a home Human-Computer-Interaction (HCI) based telehealth system that utilized the internet to communicate user data to the therapist located at the clinic. The system was designed to be a sensor system that captures body function (movement) and should give controlled manipulation of selected multimedia feedback that should be pleasing to the user.

Following a user profile creation built by the therapist team through initial study sessions at the clinic, the progress data received from the user’s home is logged and compared with expected information so as to distance monitor user progress during self-training.

The stated objectives in the research protocol were:

- Does Personics give patients with acquired brain injury with physical injuries, an increased physical level of activity and function?
- Does the Personics System have the potential to become a relevant and novel system, and can it increase motivation for physical rehabilitation?
- When training in the system: Is a more free style of training (e.g. no specific physiotherapeutic exercise or goal) preferable to a more restricted type of training (e.g. specific physiotherapeutic measures and aims, comparing achieved goals, etc.) or vice versa?
- Can results from the Personics System be shown to correlate with functional change measured by traditional physiotherapeutic tests? And if it can; which functions will it be possible / desirable to measure?
- Working with the Personics System: Are creative and motivational aspects of specific activities outside the training sessions affected?
- Is implementation of the Personics System as a training measurement system in private homes a viable prospect?

3.1 Participants

The single-case study strategy was selected so as to include 12 adult participants selected among patients formerly enrolled in the traditional post-acute rehabilitation program at the CRBI. At a very general level patients enrolled in this program are typically half a year to three years post-injury and are able to handle most essential ADL at a reasonable level. A total of 51 adults, 26 male and 25 female former patients with acquired brain injury (stroke or trauma) aged 24-62 years were selected as potential participants. Exclusion criterions were inherent cerebral dysfunction, any history of psychiatric disease and substance abuse. All participants continue to have physical impairment following their injury (this means that a reduced function of one or more body parts is observed by means of common clinical, neurological assessment). Time post-injury for most patients was two to seven years having participated in the rehabilitation program zero to four years ago. Since the patients of the Centre (CRBI) are among the best functioning 30 per cent of all Danish people with brain injuries, many of them will be occupied in jobs in some measure. Homogenous groups of patients in relation to age, gender and localization / degree of injury were created. Focus was put on the largest possible variation of physical after-effects from the injury/the illness.

Offers to participate were sent out to all potential participants, after which they were invited to an information meeting with a demonstration of the system and a presentation of the staff. Those who were interested could then volunteer for a test period with two to three sessions lasting one (1) hour, in order to get to know the system better. On the basis of this test period, the twelve participants and four reserve participants were finally selected. At the same time, a draft was made for the particular exercises in the Personics System which was expected to be pertinent for each participant. An equal division of age and sex has been a conscious aim, and also as large a spread as possible in terms of time of injury, localization of injury, and degree of injury.

The session research team consisted of a physiotherapist, a neuropsychologist, and a psychologist. They were all employed at CRBI. The SoundScapes founder, conceptualist and designer of the methodology (author Brooks) was based at the CRBI for the duration of feasibility and main project.
3.2 Procedure

For the full project a makeshift laboratory was set up in a large room under CRBI offices. A screen of dimensions: 1 meter high x 1.2 meters wide was hung from the ceiling at one end of the room with a LCD projector arranged for back projection. Figure 3 illustrates the set up where a patient uses his balance to control an animation of a glass containing liquid on a tray.

The prototype Personics passive infrared sensor system was arranged according to physiotherapist desires, however this was not a strictly adhered to position (needing to be changed for each individual session) thus establishing an unforeseen difficulty in post session corroboration between sessions where consistent data is required. A video camera was also set up to record the sessions.

![Figure 3: Personics exercise: A game where the balance of the patient adjusts to keep the glass on the tray.](image)

Each participant was instructed in one or more of the jointly chosen exercises, and together with the physiotherapist, he/she selected a feedback that was deemed motivating for the participant as well as useful in terms of the exercise. The actual training with the Personics system, and the accompanying tests were carried out over two ten weeks periods. Six patients were trained in each period.

During the training period all patients were to be individually trained by the experienced CRBI rehabilitation physiotherapist in one hour duration sessions that took place two to three times weekly (depending on patient availability). Each session consisted of 20 minutes of free movement and 40 minutes of physiotherapist directed activity directed towards the patients’ needs, which in most cases was a form of endurance training for this target group. It also demanded much concentration from the participants. The entire session utilized the Personics System.6

At first, it was foreseen that typically there would be a need of physiotherapeutic involvement in the form of correction, guiding and changes of initial positions, but it was the plan that this involvement was to decrease gradually towards the goal of a self-training tool which can be used by the patient in their own homes.

3.2.1 Test Procedure Overview

For each 10-week period all patients were individually tested following the schedule below:

- At inclusion: User Interface Questionnaire / Prior experience with computers.
- Immediately before and after each 10-week period: Physiotherapeutic testing included tests of general fitness, balance, level of activity, and quality of movement. Psychological testing of creativity and motivation.
- At two and six and ten weeks into the training period: Focus group. (Video recorded open group-session with all participants). User interface questionnaire / Personics System interface.
- At every training session: Video recordings and audio comments taped by the physiotherapist.
- Where possible, results from tests carried out immediately after the traditional rehabilitation program at CRBI were used as reference points.

6 Before the study was carried out the system was made available to the staff involved for one and a half month accommodation period. This period included the before mentioned trials with patients using the system.
4 Results

The results are presented as they were interpreted within the research. The meta-analysis will be reflected in the following section. Results from almost all physiotherapeutic tests showed that there were no achievements among the participants. It was underlined that these results should be seen in the light of the concentrated training efforts the participants have carried out during ten weeks period, which should have shown measurable achievements. Especially since the project intervention level was higher than the participant’s normal level of training.

The creativity tests indicated a correlation between the test results and the diversity of ideas related to use of the system within the “free movement part”. The two participants, who had the highest level of creativity, also were those who said that they benefit from working with the “free movement part”. At the physiotherapeutic directed part of the training all participants seemed to be motivated to participate, though their engagement was affected of the problems with calibration and correction of the system.

The motivation tests showed that the participants primarily were directed by intrinsic motivation, and less by external factors. During the physiotherapist directed sessions and according to the feedback from the system, age seemed to be a factor that mattered. Fewer efforts were needed to attract the older generation of participants, and, thereby, less efforts were needed to motivate them.

Results from the focus group interviews showed the participant’s creativity and motivation through their many suggestions of concrete ideas about how the system could be used. The participants also showed a strong wish to continue the training even though there were a lot of technical problems when using the system. The participants’ valuation of the user interface showed that the participants in general had positive expectations on the system before the use of it. The high expectations were related to the short presentation of the system that was given to the participants utilizing the SoundScapes system by author Brooks prior to sessions start. The questionnaire was answered after the 10 weeks of training with the Personics system. The main results showed that all participants did not think that the feedback (sound/video) of the Personics system was usable in a long term perspective as it was not inspiring enough for further training.

5 Conclusions

The aim of the system was that it should be able to give motivating feedback during free movement sessions and during physiotherapist directed sessions, which, in turn, was planned to facilitate an increase in the participants’ everyday movements. So, for example, he or she would be able to open a door even though this should almost not be possible to achieve due to the participant’s physical limitations. However, during the realization of the project it was shown that it was only possible to work within limited restrictions due to an unwillingness and/or perhaps incompetence of the Personics company to satisfy requirements as promised.

The prototypes that were developed during the realization of the project, supposedly (as stated by the company) with a correcting feedback, showed to be unusable do to their inability to register at a sufficient resolution without problematic noise and false triggering. The results showed that the participants from a rehabilitation perspective reached a low degree of exchange when they were training with the system. It was hard to value the few physiotherapist positive results as this could be related to the high level of involvement and support from the physiotherapist (placebo effect) as well as to the training with the system. The former were considered to be the case. Thereby, the Personics System was considered not to have fulfilled the aim of developing a new, different and motivating rehabilitation aid, which should have stimulated the participant’s creativity.

The training situation and the testing were evaluated from a strict individual, physiotherapeutic and psychological perspective. Nevertheless, the results point toward possible social and contextual interpretations, which open up for opportunities to broaden the understanding of the result of the project. The meaning of inter-subjectivity and the environment suggest that the training basically is situated, material and social when, and if, it is useful.

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7 During the “free movement part” the participants themselves can choose tasks/movements, instead of focusing of specific therapeutic goals.
Working with the system during the free movement parts of the project, immediately showed that there was a need for a much higher degree of involvement by the physiotherapists than was expected from the start of the project. Consequently, there were just very few exercises that the participants could come up with without support from the physiotherapists in the form of corrections and evaluations. However, this could be understood as the training with the system not only seemed to be an individual matter, and not only related to the interaction between the system and the user. The training also required social interaction and inter-subjectivity to be meaningful. Inter-subjectivity is about sharing of purpose and knowledge and is central to motivation and creativity (Rosoff, 1990; Tikhomirov, 1999). Petersson and Bengtsson (2004) underline the importance of sharing purpose to develop trust among group members and facilitators and concern a central aspect of participation (Pettersson, 2004). This trust includes authentic creation of belief in other people’s ability to come up with suitable solutions to problems. Furthermore, inter-subjective experiences and knowledge sharing are connecting the user’s internal and external worlds (Vygotsky, 1978) and can change perceptions and expectations (Wenger, 1998).

These matters also stress a learning fact that the participants, as novices in using the system, accommodate to the understanding through underpinned joint activities with the physiotherapist who is considered as being more expert than them, which underline the importance of scaffolding performance (Wood, Bruner and Ross, 1976) in training situations. If the training with the system should be active, motivating, and creative, the participant must be empowered to, at least unconsciously, visualize the kinetic space, and understand the use of the system on their own terms. Through scaffolding performance the participant can learn and internalize the ‘rules’ of the system in order to make own creative contribution. Thus the user achieves clarity of the structure and accessibility of the system (Csikszentmihalyi, 1996). In line with Petersson (1999a; 1999b; 2004) the system by this should constitute a resource that through its design articulates and offers a network of choices for use (e.g. play and interaction), and the use of it could be connected to ‘actability’ rather than functionality (Pettersson, 2004).

However, if the training always operates well within the participant’s competence resources, then what happens is that the participant continues to experience success by doing the same things. This is good for masterful performance, but it is not good for developing newer and higher skills. But, as has been noticed from the results of the project, if the training operates outside the participant’s resources, the user will be frustrated and perhaps give up. In other words, the training should be balanced between ‘fun’ and ‘difficult’ aspects - this being both frustrating and enhancing, which in terms of Petersson (2000) means to increase the task in line with increased skills. ‘Within’ the participant’s area of competence, should, from the described viewpoint, be understood as being at the outer edge of the participant’s resources so that the system is experienced as challenging, but not unachievable. This is also part of what characterize an open-ended system (Pettersson, 2000). The criteria of open-endedness concern the complexity and flexibility of the system, which, for example, means that it is hard to predict exactly how to handle a task in order to proceed playing with the system. This, in turn, mean that an open-ended system embeds the aspect of surprise, which concern that it should not be easy to predict different situations, for example, if the child handle a part of the system the same way as the child did before, this is not a guarantee for the same thing to happen again. The system should surprise (a.a.). As such a masterful performance should encourage explorations without immediate goals as in play or curious discovery (Berg, 1992) so as to facilitate creative achievements. These ‘masterings’ could in line with Bigün, Petersson and Dahiya (2003), be characterized as non-formal learning processes in form of exploration and curiosity, rather than traditional formal physiotherapy.

The results and focus of the project emphasized the system merely as a training aid, alongside with the fact that the training took place at an institution, could have affected how the participants viewed the system. If the system to a greater extent would have been emphasized as a (complementary) tool for enjoyment and if the testing had been carried out in a home-environment, the results might have been slightly different. The way we name and contextualize our doings have an impact on how we approach and apprehend them. In a traditional physiotherapeutic training situation it is probably natural that the physiotherapist provides and guides the participant through the training. In this case the participant is more or less viewed as a passive recipient. That is, due to the aims of the project, a distorted view, as the future use of the system should not be in form of a traditional training situation, but rather in a non-formal creative and enjoying situation.

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8 This parallels Csikszentmihalyi’s theory of flow (1991; 1996).
9 This reflection is related to Vygotsky’s notion of the Zone of Proximal Development in learning situations (1978).
It may seem like a small change, but the words used can make a big difference in how we think and what we do. In fact, it was thought that the participant was supposed to train the most, and enjoy the most, to be engaged as an active participant. But, in a traditional and formal context it might be easy to fall back on training and thinking only what is simple and easy. The key is to find ways to make hard things life enhancing so that people are motivated to actively experience the world in a new way.

From the documented results it would appear that there were differences of the qualities related to what the different types of personalities gained from training with the system. The indication was that creative personalities gained a lot of possibilities, or at least potentials, to work “free”. Typical for individuals with brain injury is also that they merely think in a concrete way. For this type of persons it is necessary with far more unequivocal, direct, encouraging and challenging feedback on their movements. From a technical point of view it has been shown that it has been difficult to register and process movement pattern in “real time”, which has relevance for the training of this group of patients. Because of that, this task should be focused, instead on the entertainment value, in future developments of the system. However, from a critical and holistic point of view, it is a danger to separate the technical and the entertaining parts in such future developments of the system, they should walk hand in hand. Neither of the parts should be a later ‘add-on’, but should be central to the future development process from the beginning. These aspects put forward the fact that integration of perspectives and aims as well as inter-disciplinary collaboration in general is not an easy task. It is not only the aims of the specific project that have to be known, shared, and internalized by the project partners and participants. It is also a matter of making every partner’s and participant’s agenda to join the project clear to everyone, especially the so called hidden agendas, if the project should have a chance to be successful. In consideration of the dimensions above and the issue of flow (Csikszentmihalyi, 1991; 1996; and Brooks 2002, p. 841) one design factor planned for the future SoundScapes is where machine intelligence plays a role so as to adapt according to user input. This depiction can also be considered related to Vygotsky’s theories in respect of learning and development (see footnote 9) and have intrinsic entertainment value.

Finally we state that the potential of the initial design (SoundScapes) is still sound accounting for the dimensions listed above. The home telehealth concept that was originally formulated upon musical peer to peer exchange of digital protocol information from remote locations and interacted to locally is seen as viable. The increasing speed of data exchange and accessibility of online networking stimulated the design of an advanced system that was to take advantage of the internet so that users would have the benefit of selecting their practitioner/therapist/clinic without restriction of distance; be able to train at home with family support; be alleviated the stress, economic and time burden of traveling to the clinic for sessions; and to assist the ever growing burden of time management for clinicians.

To conclude we reiterate the point that “SoundScapes revolves around the creation of a ‘play’ experience that is stimulating and entertaining for the user” (Brooks 2004a) this point reflects the final comment from the interview with the physiotherapist in Humansics 2 with the Personics system where she was asked ‘If you should start the whole project again, what would you have done differently – suggest improvements to the system, concept, and methodology based on this’.

I would make it the most important that the users had fun while using the system. That the movement itself was more important than how the movement was performed. The system would be like a play or game tool rather than a physiotherapeutic rehabilitation tool.

J. Sørensen, physiotherapist, Center for Rehabilitation of Brain Injury (CRBI) interview, (personal communication, March 7, 2005)

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10 Lessons learnt from the project will be implemented in future development of the SoundScapes system.
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Abstract

The paper reports on an initial explorative study that inquired to the response of persons with profound and multiple disabilities in an interactive environment. Our goal was to explore the potentials of interactive environments for improving quality of life for people with special needs and those around them. In the study they were empowered within a volumetric non-invasive interface to actively experience gestural control of sonic events. Case studies exemplify the findings indicating a potential that can encourage social interaction and benefit user, carers, and family. Conclusions highlight evaluand significance to other interactive research such that when a state of flow is achieved both a new reality and state of consciousness are opportune.

Key words: Disabled, flow, quality of life.

1. Introduction

Persons with disabilities enjoy interaction as much as the next person. This may be more so for those with profound and multiple disabilities, and those challenged developmentally, as their social contact is limited. This has been suggested by Clegg (et al., 1991) as because carers are unsure how to interact with these people. Others point to the violence from those with challenged behaviour as the reason of the limited contact and interactions (Emerson & Hatton, 2000).

Previous research (Davies, 2005) emphasizes difficulties in regard to traditional strategies of measurement, replicability and objectivity, regarding the sector of the special needs community. Understandably then, in terms of research, this group may be “considered too complex and diverse in character to tackle, and in terms of healthcare, not necessarily able to make their voices heard” (Davies, 2005, p. 285).

In creating adaptive environments that encourage interaction for these groups of people within the special needs sector, we believe new opportunities in improved quality of life is a distinct potential, for them and even more so for the staff caring for the people. Having enjoyable experiences together in interactive play scenarios alone - with staff supervision passive-, or with active staff intervention, is in our experience conducive to improving relationships and in the long term could improve the work place for careers.

2. Intersubjectivity and individual processes

The actions and interactions in interactive play scenarios are, in this study, characterized as non-formal learning processes (Petersson, 2000; Petersson, 2004; Bigün, Petersson, and Dahiya, 2003) in an intersubjective manner (Aderklou, Fritzdorf, and Petersson, 2001), as important basis for individual processes. Convergent references to the notion of intersubjectivity are described as “mutual understanding”, “symmetrical dialogue”, “sharing situation”, and “joint participation” (Rommetveit, 1978; Trevarthen, 1979; Rogoff, 1990). Vygotsky (1978, 1981) states that intersubjective experiences and knowledge sharing connects the individual’s internal and external worlds. Wood, Bruner, and Ross (1976) describe this process as a “scaffolding” performance. Furthermore, the shared situations are negotiated through semiotic mediation (Wertsch, 1985), in this study including mainly gestures, and sounds.

2.1 Capacities of action

We suggest that the basic understanding of intersubjectivity needs to be modified beyond harmonious processes. Interactions that are not conforming to the traditional understanding of intersubjectivity plays a vital role in the formation of the individual. We define divergent moments as part of intersubjective functioning.

In doing so we draw on Burke’s (1969) notion of dramatic action, which, according to Gusfield (1989), includes “conflict, purpose, reflection, and choice” (p.
Burke (1969) introduces a pentad to provide a basic form of action (e.g. Rogoff, 1990). Burke (1969) delineates his dramatic pentad in terms of act, agent, scene, agency, and purpose. In the pentad framework ‘agency’ is the corresponding term of mediation, and furthermore in respect of the emotional signalling via expressive behaviour (Scherer, 2000) which we focus upon, it can be seen (section 3.4) how action tendency is a component of the emotional reaction triad (Scherer, 2000) and thus pertinent to Burke’s theories as presented here.

### 2.2 Capacities of mediation

Mediation, in terms of Vygotsky (1981) provides a link between the actions carried out by the individual, on the one hand, and the institutional context, on the other. Wertsch (1991) expands upon this framework by adding analysis of the artefact as a mediator. Artefacts are essential as they shape actions. Thus, mediation is an active process (Wertsch, 1991). Accordingly, mediation is seen as a process involving the potential of artefacts to shape action, on the one hand, and the use of these artefacts, on the other.

The use of the non invasive interface and content is empowering as well as constraining, and, thereby, it opens up new avenues of action for the people with profound multiple disabilities. The kind of constraints that we have in mind is often recognized by the facilitator, and often retrospective. How to use and overcome these constraints is a concern for the facilitator in the immediate situation. In view of that, we have coined the Zone of Optimized Motivation - ZOOM (Brooks and Pettersson, 2005b), which refers to an interactive space that encourages and supports immersion, engagement and concentration through machine controlled intervention.

The Zone of Optimized Motivation is important as it encourage the user’s unintentional and/or intentional explorations and expressing of him- or herself. By this, the expression has an immediate character, which places the participant in the midst of the experience as in a flow state (Csikszentmihalyi, 1996). In this paper the state of flow is creating both a new reality and state of consciousness and where non-formal and unintentional learning occurs. Accordingly, the state of flow creates a new form of reality. A main point we would like to make here is that this is an area where rehabilitation and education has an opportunity to expand children’s skills substantially, particularly so, as play is so closely related to intrinsic motivation. Optimally, this matching is intrinsically rewarding (Csikszentmihalyi, 1996) and the enjoyment derives from the use in itself.

### 3. Case studies

This paper presents a qualitative study undertaken with persons having profound multiple disability where the individual is empowered to actively control selected content by body gesture. The warranted strategy of utilising qualitative research as the methodological paradigm for the study is substantiated by Patton (1990) who offers the four traits (i) the emphasis on individual outcome; (ii) the detailed in-depth information about the phenomena under inquiry; (iii) the study’s focus on diversity and unique qualities of individuals; (iv) no available standardized, valid, and reliable instrument.

We selected four case studies from our sample of 18 (see section 4).

#### 3.1 Equipment

The system used for the study was based on non wearable devices that did not encumber the body of the participant, i.e. wireless. The system consisted of sensors\(^1\) that created a volumetric information space which in prior research has been coined as Virtual Interactive Space (VIS) (Brooks, 1999) and which is more recently referred to commonly as a Virtual Environment (VE). Movement in the information space generated output signal data from the sensor. This data was routed to a computer and a sound module/synthesizer. The output of the sound module was routed to a playback system for the participant to audition the sonic response to the participant’s gestures.

#### 3.2 Set up

In setting up the system there were two main zones of volumetric information capture available for the facilitator to place the participant. Established around a perpendicular axis emitted from the small sensor head were two 3D zones that were defined by the sensitivity programming of the onboard circuitry. The first zone was defined initially for size and sensitivity. The second zone was enhanced through retro-reflective microprism technology which activates an additional zone having a trait of reverse polarity. Each zone polarity information output could be reversed in the sensor but they had to remain opposite to each other (Brooks, 2005). This enhanced information space – the additional second zone – offered a freer environment for motion to data capture as it can extend up to over 14 meters and thereby offers and encourages a direct contact with the content feedback rather than a fixation on the mediating technology. In other words the interaction becomes more intuitive as body weight change, rotation, or other activities trigger events.

\(^1\) The term sensor relates to cameras, microphones and various devices using ultrasonic or infrared technologies.
3.3 Design and procedure

The participants in the case studies had sessions individually over a two year period. The participants had no prior experience of interactive environments. The time frame varied due to illness one of the participants. The participants experienced a situation where movement created an event from movement in free space. Thus a limb, head, torso, or whole body was sourced for information to make music. Initial sessions were in establishing an understanding of the interactive space through facilitator guidance. This meant actively taking the hand of the participant and guiding it through the sound space. Tactile response that was exchanged between facilitator and participant guided the participant’s understanding of the space and subsequently the space was explored by the participant through hand and head movement without guidance. A silent space – i.e. no interaction - was always available which also indicated to the facilitator an interpreted understanding through use as a pause place.

All sessions were video taped. The analysis of the sessions involved rigorous manual observation technique. The video data was analysed for defining peaks and lulls of emotive indices and labelled through cross reference to the field notes and memos from the sessions (Appendix 1).

Ethical considerations were taken. Parents and facilitators were approached about the study, informed of the goals, and gave their permission beforehand.

3.4 Annotation

Usually three types of annotation of emotion are implemented (1) appraisal dimensions (2) abstract dimensions (3) verbal categories, the latter being the most common (Abrilian, et al., 2005). However given that we did not have any verbal expression from our sample we focused on the subjective emotional signalling, via expressive behaviour (Scherer, 2000). In this respect we were influenced by Efron (1972), Ekman (1982), and Knapp and Hall (1992).

Other components of emotion also have a bearing for our study – namely: feeling; motor expression in face and gesture; neurophysiologic response patterns (in the central and autonomous nervous system); cognitive evaluation; and action tendency which is referred to as the “behavioural consequence” of emotion. The first three of these – feeling, physiology, and expression are referred to as the emotional reaction triad (Scherer, 2000, p. 156).

Segmented video annotation analysis was instrumental (e.g. appendix 2) and again influenced directly by nonverbal strategies of investigation as listed above.

4. Results

Four case studies were selected to best illustrate the exploratory inquiry of people with profound multiple disabilities and response in interactive environments. The four individuals were John, Mats, Beata, and Hans. The unit of analysis was the artefact-mediated-action. In particular, and inspired by Burke (1969), we focused on qualitatively different transformations in action when using the artefact. Basic coding was to look at transformations in form of conflict, shared situation, reflection, and choice related to the participant’s facial and other nonverbal semiotics gestures. In John’s case of significance was a suggested coupling between the facial and hands signalling that prompts further investigation.

4.1 Semiotic interplay

Appendix 1 shows a sequence from a single session with the agent John, which constitute a visual example of semiotic interplay during sessions. The semiotic interplay involves individual, social, and material processes, which are based on that the artefact (agency) in question shapes actions in use. The facilitator was also a part of the scene as he/she challenged John through empowering and constraining the different on-going processes. However, focus of the results in this section is merely on individual internal and external processes, rather than on results based on intersubjectivity, which is the theme of the results presented below in section 4.3. Average length of sessions was around 27 minutes. The six segmented images in Appendix 2 illustrate how focus on the facial expression is in accordance with the hands. The image sequence constitutes an action cycle within one (1) session. Each action cycle lasted on average around 3-4 minutes segmented by a distinct pause. The <start> image, tagged ‘pensive anticipation’, was where John indicated recognition that a VIS was being set up with a sensor for him to manipulate sounds with his head. Following the registration of the sounds he joyfully explored; got a surprise; and, focused on the feedback – his face and hand expressed a concentrated effort. His final phrase in the initial session phase was defined head realignment where his vocal utterance was recognized by parents in the video interview as related to the pitch change of the sound patch he was manipulating. This achievement – accompanied by a relaxation of the hands - was followed by a state of rest <End>. Intervention strategies were also incorporated with John whereby a volumetric sensor was positioned immediately in front of his face so as to source his cheek muscle. The facilitator informed that this was his only perceived controllable body part in an effort to play drums.

These behaviour signals were relative to the components of emotion (Scherer, 2000) for each individual case and with obvious variance had a commonality. The
transformation between inner to outer processes had temporal variance between cases but in all cases the interactive technology was as a mediator to the process. The technology was also used by the facilitator to challenge the agent through improvised play within the knowledge boundaries, e.g. from the functional abilities profile – i.e. abilities, limitations, preferences and desires.

At all times it was important to challenge from the perspective of play and not a user perceived “therapy session” mindset so that an intrinsic motivation or interest was achieved (e.g. Taylor, 1960; Hunt, 1965). Notably, with the cases presented in this paper the extrinsic or non-autotelic attributes of interaction were not as prevalent as with for example acquired brain injured (Brooks, 2004a, Brooks & Petersson, 2005a).

4.2 Optimized intersubjectivity

Figures 1 to 4 show images from three different single sessions with the agents Mats, Beata, and Hans. The duration of the sessions with Mats, Beata, and Hans was approximately 14 minutes. Optimized intersubjectivity involved a scene with the participant as the main agent. However, the facilitator was as important in this section as an active inter-agent who actively reflected and interpreted the scene to make conscious choices to overcome constraints and encourage empowerment.

Figure 1 and 2 shows Mats. His optimized interaction was achieved in sessions when he was able to interact with the sounds that he himself generated: a grating of the teeth and a constant humming of musical tone that had been sampled and assigned mappings from the movement data. This as opposed to mapping the movement signals to a synthesizer or digital sound module.

The early sessions had instances of significance where Mats’ behaviour would signal his desire to participate more fully with increasingly extended instances of hand gesture raised to either side of his head being the obvious indicator of “in” – however, care with intervention had to be taken as it was a case that Mats individually had to locate and explore the space. The facilitator could only hint to location of the active space as Mats would signal direct dislike to too much intervention.

Figure 3 shows Beata. She did not require any intervention to discover the interactive environment. Once she entered the space she immediately signalled recognition when her behaviour was affecting the sounds and subsequently she physically explored the space through rocking back and forth in her wheelchair over long extended periods until she was stopped by the facilitator. In the sessions the wheels of the chair often had to be secured because she was so engrossed and physically expressive of the empowerment. The role of the facilitator with Beata was as an observer and note taker as various sound patches were explored. Her functional abilities profile was referenced mostly to determine preferences in cooperation with her long-term facilitator.

Figure 1 Mats

Figure 2 Mats

Figure 3 Beata
Figure 4 shows Hans trained by an external facilitator in front on a 3D infrared sensor that played sounds as their hands moved in front of it. In the picture he is guiding his facilitators hand as if he had learnt a new ‘thing’ (sensor space plays music) and wanted to guide her in sharing the understanding. The role play was motivating Hans and was optimal with his own personal facilitator.

Another case study, John, is the focus of appendix 1 and 2 which features video segmentation analysis and a more detailed explanation of the process of enquiry.

5. Conclusions

This initial exploratory qualitative inquiry has presented the feasibility of a non-quantifying strategy where transformation between components of emotional valence in response to feedback from within an interactive environment can be represented by facial expression and other nonverbal signals through behaviour.

We also pointed out a correspondence with hand gesticulation though at a more visceral level. The findings in the study reflect on a conscious use of non-intrusive interfaces that are applied in consideration of the participant’s specific needs. The use in real-time interactive virtual environments present how digital technologies can be used to enhance life quality opportunities through empowering creative expression for people with special needs through embodied interaction. The work consciously applies non-intrusive/invasive technologies so as to target freedom of person and freedom of creative expression rather than what traditional state of the art presents; utilizing HMDs, body suits etc.

Relative to Burke (1969) (section 2.1) and the system used in the study, we suggest the act as a gesticulation sourced by the interface with the agent as the human participant. The scene is the interactive environment mapped via the interface with the feedback as agency. The purpose is manifold.

For the agent the purpose is to enjoy, play and have fun. For the facilitator whose role it is to encourage the agent enjoyment, there is the additional role of awareness of data capture for progress analysis, be it video recording or computer data archiving. For the system the purpose is to source the motion data from the interface and map it to preferred feedback content, whilst simultaneously archiving for session to session analysis. Reflecting upon the inter-, intra- and mediating statements referenced to Vygotsky (1978), Rommetveit (1979), Trevarthen (1979), Rogoff (1990), Wertsch (1985) in section 2, the ‘here and now’ flow state of Csikszentmihalyi (1991) (section 2.3), and then cross reference to artist inventor Rokeby (1998) who gives insight to the shared interactive space of art and his observation of the public within his pieces, we can see that an intrinsic motivation where play itself mediates without extrinsic goal of control, or apparent ego, is the cumulative optimal state for development and interaction, which relates to the concept of the Zone of Optimized Motivation - ZOOM (Brooks & Petersson, 2005b).

5.1 Implications and further research

The findings from this study suggest that interactive environments can have benefit within the field of special needs. Our study, working within a specific sector of this community, suggests at a more generalised potential. One aspect of the outcomes from the study is that the increased social interaction element gives an opportunity to alleviate the violence shown by those with challenged behaviour. This is by encouraging shared enjoyment, and hence improved social contact between carers and agents so that working conditions are improved. Additional, this improved social contact offers the agent greater opportunities for improved quality of life.

In prior research we have explored non-wearable and marker-less tracking in Virtual Reality with profound and severe disabled children (Brooks, et al., 2002). We have also used the same system to empower the children to control ‘intelligent’ robotic feedback (Brooks, 2004b), and investigated use of the system with acquired brain injured rehabilitation (Brooks, 2004a; Brooks and Petersson, 2005a). In summary, this paper has presented the raw unbiased response of those who are experiencing the interactive environments that were created with the clear purpose of enjoyment. The state of flow that was achieved by the participants is suggested as superseding the ‘presence’ state which is targeted in existing VE research. In other words, as an explored state relating consciousness to ‘human experienced reality of the virtual’ we suggest that flow takes precedence. Furthermore, we suggest that the Zone of Optimized Motivation – ZOOM – is a fruitful base for play, learning and development and that the design of virtual environments advantageously should rest upon these theoretical foundations (see Petersson, 2004).
Figure 5 Future Convergent Technology Interface

In closing we predict a future convergent technology interface to optimize exploration of alternative realities that would not require head mounted displays, worn trackers, or the like. Existing at a molecular level and inhabiting the Kinesphere (Laban, 1963) it is conceptualized as utilising the bi-directional communication attributes of nano technology, as closure stimuli of the human affrent effrent neural loop, also known as the stimulus – response chain (Scherer, 2000); shown in figure 5 and previously stated by Brooks (2000; 2004a).

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References


Background on John: Although born 1975 without a disability at age 2.5 years a vitamin pill became lodged in his throat causing his state. Following this incident he did not move or respond to any stimulation for 2 years. The SoundScapes sessions with him began in 1998. He deceased in March 2000. The extracts are from just one of the video taped sessions carried out during this time. In 2005 this video tape was presented to the parents. The involved music consultant for adult handicapped was also present. Together the three parties were interviewed by an independent researcher with the help of a translator and they were video recorded as they watched the session video. The emotional viewing session followed a semi-structured interview created for the study. Subsequently they supplied John’s personal diary which was completed by the day-care personnel during the period of sessions. Both diary and interview/viewing stated to the positive effects of the sessions. N.B. Most people upon viewing the figures focus on the facial expression, thereby mainly ignoring the hands. The six segmented images in appendix 2 illustrate how segments of the whole combine to indicate a ‘gestalt’ individuality of expression which is conveyed through body semantics that the facilitator should try to recognize. This constitutes the analysis segmentation theory as outlined in the text.
Appendix 2: The images above (and appendix 1) are selected from an extended investigation with John (name changed) a SoundScapes participant with profound disability hosted at a day centre in Denmark. In the sessions the participant’s gestures (head and hands) manipulated various ‘short staccato’ sound patches on a digital synthesizer; this through non-intrusive 3D infrared volumetric sensor technology. The ‘start’ image above is his mode without interaction. Following the registration of the sounds he joyfully explores; gets a surprise; and intensely focuses on the feedback – his facial/hand suggest a concentrated effort. His final phrase in the action cycle is defined head realignment that corresponded to a vocal utterance that was recognized by his parents in a viewing segment of a video interview (see Brooks and Petersson, 2005) as being related to the pitch change of the sound patch he was manipulating (so mimicking/mirroring the sounds he played). This achievement – concluded with a relaxation of the hands and was followed by a state of rest ‘end’ where the hands can be seen as resembling the state in the ‘start’ image. Intervention strategies were also incorporated with John whereby a volumetric sensor was positioned immediately in front of his face so as to source his cheek muscle which the helpers informed was his only perceived controllable body part in an effort to play drums. For more on this intervention facilitator role and guided participation, see Brooks and Petersson (2005).
Non-formal Therapy and Learning Potentials through Human Gesture Synchronised to Robotic Gesture

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Long paper

Abstract

Children with severe physical disabilities have limited possibilities for joyful experiences and interactive play. Physical training and therapy for these children to improve such opportunities is often enduring, tedious and boring through repetition - and this is often the case for both patient and facilitator/therapist. The aim of the study reported in this paper was to explore how children with a physical disability could use an easily accessible robotic device towards achieving joyful experiences and interactive play. Matched exponential mappings of sourced user feed-forward data to system multimedia feedback stimulus are detailed and offer quantifiable qualitative data. This is mediated through use of a robotic device capable of generating synchronous user-system interactive multimedia feedback. Results from multiple sessions with four children suggest that the interactive elements of an idiosyncratic immersive environment offer motivational non-formal potentials in therapy and learning to supplement the field.
1. Introduction

This paper reports on a non-formal therapeutic approach where children having severe disability were encouraged to “play” utilizing their physical gesticulations which are mapped to control synchronous robotic physical movement that results in multimedia feedback in the form of visual stimuli (light patterns/colors) and synchronous sonic stimuli in the form of sequences of notes (scales or melodies).

The approach presented in this article considers non-formal therapy as unintended therapy that encourages engaged play whilst offering a resource for joyful experiences and expressive interaction. Thereby, non-formal therapy always has a character where the individual is motivated by an interest to find the best possible form for expression.

1.1 Non-formal therapy

A ‘wireless’ link is established between a child’s available natural 3D movements and synchronized robotic movement. In this way the child controls his or her own multimedia feedback stimuli. The establishing of a Stimulus-Response (S-R) feedback loop [25] through gesture and multimedia feedback corresponds to the afferent-efferent neural loop closure shown in figure 1. This loop closure is a core component to the targeted goal of supplementing existing therapeutic (re)habilitation and learning through novel apparatus and new methods. Our research implementing robotic units synchronized to human gesture began in 1994.
The situated empowerment is thus the child’s control of the robotic device through it being synchronized to his or her gesture without encumbrance from worn body attachments and wires. Behavior indicating play sequences are thus - in our case - based on gesture of the user where a deliberate exploration of the ‘interactive volumetric information space’ is subject to transformational sequences whereby the user is able to detect the affective causality evoked through interaction with the robotic device. Fagan [12] suggests that ‘using a tool’ exemplifies such affective transformation. Accordingly, we focus upon the use of an interactive robotic device as the “tool” for the therapist to utilize towards the yielding of beneficial effects.

2. Background

This chapter offers a background to the research with the first section delimited to inform of selected other studies, fields of application and purpose of use of robotic devices reported in enquiries of human well-being. The second section informs of the interactive play inherent to our study and our understanding in its relationship to the development of a child. A third section reports on the intervention strategies implemented by the facilitator in the investigation and the significance in regards to design issues of the created interactive environments for the sessions.

2.1 Robotic devices in rehabilitation, therapy and learning.

In the last decade robotic devices have been created specifically for human interaction so as to motivate subsequent behavior and well-being [27, 35]. Robotic devices have been used in children and elderly wards in hospitals as well as
senior-citizens homes as companion entities [11, 13]; as a robotic pet for preschool children [16, 32]; and as automated home helpers [14, 21]. Hogan [15] details the therapeutic training of a damaged arm of a person with acquired brain damage (stroke) who is interacting with a device resembling a robotic arm. Social and interactive communication issues with a robot are also undergoing extensive research [17, 20]. The difference in response is evident in children when there is responsive movement interaction from a robotic device [28] and associated learning potentials are suggested from a study involving children with severe disability operating a robotic arm device [9].

2.2 Interactive Play

For a child with severe disabilities play situations could be more or less impossible and attached with frustration due to limited access to suitable tools for expression. Consequently, this affects the learning and fun potential for the child. Most play research informs about its relationship to children’s cognitive development, and focuses on solitary play [24]. However, this research does not account for the totality of what is going on in situations of interactive play. Our approach to play is activity driven and based on Aesthetic Resonance [5, 8] which is engagement where interaction is such that it subliminally encourages the child to disassociate from pain that may otherwise be present as a result of the physical movement involved in the conveying of his or her intention in interacting with the system.

In related work play in the form of intrinsic motivated exploration is considered as an important resource for non-formal learning [1, 4, 22, 23]. This is similar to what Csikszentmihalyi [10] names autotelic activity, which is characterized as an endeavor carried out for its own sake by inner goals generating the state of flow.
The robotic system used in achieving play experiences for the child may be viewed as a support to increment his or her current level of development [33]. An adjusted support for the child is offered by the interaction with the robotic system, which challenges the child to reach a level of mastery. Rogoff [24] names the process of support “transfer of responsibility” (p. 201). Inherent is the balance between challenge and sensibility that is allowing and encouraging change. This, in turn can result in an experience of self-agency and gained competence. This is characterized by two simultaneous processes, on the one hand it concerns use of technical tools and on the other hand it concerns mediation of psychological tools [34]. Hence, in our approach there is a constant transformation of existing interactions and the constant making of new interactions in an on-going process between the robotic device, the child, and the facilitator; all guided by the child’s and the facilitator’s individual interest. This relates to the non-formal learning that is contextually affected by the intervention strategies involved in the designed session participation and outlined in the next section. To derive meaning from the interactive play we next consider the intervention strategies involved in evaluating the children’s interaction with the robotic device.

2.3 Intervention strategies toward an evaluation methodology

When working with severe disabled children idiosyncratic attributes must be addressed so as to account for variance of facility, preferences and limitation. The facilitator’s ability to improvise and optimize the situation within the session through knowledgeable and timely intervention is expected as well as a trained competency in predicting the effect of system parameter change on the participant. In this way conditions encouraging creativity becomes central for use
in therapy and additionally for learning where the situation promotes investigation of the learning potentials within the personalized interactive play environments.

Intervention strategies by the facilitator are inherent in designing the interactive responsive environment where the interaction with the robotic system is taking place. Previous work emphasizes the facilitator’s role relative to participatory and recursive analysis of session data [6]. Informed input from helpers as to the child’s possible preferences increments the developing personal profile and assists the facilitator understanding the child’s engagement with the robotic system. This supports the facilitator’s reflection in action and, afterwards the research team’s post session on actions [26].

In this way session data are used to assess the optimal configuration of the system matched to the specific user profile. This is achieved through a process of session-to-session reflection and refinement towards a systematic evaluation method. The sequence of steps involved in a session is (1) preparation, (2) action, (3) observation, (4) reflection, (5) refinement. This becomes a temporal cycle when relating to a series of sessions and relates as a qualitative action research methodology which acknowledges facilitator intervention and desire for change. The interpretation of meaning is understood from synthesizing a hermeneutic approach to the whole or part - of the series, sequence or step. The resulting intertwined model can be visualized as an action research/hermeneutic spiral (Brooks, 2006 in press).

We suggest that facilitator intervention strategy makes a significant impact by manually optimizing the therapy situation. Thereby, the child and the facilitator develop means for an inter-subjective and joyful learning experience, which supports the child’s creative achievements. Optimally, this results in a masterful performance encouraging explorations without immediate goals as in play [3]
which are characteristics of a non-formal approach to therapy rather than traditional forms [7, 8].

3 Method

The aim of this research was exploratory and centered on achieving an understanding of learning potentials of interactive play situations with robotic lights and multimedia feedback as a supplement for traditional forms of therapy. The decision was that this aim was best achieved by qualitative research methods. A qualitative study using observation was conducted with children with severe disabilities who were interacting with responsive ‘synchronous to gesture in real-time’ robotic devices as a supplementary tool for therapy. Additionally, semi-structured interviews with each of the children’s carers were conducted and in this way it was hypothesized to be able to define characteristics of the robotic tool for use in rehabilitation and habilitation. These characteristics are embodied within the multimodal layered environment model, which has at the top-most level a user-perceived interactive “play” aspect and lower levels that relate to evaluation and analysis. All levels idiosyncratically reflect to each child’s personal profile with inclusive participation as an element of the methodology.

3.1 Inclusive participation

As the context of this study included children with severe disabilities including limited abilities to communicate their own wishes and desires, the carers became key persons when it came to the understanding of the specific child’s needs. The carers were inclusively involved in the study in order to optimize the understanding through their tacit knowledge about the child. The carers were asked to contribute with opinions, appraisals and interpretations of the specific
session situation and of the collected data. Each child's personal carer was in attendance at each session to ensure well-being. By this, we wanted to strengthen the validity of the study by decreasing mistakes like rash and naïve conclusions as well as simplified interpretations. This approach can be considered as participatory research, though to a limited extent [30]. Carers give their knowledgeable input but do not influence the research process as a whole, but merely the interpretation of data and, partly, also the concrete planning of the sessions. However, the inclusive participation approach used in this study was intended to involve the carers actively in the creation of specific user knowledge, rather than only being informed or consulted. Implicitly, this approach has a divergent nature [31] and, thereby, a situated character of understanding and communication. This means that the understanding is defined relative to actional contexts, not to researcher-self-contained structures [18]. By this, the creation of knowledge is participative and mediated by the differences of perspective among the researchers and the carers.

3.2 Subjects

The institute involved was asked to volunteer children who were all able to see and hear. Four children between 4 and 6 years of age were selected and included in this qualitative study. The children were from the community that is classified in Scandinavia as Profound Multi Learning Disabled (PMLD). All of the children were receiving regular physical therapy.

3.3 Equipment

An 8 channel moving light controller (Elektralite CP10) capable of translation of MIDI (Musical Instrument Digital Interface - a standard digital communication protocol) to DMX 512 (robotic device control protocol) was central to the system
with the graphical programming software Max\textsuperscript{1} used for the DSP (digital signal) mappings. The robotic device chosen was the moving head MiniMAC Profile intelligent lighting unit manufactured by Martin Light of Denmark that projects multi-colored light patterns of high contrast from a projection lens head capable of up to 540 degrees of pan and 270 degrees of tilt. Three MiniMAC units were used in the study.

### 3.4 Session Procedure

Each participant was involved in three sessions which took place at the Center for Advanced Visualization and Interactivity (CAVI) in Aarhus, Denmark. The set up of the sessions was in a large empty room approximately 25 meters by 25 meters x 6 meters high with white painted walls.

Most of the sessions lasted around 30 minutes, with the shortest at 11 minutes and the longest at 46 minutes. Information regarding the interventions that the children were engaged in during regular physical therapy was collected from the carer of the child. A basic child assessment coding scale for each session was established by asking the carer (1) how the child was perceived at the start of every session, (2) how the child was perceived during the session, and (3) how the child was perceived following the return to the institute.

Sensor selection and set up was logged to a user profile. The white-walled large empty room enabled that the full range of the robotic moving heads could be programmed to extend beyond the users peripheral field of view so that a head movement was required to observe at full extremities the moving light images projected by the robotic device onto the wall facing the child.

\textsuperscript{1} http://www.cycling74.com
As shown in Figure 2, the user was positioned near the center of the room with a camera behind to capture the scene. A second camera was positioned in front to capture facial expression and upper torso (including arms and hands) gesticulation. A sensor was set up according to the user’s ability of movement. Infrared volumetric sensors and ultrasound were used.

**Figure 2 – session set up (see p. 24)**

### 3.5 Data Collection

Total observation time for each participant ranged circa 90 minutes. Each session timeline involved dynamic interaction and response showing a recurring pattern. The resolution and sensitivity of gesture to the resulting feedback was totally programmable to accommodate the children’s variance and limited only by the physical constraints of the hardware and room location.

In this study, a qualitative observation guide based on the exploratory aim of the study and a review of literature was used. Four topics guided the observation process: (1) the child’s perception of the interactive play environment, (2) specific interests (3) (self)guidance, and (4) achievements. All observations were video taped. Field notes were generated after every session noting important information including possible questions to ask of the carer, the observation environment, and intervention strategies. After every session the carer was involved in the reviewing of the collected raw video data. This approach is in line with related research where we have developed a methodology named participative involvement through recursive reflections (Brooks and Petersson, 2005a). See also section 3.1 in this paper concerning inclusive participation.
3.6 Analysis Method

Video annotation was central to the analysis. The transcribed observations were coded separately by the two authors and then checked for validity and edited by the two authors together. The coding system was for each child and created with assistance from the carer who was familiar with the child’s various responses. The data were analyzed using an explorative, inductive method [2]. The appropriateness of the coding was assessed by the authors independently coding the video material followed by comparison to establish the credibility of the analysis. Notes on thoughts of the authors from the coding process, the development of themes, and other information that was important to the research were maintained in a notebook [29]. The results of the analysis were shown to the four carers separately for their review and opinions regarding the results. The carers were in agreement with the generated themes.

As best as possible we generalized common expressions among the children accounting for each child having individual faculty limitations and abilities. Typically, facial expression related to head and limb gestures. A smile, a mouth opening, a quieting, an eye focus, a frown, or hand gesture as well as lower torso movement were noted and reflected upon as to meaning.

Our parallel research with children in virtual environments [7] used a camera based software algorithm to analyze quantity and segmentation of movement and pauses post sessions, however in the study reported here it was found unusable due to (1) the excessive dynamic light change in the dark room, (2) insufficient background segregation (i.e. personnel movement in camera’s field of vision) and (3) the use of infrared night vision hardware that unknowingly caused corruption to sensor infrared data.
3.7 Ethics

Parents and responsible staff at the institution were approached about the study, informed of the goals, and were asked to give their permission on behalf of their children beforehand. Consistent with our earlier research at all sessions there was a knowledgeable carer to ensure no discomfort for the child. The carers were informed of their option/right to interrupt the session whenever they considered it necessary. At all instances we tried to be aware of biases that could affect the understanding of the session situations and of the collected data. Any research that involves individuals inherently includes sensitivity and integrity issues of those investigating due to their role as primary instrument of data collection and analysis [19]. This fact has its advantages, but also limitations. Throughout this study, an inclusive participation approach was used so as to decrease the limitations of relying on our own instincts and skills involved in the understanding of the observed interactions between the child and the system.

4 Results

The results are based on the analysis of three “robotic light interaction” sessions with each of the four children involved in the study and the analysis of semi-structured interviews in form of questionnaires answered by four carers. The child’s facial expressions associated to the head and limb gesticulations that afforded the interaction with the system were the basic unit of analysis. Our findings presented the facts that it was useful to apply an inclusive participative analysis of the video material to understand critical emerging elements in the children’s actions and interactions. Two main themes emerged from the data that were related to the child’s interaction with the robotic light. These themes were: (1) Doing as sensation [section 4.1], and (2) I am in control here [section 4.2].
The results pointed to learning potentials from Human Robotic Interaction [HRI] within a Virtual Environment [VE]. The choice of the MiniMac profile robotic intelligent light devices was astute through their ability to generate variance of multimedia feedback and to project the stimuli across a required range of physical wall space. The ‘physical-ness’ of the units, i.e. being robustly real and touchable with inherent machine noise, also seemed to offer a conduit that the children liked according to the carers.

The units responded with a latency of around half a second which was acceptable for this explorative study but not optimal. We tested various gobos (patterns) and colours but could not ascertain if they were making a difference to the child.

4.1 Doing as Sensation

The children in this study showed engagement in every session through an observed concentration and consciousness of intent. The twelve picture sheet in figure 3 illustrates various moments from the sessions where engagement was apparent. These pictures alone cannot tell the whole story, but only hint at the explorations and experiences gained.

**Figure 3 – 12 session shots of children** (see p. 24)

The carers stated that the children were tired following the return to the institute after the sessions and that the physical exercise from whatever limited abilities they had was a positive way to energize their available skills. This was observed as the children were generally more content and happier after the session. One of the carers stressed that the child’s engagement with the robotic device had an impact on the child’s personal life, as the child learned new ways to play, train, and enjoy through this activity. Normally, it was difficult for the children to fully
participate in play activities due to their limited abilities. To varying degree the
carers reported that the difficulties in having play experiences possible affected
the children’s development in general.
The children’s expression of *doing as sensation* was analyzed in terms of the
dynamic interaction between the child, the activity and the robotic lights. In terms
of the dynamic interaction, facial expressions associated to head and limb
gesticulations showed concentrated efforts in relation to the new experience this
interactive play provided them. The children’s exploration of the virtual
interactive space pointed towards awareness and enjoyment as the interaction
empowered them to manipulate the robotic device. The physical relationship of
synchronized child movement to robot movement reinforced the activity of the
child. The carers emphasized that the interactive play with the robotic lights was a
kind of therapy and that noticeably recognized utterances from the children gave
positive meaning to the interaction. Furthermore, one of the carers underlined that
the interactive play was better than traditional physical therapy as it added the fun
factor to the therapy, which enabled the child to have motivating experiences
instead of becoming bored.
Two of the carers noted that the interactive play enabled the children to develop
skills and supported them to incrementally push their movement limits.
Furthermore, three of the carers noted that following the end of the series of
sessions the children were noticed to be aware of social contact at a slightly higher
level and three of the four children showed indications of improved eye to hand
coordination and concentration.
4.2 I am in Control here

The children’s possibility to experience a sense of control within the interactive play was an important aspect that was emphasized by the carers. For example, the child had the opportunity to choose if he wanted to interact or to “rest” within the “silent” space, which was available, which is to say “no interaction”. Another factor that was mentioned by the carers was the easiness of the interaction and the child’s ability to maneuver and control the interactive play almost immediately following a short exploratory learning curve. One child however was not comfortable in his chair due to his back problem so we accommodated his position by placing him on a floor mat that was adjusted so that he was able to see his control of the light patterns. One child was asleep upon entering the Virtual Interactive Space [VIS] – a termed coined for the invisible interface space [5] - in one session. Slowly he awoke and explored with playful head movements that were mapped to the control of the device. Accordingly, the children exhibited a swift understanding of how to best control their movements and gestures in order to meet the challenge. The carers noted that the children enjoyed this challenge as they developed skills in their physical manipulation of the robotic device. The children were dynamically exploring what was happening under their control and discovered the interactive space further through varying the range, the speed and direction of their gestures. Two of the children especially indicated an early awareness of a direct correspondence and control to the physical movement of the robot head and the subsequent movement of the lights. Such self-achievement is a rare commodity for such children and was afforded by the simplicity of the system and set up which enabled the desired short learning curve exhibited.

The sessions followed a recurring pattern similar to the subject of children’s play, where exploration gives way to play the emphasis changes from the question of
“what does this object do?” to “what can I do with this object?” The study showed that along similar lines the sequence was hereby extended with further emphasis change of “when I move - the light patterns move:” “when I move - I hear sounds:” “… when I stop moving I hear neither sounds or see the light patterns moving!” … “Hey I’m in control here- and its fun!” Observations further suggested that this emphasis was extended to “well nobody told what I should do, or for how long, so I will just have more fun with what I have learnt I can do with this object!” Sessions were ongoing until the child signified cessation through a reduced engagement. This was confirmed by the child’s carer who was observing a monitor which showed the child’s facial expression throughout the session.

5 Discussion

Key components that are required for self-agency and autotelic experience will be discussed relating to individuals engaging in play with robotic devices and multimedia feedback. Implications in therapeutic use of robotic tools will also be touched upon. Before discussing these issues [section 5.1, 5.2, and 5.3], reflections concerning improvements of the technical set ups have to be clarified. The set ups could have been improved, especially the sensor locating for gesture capture from the human user. The sensor should be remotely controlled from a distance so as not to interfere with the user and also wireless. This has been addressed in the latest generation of sensors with the implementation of Bluetooth technology. The use of front camera night vision setting needs to be further tested due to infrared impingement on the subject corrupting sensed data change by the movement sensor infrared receiver. This corresponds to the spurious infrared data mentioned in the text which initially confused.
5.1 Interactive Play and Self-agency

Through interactive play in interactive environments a child could acquire new abilities, interactions, expressions and emotions, enabling a mastering of tasks and practicing of skills. As such, the interactive play situations indicated an enhancement of the quality of play and learning, which, in turn, facilitated engaging explorations that were utilized in the therapy. This is to say that play had a motivational potential achieved from the interactive virtual environment. The children’s concentration when interacting with the robotic system furthermore emphasized the autotelic quality of the play. The virtual interactive environment had the potential to evoke the child’s interest in practicing otherwise limited skills.

However, the carers emphasized the children’s limited opportunities for play experiences in their everyday life. Thereby, the children had limited chances to challenge their skills and to develop new skills, which is vital in facilitating an optimal experience. If the child is limited in expressing him or herself and is unable to test his or her skills, this will limit his or her interest in trying. Rogoff [24] underlines that interest has a motivating character that channels the child’s choices involved in ‘doing’. After the children’s engagement in the interactive play activity the carers described an improved awareness, eye-to-hand coordination, and concentration. Thus, we would like to suggest, that through practicing of skills the child experienced a sense of control and, thereby, mastery and consciousness of the therapy situation. Furthermore, that the interest and the novelty involved in the therapy situation was influencing the child’s development of competencies in a positive way.
The main point we would like to make here is that these aspects show that non-formal therapy has an opportunity to expand the child’s learning experiences, as learning is so closely related to play and intrinsic motivation.

Our assessment of the contented happiness factor is that it may have been from the empowered activity resulting in achievement of control for the child whereby the success factor, often unattainable from children with such severe disabilities, was contributing to their emotional self-esteem.

5.2 Facilitating the Autotelic Experience

The approach was rich in promoting collaboration on different levels of participation; on child and facilitator level; and on researcher and facilitator level. In total, the collaboration motivated the participants to achieve more than they would be able to individually. Hence, we would like to suggest that intervention strategies have the potential to support emergence of new and improved forms of actions and interactions, in design of therapy. Thereby, the facilitator facilitates the child’s optimal experience of the interactive play through the adaptation of the interactive space. This situation empowers the child to meet the challenge. Thus, in interactive play there is a fit between the skill level of the child and the challenge offered by the interactive application. Interactive play facilitated by facilitator intervention offered a play experience where the children were able to experience an autotelic state that facilitated mastery and growth.

The children were observed enjoying the interactive play experience. The carers described the enjoyment as rewarding and that the interactive play with the robotic tool was an alternative to traditional therapy. The child’s enjoyment was related to the facilitator’s personalization (adaptation) of the multimedia feedback while the child was engaged in the interactive play. The children demonstrated
consciousness and concentration as they were in control over the interactive space, choosing the movement they wanted to produce or if they wanted to rest in the ‘silent’ space.

5.3 Implications for Non-formal Therapy through Robotics

We suggest that the following design issues might generalize from this study to other interactive non-formal approached therapy designed as remedial play environments for children with severe disabilities.

*Controlled and joyful play environment:* Children with severe disabilities cover a huge range of different skills, needs, and desires. The specific child therefore needs to be identified very clearly, but even then the interactive play environment needs to account for individual needs of the children. Interactive environments can be designed as spaces for play and learning [9]; for rehabilitation and therapy [17]; and exhibits a great potential for use with children with severe disabilities [7, 8]. In such tailored environments the feed-forward action from the child can be monitored and the feedback can be controlled. Successive therapy sessions can be evaluated in order to monitor progress of rehabilitation objectives, controlled by the facilitator. The interactive environment can be adapted and personalized to account for individual differences. Children can be guided through the play experience and explore actions themselves. Such environments can provide a space with as much or as little intervention that is needed in the specific situation by the facilitator. This kind of environment can partially replace routine therapy sessions. Such environments should be created in a novel, playful, and exploratory context where the children can use the environment in a creative way. Enjoyment and increasing the children’s quality of life is desirable.
Embodied and engaged interaction: The non-invasive design of the interactive play environment was promising and supported interactions involving the whole body in set ups where the children were free to move. They were not required to wear special devices on their bodies and by this their movements were not constrained in any way. An interactive play environment of this kind can explore new therapy practices based on a non-formal therapy approach where the children and the facilitator can explore and play, involving physical movements. These aspects are important prerequisites for the sense and experience of being engaged. In contrast to traditional therapy approaches, robotic and other interactive play environments are intuitive as it offers the child a direct contact with the content feedback. Embodied interaction can, thereby, provide new features to traditional therapy where the embodied interaction itself is a therapeutically content of the action and interaction.

6 Conclusions

In this study the goal was to explore the feasibility a non-formal approach to robotic therapy. The results showed that in respect of the sample all believed (or showed) that there was a potential for the concept as such. Remarks were made to the simplicity and uncomplicated nature of the concept which transcended many existing methods. Physical movement of the robotic device was synchronously manipulated from sourced data movement information from each child. The data was sourced through invisible volumetric non-invasive sensor technology. Mapping algorithms were used to ‘tailor’ match the range of sourced data – limited through dysfunction – to the full range of the robotic device movement. The results highlighted the positive effect of physical robot control by those with physical dysfunction and conclude at the potential of the concept as a supplement
to traditional therapy techniques. Furthermore, the results highlighted the intervention strategy with the facilitator as a key person as a prerequisite for engagement and for joyful experiences.

6.1 Limitations and Future Research

One of the limitations of this study was the small sample size. Although the results were sufficient to ensure that the main issues were elicited, it may not have been representative of all children engaging in interactive environments with robotics if given the opportunity. However, this study met the exploratory needs of investigating the children’s individual perceptions when participating in a new kind of therapy. The needs were supported by the carers that were closest to the children in their everyday activities. A second limitation of this study was the short term design of the study. Upon subsequent contact with the institute approximately one month after the end of the sessions, the carers stated that the children showed no significant long term improvement compared to their condition prior to the limited numbers of sessions. The initial elevated happiness had returned to the level prior to the study. These facts indicate the need for a long term study in order to study the potential of using robotics for children with severe disabilities, as well as to develop models of application. Furthermore, we emphasize the need to develop appropriate techniques, means of measurements, and instruments that are suitable to assess results and impact of the research.

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References


Play Therapy Utilizing the Sony EyeToy®

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Abstract

An international collaborative explorative pilot study is detailed between hospitals in Denmark and Sweden involving rehabilitation medical staff and children where the affordable, popular and commercially available Sony Playstation 2 EyeToy® is used to investigate our goal in enquiring to the potentials of games utilizing mirrored user embodiment in therapy. Results highlight the positive aspects of gameplay and the evauland potential in the field. Conclusions suggest a continuum where presence state is a significant interim mode toward a higher order aesthetic resonance state that we claim inherent to our interpretation of play therapy.

Keywords— Flow, Therapy, Training, Play.

1. Introduction

Our hypothesis is that game playing using embodied user interaction has evaluable potentials in therapy and thus significance in quality of life research for the special needs community. A state of presence is inherent where stimulation of fantasy and imagination involves engagement and subsequent interaction with a virtual environment (VE). Once this engagement is achieved and sustained we propose that a higher order state is achievable through empowered activity toward a zone of optimized motivation (ZOOM) [1]. This is possible by using an interface to the VE that is empowering without the need for any wearable technology that is deemed encumbering or limiting for the participant. The interface data – participant motion - is mapped to control immediate feedback content that has real world physical traits of response and is interesting, enjoyable, and fun for the participant so that experience and engagement is further enhanced.

Subjective presence has predominantly been investigated in respect of optimal user state in virtual environments and has been suggested as being increased when interaction techniques are employed that permit the user to engage in whole-body movement [2].

Our findings to date indicate at the motivational potential from an enhanced state of presence achieved from game environments where the body is used as the interactive unencumbered interface [3, 4, 5, 6, 7].

1.1. Presence and Aesthetic Resonance: as a ‘sense state’ continuum

We are interested in observed behaviour aspects of presence where there is evidence of only a limited body of research.

Accordingly the case is made for a continuum beyond presence that satisfies our requirement of a play therapy scenario where, from within what is termed a state of aesthetic resonance, we enquire to the potential from game systems with mirrored user embodiment by using the EyeToy®. As a result of this initial pilot enquiry we intend to reach a point from where to launch a fuller investigation with a more optimized environment, method, and analysis design.

Aesthetic Resonance (AR) is when the response to intent is so immediate and aesthetically pleasing as to make one forget the physical movement (and often effort) involved in the conveying of the intention and is in line with [4, 8].

Within targeted aesthetic resonance our strategy is to approach the same immersive engagement that occurs between a child and a computer video game that is often subject to negativity and reverse the polarity of attitude so that it is positively used to empower activities beyond the usual limits of the special needs participant through encouraging an immersed ‘play’ mindset rather than a ‘therapy’ mindset which our prior research has shown as optimal [9].

Within this set up the same information that is used as control data to the interactive feedback content is available for simultaneously performance progress monitoring.

System tailoring as a result of observations of user performance – both physiological and psychological – is opportune with related testing that supplements traditional forms of performance measurement.

This in line with our earlier approach to interaction in virtual environments with acquired brain damage patients [4, 5, 9, 11] and is related to a study concerning brain neuroplasticity and associated locomotor recovery of stroke patients that reports on users interacting with games and perceiving the activity not as exercise or therapy, but as play [10].
1.2. Play

Most play research informs about its relationship to children’s cognitive development, and focuses on solitary play [12]. However, this research does not account for the totality of what is going on between children in situations of interactive play therapy. Our play therapy approach is activity driven and the targeted aesthetic resonant state of the user we suggest is beyond the often used all encompassing term of presence.

Significantly, others have approached presence as an activity including video games [13] - but conducted in a laboratory which we question due to the situated effect of the environment on the participants. In previous studies [1] we state that activities always are situated, which underline a complex relationship between the individual, the activity, and the environment as mutually constitutive [14]. Thus a relationship to situated presence is implied as we base our enquiry at locales of predicted use with real users. The goal being exploratory is thus implemented in a pilot study so as to define problem areas to achieve preliminary data on potential of video games in therapy.

1.3. Under used resource for therapy

With the advancement in computer vision techniques and camera advancements we claim that systems such as the EyeToy® which focus on the body as the interface are an under resourced opportunity for therapists to include into training as unlike traditional biofeedback systems specific licensing is not required as there are no attachments to the patient. The system also achieves an essential aspect of licensing is not required as there are no attachments to the training as unlike traditional biofeedback systems specific opportunities to express him- or herself through non-human directed efforts in order to keep and increase the child’s immediate spontaneity in the situation (e.g. reactive content that promotes subsequent interaction from the child).

For environments to be supportive in this sense, they must engage the child in challenging ways. Even though environments provide children a sense of challenge, they have to feel that their skills meet the challenges. If there is an imbalance between the challenges and the child’s skills the child will become stressed or bored. Play and exploration encourage a sense of flow (immersion in enjoyable activities) that “provides a sense of discovery, a creative feeling of transporting the person into a new reality. It pushed the person to higher levels of performance, and led to previously undreamed-of states of consciousness” [15, p.74]. Optimal experience is also described as “a sense that one’s skills are adequate to cope with the challenges at hand, in a goal-directed, rule-bound action system that provides clear clues as to how well one is performing” [15, p.71].

These activities are intrinsically rewarding and the enjoyment derives from the gameplaying activity in itself, which is related to the notion of the Zone of Proximal Development in learning situations [20]. In an explorative manner the child’s cycle of movements can be shown to be fluent and intense or segmented without connection.

Laban [18] defines such changes in movements as important as they indicate whether there is a presence or absence of flow from one action and state of mind to another. As such the ZOOM [1] is important in its encouragement of the child’s unintentional and/or intentional explorations, without immediate goals as in play, or curious discovery, and as a foundation of evoked interest [21]. This kind of interest indicates that the state of aesthetic resonance facilitates a foundation of creative achievements.

The motivational feedback loop described in this paper is also influenced by Leont’ev’s [22] description of the formation of an internal plane. We have chosen to use the term of mastery to describe such processes where emphasis is on how the child’s use of the game features leads to development of certain skills rather than on internalization [20], or more generalized abilities.

Thus, gameplaying actions do not need to be conscious, as at a certain level they can be unconscious skills, which, supported by playful aspects of the game, proactively push the child’s limits towards new levels of movements.
As a preliminary investigation, we attempt to understand movements according to a semiotic interplay between the child’s inner and outer world [23] and relate the understanding to presence, through which spontaneous movement engagement and intensity is assigned [18].

We compare this to Wenger’s [24] and Vygotsky’s [20] description of emergent development processes. Bigün, Petersson and Dahiya [25] characterize such processes as non-formal, where exploration and curiosity are central conditions, rather than traditional formal training conditions.

The movement cycle of the gameplaying child includes a construal of rhythm. The movement cycle is concentrated on the game’s external achievement and by moving the body to achieve the external goal the child relates the inner world to the outer. However, it is not so that every movement unifies the inner and outer worlds, there has to be a “reciprocal stimulation of the inward and outward flow of movement, pervading and animating the whole of the body” [18, p.110] in order to enhance a sense of aesthetic resonance. In this way there is a range of flow through presence, from excitement to stillness, which increases and decreases the child’s participation in the gameplaying activity.

This range embraces an orchestration of expanding bodily action in space, or, in terms of Laban [18], includes different trace forms of movements that demands continuity of gestures and it is these gestures that we analyse.

3. Method

In consequence with our interpretation of the referenced theories and to fulfil the goals of the investigation we used a triangulation of qualitative methodologies to qualitatively analyze the combined materials from the two hospitals:

- Video observations of children playing with the Keep Up EyeToy® game;
- Interviews with children and facilitators;
- Questionnaires to the facilitators involved;
- Diaries/field notes from the facilitators involved.

The subjects in the studies were 18 children (10 females and 8 males) between the ages of 5 and 12 years, mean age 7.66 years, in 20 gameplaying sessions. The children were selected by the hospitals not in sessions [5, 9, 11]. The facilitators involved at the hospital were two play therapists and three doctors.

3.1. Description of material

In 2003 Sony Computer Entertainment Inc. released the EyeToy® as a new video game series for its market leading PlayStation®2 (PS2) platform which is based upon using the player’s body movements as the interface to the game.

This controller is unique in concept as all interactions to the game are through the video window rather than through the more common handheld gamepad or joystick device. The system is thus ideal for our enquiry.

The EyeToy® game chosen for this study was called ‘Keep Up’ due to its immediate action content, built in scoring, and cross gender qualities. A monitoring system based on multiple cameras supplemented so that post session analysis was available.

3.2. Description of procedure

EyeToy® games have ‘tasks’ for the participants to accomplish. The task within this game is to keep a virtual football - with animated real-world physical properties - ‘up’ within a virtual environment.

One game sequence is limited to three balls and three minutes.

After three balls, or alternatively three minutes, the game agent turns up and gives the player negative or positive feedback related to the scores of the game. The player can increase or decrease the scores by hitting monkeys and other animated characters with the ball as the game progresses.

At both hospitals the studied activities took place in rooms that also were used for other purposes, such as staff meetings and parent information. The children were not normally playing in this room and the system had to be set up around positional markers on floor and tables.

Parents were approached about the project, informed of the goals, and were asked to give their permission on behalf of their children beforehand.

Following the parents signing their permission the children were also asked to sign their permission to participate.

The process started with positioning the child in the calibration upper torso outline on the screen and after an introduction the game was started.

The gameplaying activity was observed and video recorded by the play therapists and doctors.

After the ending of the session the children were immediately asked follow up questions concerning their experiences of the gameplaying activity.

After the end of all sessions the play therapists and doctors were asked to fill in a questionnaire concerning their own experiences.

A final interview with the play therapists and doctors was also carried out to conclude the field materials.
3.3. Description of the set up

In previous research on camera capture as game interface [6, 10] standard TV monitors were apparently used. Our approach uses a LSD projector for large image projections approaching a 1:1 size ratio of the child (mirroring). This strategy is built upon our prior research investigations [1, 3, 4, 5, 8, 9, 11, 16] to optimize the experience. A related study is reported in the case of presence and screen size [17]. Traditional use of mirroring is used in therapy training at institutes for people with disabilities and thus our design is ‘fit appropriate’ to this context. Figure 1 (above) demonstrates the set up of the gameplay. The components included in the set up was: (a) EyeToy® camera plus front monitoring camera to capture face and body expression (b) VHS tape recorder (c) screen (d) PS2 (e) projector (f) the user space (g) rear camera to capture scene and screen (h) VHS tape recorder #2.

3.4. Description of analysis

The video recordings underwent numerous tempospatial analyses [26] where the units of analysis were the qualitatively different expressions of movement. The material attained from the sessions consisted of 36 x 1 (one) hour mini digital videos (rear and front views) – and corresponding additional backup VHS video tapes - of the 240 video games that were played by the children (n = 18) in 20 sessions at the two hospitals. Each video was digitized for the subsequent analysis; similarly, all video interviews, written notes, memos and written interviews were transcribed and transferred onto a computer workstation.

3.4.1. Manual analysis

Annotation was conducted by two coders. An initial series of four manual annotations of the video materials were conducted. These accounted for observed expressive gesture of the children (facial & body) (see Figure 2, and Appendix 4: Table 3).
experience the movement. Laban [18] states that the repetition creates a memory of the experience, which is needed for new inspiration and insight to develop. More specifically the temporal data was classified into discrete units for analysis by applying the specifics of speed, intensity, and fluency of movements [18, and Efron in 26].

The spatial specifics concerns where the body moves through extended movements towards another situation in the spatial environment. Example of spatial events are the qualities that are in play when the child seeks another situation in the spatial environment, e.g. moving like jumping or leaning the body from one side of the screen to the other whereby the central area of the child’s body is transported to a new position when keeping the virtual game ball up in the air. The spatial data was classified into discrete units for analysis by applying the specifics of range and intentionality of movements [18, and Efron in 26]. Alongside with these tempospatial qualities children’s face expressions and utterances were analyzed.

Thus, a detailed manual multimodal analysis of the videos was realized so that:

- each video was watched twice before the detailed analysis began;
- the analysis of the first eight videos was realised twice each and the following eight videos once each;
- each minute of video was systematically analysed and transcribed into an excel flowchart in relation to the categories described above. The categories analysed represented high or low degrees of the specific movement trait. This flowchart also included analysis of a facial expression, a description of what happened on the screen (Appendix 4: Table 3);
- every category (n = 8) was analysed separately, which means that the first eight videos were watched in total 18 times each, and the remaining being watched 10 times each. Additionally the multi-sessions were annotated further four times.

3.4.2. Computer analysis

Toward a goal to amass indicators of the overall motion attributes of each child an automated low-level movement analysis was computed on the videos utilising software modules from the ‘EyesWeb Gesture Processing Library’ specific to the quantity and contraction aspects of the movement’. The data was then exported to a spread sheet for further analysis.

Our strategy for the automated computer video analysis was to supplement the manual annotations toward our overall goal in development of the methodology by (a) following a background subtraction on the source video to segment the body silhouette a Silhouette Motion Image (SMI) algorithm that is capable of detection of overall quantity, velocity and force of movement is used. Extraction of measures related to the ‘temporal dynamics of movement’ is computed and a threshold value slider can be adjusted according to each child’s functional ability so that he or she is considered to be moving if the area of the motion image is greater than the related (to threshold) percentage of the total area [27]. The adjustment of the threshold value is achieved in real-time annotation of the videos (Appendix 2: Figure 4); (b) a contraction index (CI with range 0-1) algorithm is used with a bounding rectangle that surrounds the 2D silhouette representation of the child within the minimal possible rectangle. The CI is lower if the child has outstretched limbs compared to an image showing the limbs held close to the body where the CI approaches 1 (Appendix 2: Figure 5). Problems were apparent with the child encroaching towards the camera, and background noise. A correcting normalisation algorithm was unsuccessful in correcting the problem and thus refinement is needed [27].

4. Results

Our explorative question concerned the potential of video games in therapy and requirements toward a meaningful and optimized full investigation. Our findings present the facts that: (1) more care in the set up of the room background is needed – some videos had curtains blown with wind and people walking behind the child, (2) attire of children should contrast background – if light background and light shirt, then camera software problems occur with differentiating between child and background, (3) lightning of child/room should be optimised, (4) the system is developed for upper torso single person play but many of the children used all of their bodies, especially in kicking when the ball was lower in the screen (5) facilitators should not talk or be in line of sight. Our instructions were also interpreted differently by each hospital in so much that (1) in Sweden a time limit of 10 minutes was established for each session, (2) a long practise period was included within the Swedish ten minute period, (3) in Denmark one of the doctors also included practice periods for his children, (4) in Sweden multiple sessions were held in the same day whilst in Denmark single session per day.

4.1. Tempospatial movements

In annotating the games Start – Middle - End segmented zones were interpreted in respect of game and pause data. As expected the best performance was achieved in the end segments on an 8:15:17 ratio (even accounting for extended play boredom through no level change).
shortest game ratio was 18:13:9; the longest pause ratio 16:12:12; and the shortest pause ratio 8:14:18.

These figures indicate that the virtual environment interaction with the EyeToy® met with predicted balance of performance and learning curve. Of interest within the figures was the fact that in most cases the best performance was preceded by the child’s shortest pause and that following the best game it was often the case that the next two games declined in performance drastically. This matches the manual annotation where the activity (play) peaks and in most cases the emotional expression from face and body gesture before and after relates.

A general result was the faces of the children giving a defined statement of their presence (and aesthetic resonance) in the interaction with the content of the game, which was mostly pleasing and a challenge for their skills.

The detailed analysis showed a connection between temporal movements and aesthetic resonance through a correlation between the categories of intensity and intentionality. When there was a high, medium, or low degree of movement intensity, the same degree was always appearing in the category of intentionality of movements. Furthermore, there was a higher degrees of aesthetic resonance related to spatial movements than to temporal as the categories of range, intentionality, and shifts had high or medium degree of movements. The categories of speed and fluency, on the other hand, had low or medium degrees of movements, while the degree of intensity in temporal movements was high (Appendix 3, table 2). The computed data analysis supported the manual analysis so as to indicate higher or lower degrees of quantity of movements (QOM) and through the threshold of motion and non motion segmentation (Appendix 2: Figure 4).

Our findings in the multi-sessions were limited to two children. The standard deviation in scores between the sessions is significantly reduced with the girl [duration] 46% [between] 30% [1st ball duration] 79% [2nd ball duration] 1% [3rd ball duration] 49%- the boy, who notably in the first session had an intravenous attachment, showed insignificant change in total. Overall, consistent to our single sessions were reduced ‘between’ times for both the girl (12%) and the boy (9%) which we claim as a possible indicator of motivation, which we relate to the enjoyment and fun in playing the game. This involves emergent learning of navigation modes and is an attribute to aesthetic resonance through its inherent presence factor. In the multi-sessions we conducted a preliminary computer analysis for duration of last pause and motion phases (Appendix 2: Figure 4). Our findings were that both the girl and the boy had increased standard deviation and average of duration of last pause phase combined with a reduced duration of motion phase from the first to second session. This may indicate that over a number of sessions less motion is required to achieve similar tasks, thus more effective movement is learnt as the child gets acquainted with the game. Further investigation in relating such findings to presence would seem in order.

To sum up, aesthetic resonance was indicated partly through the high degree of intensity and intentionality in movements. Intensity and intentionality was shown through the children’s concentration and also through their force and passion when playing the game. Aesthetic resonance was indicated by the degree of movements of range and shifts in the children’s movements. The categories of speed and fluency did not have any influence on aesthetic resonance as they did not influence the intensity, intentionality, range, or shifts in movements.

4.2. Interface and activities

In interviews with children concerning their positive and negative experiences of the EyeToy® game the main part of the children expressed positive experiences 61.1% (n = 11) of the children thought the EyeToy® game was fun, while 22.2% (n = 4) said that they liked it. One (1) child said that the EyeToy® game was difficult, but he also said that the gameplaying was fun. Concerning positive and negative specifics of the gameplay 38.8% (n = 7) of the children answered on the interface attributes and 61.1% (n = 11) on the activity attributes of the game (Table 1). The children’s negative experiences of the game only concerned activity attributes regards the content of the game. Two children answered that they enjoyed the whole EyeToy® game. Six children referred to movements – using the body and to move – when they were asked about the positive attributes of the game. Four children said that the ball-play attribute was the best, while seven children stated that the ball-play attribute was the most difficult. These facts indicate that the ball-play attribute in itself was a challenging activity, as three of the children also confirmed.

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<td>Positive?</td>
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<td>Body used 22.2% (4) Ball-play 22.2% (4)</td>
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<td>To move 11.1% (2) Monkeys 16.6% (3)</td>
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<td>Mirroring 5.5% (1) Challenge 16.6% (3)</td>
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<tr>
<td>Scoring 5.5% (1)</td>
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<tr>
<td>SUM 38.8% (7) SUM 61.1% (11)</td>
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<tr>
<td>Negative?</td>
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<tr>
<td>Activity Children Activity Children</td>
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<td>Monkeys 5.5% (3) Ball-play 38.3% (7)</td>
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<tr>
<td>Repetition 5.5% (1)</td>
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<tr>
<td>Pauses 5.5% (1)</td>
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<tr>
<td>SUM 16.6% (3) SUM 38.3% (7)</td>
</tr>
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</table>
4.2. Resource for therapy

The game agents were the main attributes when the children referred to negative aspects of the EyeToy® game experiences as it repeatedly gave negative feedback to the children. The monkeys were stated as difficult by one child, but were also considered as fun by three of the children.

In summary, the children’s experiences of the EyeToy® game indicated that the interface supported the gameplaying activity in a challenging way and aesthetic resonance was achieved through this challenge.

4.2.1. Positive aspects:
The EyeToy® game was great fun for the children who were concentrated on the tasks in the game.

4.2.2. Negative aspects:
The children quickly became bored as it was either too hard or too easy to play; three balls were too few; the game ended quickly limiting the challenge; the game agent mostly gave negative feedback, which many of the children commented upon.

4.2.3. Practical aspects:
A room allocated for the test is necessary for future research; the camera set-up was too complicated to handle; the camera set-up limited some of the children’s movements; both hospitals wish to continue with future EyeToy® research.

4.2.4. Potential with EyeToy® in therapy:
The game activity is fun and the training aspect simultaneously involved, becomes fun as well; the game activity brings in movements to the therapy, which make sense and benefits the children’s rehabilitation; playing the EyeToy® game becomes physiotherapy; if there was more challenge and action in the games, the potentials for therapy would increase as the fun and motivation for moving probably would increase.

To sum up, the results from field notes and interviews with the play therapists and doctors underlined the potential with the EyeToy® system in therapy emphasizing flow and fun aspects of the gameplaying as beneficial for the therapy training.

5. Discussion

The purpose of the study was to qualify the initial use of the system for children in rehabilitation in a hospital scenario with a consideration of the inherent logistics and practicalities. We restricted our unit of analysis to different expressions of tempospatial movements in process as indicators of a possible presence state related to behaviour and situation within play therapy. Through our exploratory investigation our findings indicate that aesthetic resonance through intensity and intentionality is related to flow and conscious reactions when a child interacts with the EyeToy® game. Furthermore, presence enhanced aesthetic resonance through range and shift related to movement increments. As far as we can ascertain, the limited computed data supports the manual annotations and our claim where observation of activity mediated within a human affective efferent neural loop closure as a result of interaction to content of a virtual environment. The field-experiments we consider as a start toward understanding the mechanisms of motivation promoted by multimodal immersion, and the triangulations of actions becoming reactions resulting in interaction in play activities.

Conclusions

Our approach relates to the heuristic evaluation strategy of Nielsen [28] where natural engagement and interaction to a virtual environment having "real-world" physical traits and being compatible with user’s task and domain is such that expression of natural action and representation to effect responsive artefacts of interesting content feedback encourages a sense of presence. Beyond presence we seek a sense state continuum that stimulates intrinsic motivated activity, and from prior research we have termed this aesthetic resonance. To engage an actor in aesthetic resonance we implement a strategy toward creating enjoyment and fun as the user perceived level of interaction where emotional expression of body is the control data of the feedback. In this way an affective efferent neural feedback loop is established. The data that is controlling the feedback content is available for therapeutic analysis where progression can be monitored and system design adapted to specifics of the task centred training. The user experience however is targeted at being solely play based.

In this document we report on our pilot study which is the first phase of an extended full scale research investigation based on our hypothesis that the positive attributes in utilizing digital interactive games that embody the actor in VE therapy will relegate the negativity tagged to video games and offer new opportunities to supplement traditional therapy training and testing. Our prior research informs that intrinsic motivation is a potential strength of game interaction where the user becomes aware only of the task and in an autotelic manner extends otherwise limiting physical attributes beyond what may otherwise be possible to achieve, and this supports our hypothesis. This study discovered that problems to overcome are the video recording system, the interpretation of instruction, and the room availability. A new single button system for optimizing the video recording system has been designed.
and budget planned to improve the next phase of the project. Similarly, the hospitals promise a designated space in future. The children’s quantity, dynamic, and range of movements when immersed in the gameplaying activity were over and above their usual range of movements. Their face expression and emotional outbursts further substantiated our claim that an initial state of presence was achieved.

Acknowledgements

Hospitals, Staff, & children: Laerns/uskeret in Halmstad, Sweden; Sydvestsydk Sygehus in Esbjerg, Denmark. SCEE, Egmont/Nordisk Film, Scandinavia; Sony Denmark. This study was part financed by cooperation between Sony Computer Entertainment Europe; Egmont Interactive, Scandinavia; Sony Denmark, SoundScapes ApS, Denmark, and the authors.

“Playstation” is a registered trademark of Sony Computer Entertainment Inc. “EyeToy” is a registered trademark of Sony Computer Entertainment Europe.

Algorithms adopted from those created with partial support from IST Project CARE HERE where author was researcher [ref - 27].

References


Figure 3 Three examples showing game play results: (top graph) Esbjerg 9 (male 7 years of age) where successes are inconsistent and possibly due to unstable presence. Game 13 is where a higher level was attempted shown by his ‘between time’ high. Esbjerg 13 (girl of 8 years of age – middle graph) achieved completion of the full game (8th game) resulting in an affirmative comment from the game agent. Esbjerg 14 (female 10 years of age – low graph) had most problems (game duration average 24/56.6) this reflective of her functional condition (brain tumor), however she achieved the most number of games (32) whilst continuously pushing her limitations and at conclusion interview described the “great fun” despite her difficulties.
Appendix 2

Figure 4 Quantity and segmentation of movement. Threshold/buffer/motion phase indicators (upper right). Buffer image, SMI & source windows (upper left), Halmstad hospital, Sweden. Algorithm for QOM, pause and motion phase duration available from authors.
Figure 5 Contraction Index (CI) analysis. Upper right shows silhouette bounding rectangle initially set on buffer image, Esbjerg hospital, Denmark. Algorithm is made available from the authors.

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Appendix 3

Table 2: Session overview: Upper = Sessions/Games (g)/Pauses (p). Lower = Movement analysis

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Table 3: Tempospatial Analysis: An example of one annotated session video file.

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42. Eneskär, Barbro: Children’s Language at Four and Six. 1978.
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Doctoral Dissertations published elsewhere


This thesis focuses on non-formal learning within interactive environments – new technology that has gained increasing importance within different sectors of the society, including that of children with different forms of disabilities. The questions that are discussed in this thesis are: What factors influence action and interaction in interactive environments? What are the characteristics of the engagement that underlies the desire of play in interactive environments? What can we learn from these activities that can assist in designing approaches to formal settings and locations? To address these questions computer-mediated spaces were created that enabled the user to interact freely, intuitively, and without encumbrances in that environment, and to experience a sense of fun and engagement in that environment. The results from seven studies are presented in seven articles. In order to get a deeper understanding, the results of these studies are viewed from a non-formal learning theoretical perspective. This approach assumes that learning and therapy is always situated. The technology is viewed as empowering the user’s active participation in activities to encourage learning. This implies that human action, social and individual, is mediated by tools and signs, which emphasizes mediation of human action through cultural artefacts. Aspects such as play, aesthetics and emotions become important when considering how people engage with technologies in order to learn new skills.

Eva Petersson is a lecturer in Medialogy at Aalborg University Esbjerg in Denmark. She is an active member of the Sensorama Research Group at the Department of Software and Media Technology at Aalborg University Esbjerg in Denmark.