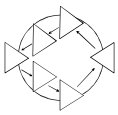
Psychologically-Based and Content-Oriented Experience in Entertainment Virtual Environments

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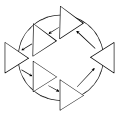
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Contents

Abstract **5**

Tiivistelmä **6**

Acknowledgements **7**

List of original publications **8**

Abbreviations **9**

1 Introduction **10**

1.1 The psychological base of experience 13

1.1.1 Experience 13

1.1.2 Consciousness 14

1.1.3 Human-environment interaction 15

1.1.4 The experiential cycle 18

1.2 Empirical evaluation of an experience 21

1.2.1 Linear or nonlinear 22

1.3 Orienting content – virtual environments (VEs) 24

1.3.1 Using VEs and playing games 25

1.4 Psychological concepts and VEs 26

1.4.1 Being and acting in a VE 27

1.4.2 Presence 29

1.4.2.1 Physical presence 30

1.4.2.2 Social presence 31

1.4.3 Involvement 32

1.4.4 Flow 33

1.5 The aim of this research 36

2 Methods **38**

2.1 Participants 39

2.2 Questionnaire and framework development 39

2.3 Procedure and technology 40

2.3.1 CAVE 40

2.3.2 Digital games 42

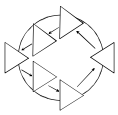
2.4 Statistical analysis 43

2.4.1 Information entropy 45

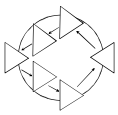
3 Results **46**

3.1 Presence-Flow Framework - PFF (Study I) 46

3.1.1 Results of Study I 46



3.1.2 Conclusions of Study I 49
3.2 PFF and movement patterns (Study II) 50
3.2.1 Results of Study II 51
3.2.2 Conclusions of Study II 53
3.3 Presence-Involvement-Flow Framework - PIFF (Study III) 54
3.3.1 Results of Study III 54
3.3.2 Conclusions of Study III 57
3.4 PIFF^2 (Studies IV and V) 58
3.4.1 Forming and confirming PIFF^2 60
3.4.2 Adaptation: presence and involvement 61
3.4.2.1 The eight adaptation subcomponents 61
3.4.3 Flow 63
3.4.3.1 The seven flow subcomponents 64
3.5 PIFF^2 – further validation (Study V) 65
3.5.1 PIFF^2 in two different FPS (Study V) 65
3.5.2 The four flow channels (unpublished study) 68
3.5.2.1 Results of the four flow channels 68
3.5.2.2 Discussion of the four flow channels 70
3.5.3 Flow in the first hour of play (Study V) 72
4 Discussion 75
4.1 Psychologically-based and content-oriented experience 76
4.1.1 Multidimensionality 76
4.1.2 The experiential cycle 76
4.2 Presence-Involvement-Flow Framework 78
4.2.1 Measurement issues 78
4.2.2 From PFF to PIFF^2 79
4.2.3 Summing up 81
4.3 Virtual versus real 82
4.3.1 Presence, involvement and flow in football 83
4.4 Future 84
5 Conclusions 86
References 87
Appendices
Original communications



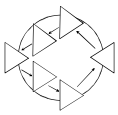
Abstract

In daily life, rich experiences evolve in every environmental and social interaction. Because experience has a strong impact on how people behave, scholars in different fields are interested in understanding what constitutes an experience. Yet even if interest in conscious experience is on the increase, there is no consensus on how such experience should be studied. Whatever approach is taken, the subjective and psychologically multidimensional nature of experience should be respected.

This study endeavours to understand and evaluate conscious experiences. First I introduce a theoretical approach to psychologically-based and content-oriented experience. In the *experiential cycle* presented here, classical psychology and orienting-environmental content are connected. This generic approach is applicable to any human-environment interaction. Here I apply the approach to entertainment virtual environments (VEs) such as digital games and develop a framework with the potential for studying experiences in VEs.

The development of the methodological framework included subjective and objective data from experiences in the Cave Automatic Virtual Environment (CAVE) and with numerous digital games (N=2,414). The final framework consisted of fifteen factor-analytically formed subcomponents of the sense of presence, involvement and flow. Together, these show the multidimensional experiential profile of VEs. The results present general experiential laws of VEs and show that the interface of a VE is related to (physical) presence, which psychologically means attention, perception and the cognitively evaluated realness and spatiality of the VE. The narrative of the VE elicits (social) presence and involvement and affects emotional outcomes. Psychologically, these outcomes are related to social cognition, motivation and emotion. The mechanics of a VE affect the cognitive evaluations and emotional outcomes related to flow. In addition, at the very least, user background, prior experience and use context affect the experiential variation.

VEs are part of many peoples' lives and many different outcomes are related to them, such as enjoyment, learning and addiction, depending on who is making the evaluation. This makes VEs societally important and psychologically fruitful to study. The approach and framework presented here contribute to our understanding of experiences in general and VEs in particular. The research can provide VE developers with a state-of-the art method (www.eveqgp.fi) that can be utilized whenever new product and service concepts are designed, prototyped and tested.



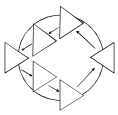
Tiivistelmä

Antoisat kokemukset syntyvät toimiessamme vuorovaikutustilanteissa sekä ympäristön että muiden ihmisten kanssa. Näin syntyneet kokemukset vaikuttavat käyttäytymiseemme ja tuleviin toimiimme. Tutkijoita on alkanut kiinnostaa, miten paremmin ymmärtää kokemuksen rakentumista ympäristön vuorovaikutustilanteissa. Vaikka kiinnostus kokemuksellisuuden ymmärtämiseksi on kasvanut, vielä ei ole yksimielisyyttä siitä, miten kokemusta tulisi tutkia. Olipa lähestymistapa mikä tahansa, tulisi aina kunnioittaa kokemuksen subjektiivista ja psykologisesti moniulotteista luonnetta.

Tämä tutkimus edesauttaa tietoisen kokemuksen ymmärtämistä ja arvioimista. Ensin esitellään teoreettinen lähestymistapa psykologiseen ja sisällöllisesti suuntautuneeseen kokemukseen, jossa mieli yhdistyy ympäristön sisältöjen kanssa *kokemuskehässä*. Lähestymistapa on melko yleinen ja sitä voidaan soveltaa moniin eri ihmisen ja ympäristön vuorovaikutustilanteisiin. Tässä tutkimuksessa lähestymistapaa sovellettiin viihteellisiin virtuaalisiin ympäristöihin (VY), kuten digitaalisiin peleihin, joiden aikaansaamien kokemusten arvioimiseen kehitettiin tutkimusviitekehys.

Tutkimusviitekehyksen kehittämiseksi kerättiin sekä subjektiivista että objektiivista aineistoa CAVE:sta ja lukuisista digitaalisista peleistä (N=2414). Lopullinen versio sisälsi viisitoista faktorianalyysillä muodostettua alakomponenttia, joilla mitattiin läsnäolon tunnetta (presence), osallistumista (involvement) ja flow'ta. Yhdessä nämä muodostivat moniulotteisen kokemusprofiilin VY:stä. Tulokset osoittivat yleisiä VY:n kokemiseen liittyviä lainalaisuuksia. Käyttöliittymä vaikuttaa (fyysiseen) läsnäolontunteeseen, joka psykologisesti tarkoittaa huomiokykyä, havainnoimista ja kognitiivista arviota VY:n aitoudesta ja spatiaalisuudesta. Tarinallisuus saa aikaan (sosiaalista) läsnäoloa ja osallistumista sekä vaikuttaa tunteisiin. Psykologisesti nämä liittyvät sosiaaliseen kognitioon, motivaatioon ja emootioihin. Mekaniikka vaikuttaa kognitiiviseen arviointiin ja emootioihin, jotka liittyvät flow'n kokemiseen. Myös taustamuuttujat, kuten sukupuoli ja aikaisempi kokemus sekä käyttökonteksti vaikuttavat kokemukseen.

VY:t ovat iso osa monien ihmisten arkea ja niihin liitetään monenlaisia uskomuksia ja seuraamuksia. Arvioijan tausta ja motiivit vaikuttavat siihen, liitetäänkö VY:öön nautinto, oppiminen vai riippuvuus. Tämän takia VY:n tieteellinen tutkimus on yhteiskunnallisesti tärkeää ja psykologisesti hedelmällistä. Esitetty lähestymistapa ja viitekehys auttavat ymmärtämään kokemuksia yleisesti ja erityisesti VY:ssä. VY:n kehittäjille tutkimus tarjoaa viimeisintä tietämystä edustavan viitekehyksen (www.eveqgp.fi), jota voidaan hyödyntää kun uusia tuote- ja palvelukonsepteja suunnitellaan ja testataan.



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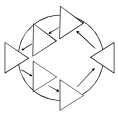
I am deeply grateful to my supervisor, Professor Göte Nyman, who encouraged me to seek out psychological phenomena in the complex world around us, who kept the faith during the sometimes long process and even funded the research. Thank you, Göte, for making this work possible. I also warmly thank my closest colleagues, Jukka Häkkinen and Jyrki Kaistinen, as well as those in the Psychology of Evolving Media and Technology (POEM) research group for their support during the whole process. I owe a special thanks to Professor Takashi Kawai for opening my eyes to the idea of orienting content and to all the co-authors of the original communications, Jeppe Komulainen, Mikko Laakso, Leif Laaksonen, Patrick May and Heikki Särkelä, as well as Jari Lipsanen and Juhani Ihanus who provided helpful comments along the way and on this thesis. I warmly thank Professor Glenda Goss for checking the English of this thesis. I also wish to thank the editor-in-chief of *Pelit-lehti*, Tuija Linden, Antti Hulsi and Aapo Puskala for their help in collecting the online data, and Matti Gröhn, Jyrki Hokkanen, Tommi Ilmonen and Jarmo Pirhonen for their help in EVE. I also thank all the gamers who participated in the laboratory studies and the Internet surveys.

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Espoo, May 2011

Jari Takatalo



List of original publications

This thesis is based on the following publications:

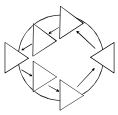
I Takatalo, J., Nyman, G. & Laaksonen, L. (2008). Components of human experience in virtual environments. *Computers in Human Behavior* 24, 1–15.

II Särkelä, H., Takatalo, J., May, P., Laakso, M. & Nyman, G. (2009). The movement patterns and the experiential components of virtual environments. *International Journal of Human-Computer Studies* 67 (9), 787–799.

III Takatalo, J., Häkkinen, J., Särkelä, H, Komulainen, J. & Nyman, G. (2004). The experiential dimensions of two different digital games. Proceedings of the PRESENCE 2004-7th Annual International Workshop on Presence October 12-15, Valencia, Spain, 274–278.

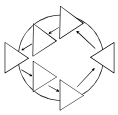
IV Takatalo, J., Häkkinen J., Komulainen, J., Särkelä, H. & Nyman, G. (2006b). Involvement and presence in digital gaming. Proceedings of the Fourth Nordic Conference on Human-Computer Interaction, October 14-18, Oslo, Norway, 393–396.
[ACM Conference Proceedings Series]

V Takatalo, J., Häkkinen, J., Kaistinen, J. & Nyman, G. (2010). Involvement, presence and flow in digital games. In *Evaluating User Experiences in Games: Concept and Methods*, (Ed.) R. Bernhaupt, Springer.
[Springer Human-Computer Interaction Series]



Abbreviations

ANOVA	analysis of variance
CAVE	Cave Automated Virtual Environment
CRT	cathode ray tube
CS	Counter-Strike: Source
EVE	Experimental Virtual Environment
EVEQ	Experimental Virtual Environment Questionnaire
EVEQ-GP	Experimental Virtual Environment Questionnaire-Game Pitkä (i.e. long)
FPS	first-person shooter
HCI	human-computer interaction
HL2	Half-Life 2
MANOVA	multivariate analysis of variance
NED	near-eye display
NFS	Need for Speed Underground
PAF	principal axis factoring
PFF	Presence-Flow Framework
PIFF	Presence-Involvement-Flow Framework
$PIFF^2$	Revised Presence-Involvement-Flow Framework
SD	standard deviation
UX	user experience
VE	virtual environment
VK	Virtuaalinen Kyselylomake (i.e. Virtual Survey)
VK2	Virtuaalinen Kyselylomake 2 (i.e. Virtual Survey 2)

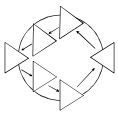


1 Introduction

Experiencing is a fundamental part of being human: we all are experts in it. In our daily lives, rich experiences evolve in every environmental and social interaction: in the workplace, on sports fields and in encounters with entertainment technologies. Because experience has a strong impact on how people behave, scholars in different disciplines are interested in understanding what constitutes an experience. Experience being psychological in nature, psychology as science should be able to provide sustainable concepts for understanding and evaluating experience and its effects. At the dawn of psychology as a field of inquiry, the schools of both structuralism and functionalism were indeed interested in subjective experience and its evaluation. William James (1890) and Wilhelm Wundt (1897) were inspired by the study of conscious experience using subjective methods such as introspection. The functionalists gave the conscious mind a clear role in mediating between the needs of the complex individual and the demands of the complex environment (Angell, 1907).

As the science of psychology developed, researchers began to demand more precise definitions of concepts and methods for studying individuals and especially human behaviour. Instead of developing the theory and methodology of the conscious experience, in the early 1900s scholars shifted their focus to stimulus-response relationships and eventually to information-processing and learning paradigms (Lubart & Getz, 1998). At the other end of the spectrum Sigmund Freud led the explicit study of the human unconscious (Freud, 1923). The study of conscious experience was thus neglected until the late 1960s, when the American Psychological Association gave their annual convention the theme “The Unfinished Business of William James” (Wheeler & Reis, 1991).

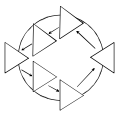
Although conscious experience was thereby returned to research topics in psychology, it did not regain its previous place in the front rank. Meanwhile, scientists had developed new methods of depicting neural processes and biological reactions, with which to study the neurobiological basis of consciousness. However, the depiction of electric impulses in neural networks is just stimulus information from our senses and a low level organization of such information. The way “neural” is transformed into “mental” is not understood, which makes the connections between neural and mental simple correlations (Revonsuo, 2006). As such, the neural explanations of the human mind offered today cannot explain the true essence of the subjective experience, such as its quality or



meaning (Rauhala, 2009). As Bandura (2000) put it, "Knowing how a television set produces images in no way explains the nature of the creative programs it transmits". On the other hand, modern philosophical inquiry considers the genuinely lived, first-hand subjective experience beyond any scientific approach (Keijzer, 2000; Nagel, 1974). Meanwhile, independent of the academic extremes, people live and experience their complex natural environments.

Bradley (2005) points out that the lack of the "science of experience" has led to a situation in which experience is defined and often abused according to the current needs of different fields of study. Although today's basic psychology encyclopedias provide numerous psychological concepts, they do not offer an integrated framework through which everyday experiences can be evaluated. Some authors argue that the whole needs to be described before we can start analysing its parts, a process called "dubbed holism", since the experience is evidently more than the sum of its parts (Bradley, 2005). Scholars interested in the daily activities (see the special issues of the *Journal of Personality* 1991 and 2005), optimal experiences (Csikszentmihalyi & Csikszentmihalyi, 1988b), economic behaviour (Pine & Gilmore, 1998) or user experience in the field of Human-Computer Interaction (Forlizzi & Ford, 2000; McCarthy & Wright, 2004) have been forced to define experience more pragmatically. Despite the clear need to conceptualize conscious experience psychologically, mainstream psychology has concentrated on other issues, such as mental illness (Seligman, 2002). However, works of Simon (1967), Lazarus (1991a), Lubart (1998), Dörner and his colleagues (2006) or Bradley (2005), for example, have attempted to understand the human mind and experiential phenomena holistically.

Because of its complex nature, the psychological investigation of the conscious experience must begin with a careful definition of both the scope and the type of experience and the attempt to understand its various characteristics in different situations (Gelter, 2007). The present research concerns experiences that evolve from direct observation or participation in an event (Visual Thesaurus, 2004). Thus, the conscious experience is constituted by an organism-environment system: how we perceive and interact with the world (Järvilehto, 1998). Consciousness as such is not within the scope of this study, but rather the focus is on the way consciousness extends outwards into the environment. Before we can analyse or evaluate conscious experience, we need a holistic



picture of it. However, there is no consensus on a generic psychological theory of conscious experience (Bradley, 2005). That is why this dissertation first presents a candidate approach to psychologically-based and content-oriented experience. This approach has been developed gradually through a number of studies, as explained below. It involves fundamental psychological subsystems and provides guidelines on what to include in the study of conscious experience. Here this approach is further deepened and applied in practice.

The approach has been developed in collaborative projects based at the University of Helsinki, namely, the Psychology of Virtual, User Experience in Digital Games and Game-Display Experience. The projects yielded five individual studies, each of which is described in the course of this dissertation. Eight members participated in the writing of the studies described here, all of whom are presented on p. 8. My particular responsibilities were planning, developing and organising the experimental test set-ups, preparing the questionnaires and analysing the collected data. I also prepared and submitted all the studies except Study IV, in whose planning and producing I nevertheless participated. I collected the data used in Studies III and IV. Hereafter, "we" refers to the joint findings of this team of researchers.

A psychologically-based and content-oriented approach covers both classical psychology, which forms the basis for experience and central aspects of the environmental content, which shapes (or orients) this psychological base. The approach is generic and can be applied to the investigation of conscious experience in multiple human-environment interactions. Because the approach is psychologically multidimensional, it provides a taxonomy with multiple characteristics, which guides the evaluation of experience. Central to our approach is the *experiential cycle* (Figure 1), which connects the psychological base with the orienting-environmental content and depicts the experiential process between the human and the environment, as was suggested by the early functionalists (Angell, 1907). We apply this theoretical approach to modern technology environments, namely to entertainment virtual environments (VEs). Digital events taking place in VEs usually have a clear beginning and an end; they provide the best available conditions, in which to study rich human experience in the laboratory (Germanchis, Cartwright & Pettit, 2005). In addition to theoretical background, the present research

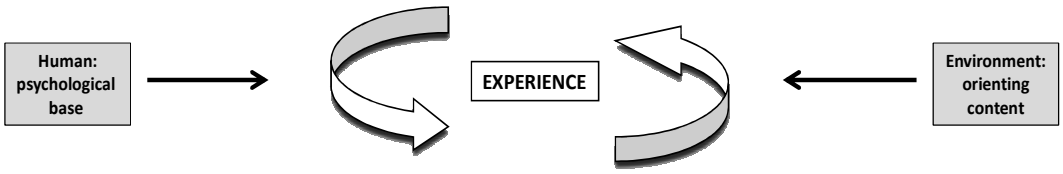


Figure 1. The starting point for a psychologically-based and content-oriented approach to conscious experience.

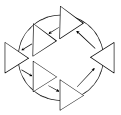
presents empirical data collection and development as well as a validation of a methodological framework with which to study experience in VEs.

1.1 The psychological base of experience

1.1.1 Experience

Experience is such a widely (mis)used term that in order to understand and evaluate its characteristics, it needs to be well-defined (Gelter, 2007). In this study experience is conceptualized as those mental and bodily states that follow our participation or observation with environmental events or objects. Experience evolves when we live through events in our lives and interact with objects and other people (Visual Thesaurus, 2004). We consider experience in scope as 1) *external*, thus, based on perceptions of our external (exteroceptive) senses and human-environment interactions as well as 2) *conscious*, in the sense that we actively focus on and interpret the environmental information relevant to us and use this knowledge in formulating our future actions. This definition excludes knowledge based on prior experiences as well as experiences such as daydreaming, imaginary and sleep states evolving from solely internal (interoceptive) senses and memory. Experience in scope is a top-down process in which we gather information from our environment, interpret it and use it to construct the reality around us (Janssen & Blommaert, 1997).

In our everyday unsleeping existence we are constantly perceiving and experiencing the world around us. However, in this study the interest is not the stream of consciousness, but in the clearly distinguishable events that take place within this stream. Although our approach can be applied to daily experiences as well, the focus here is on events that have a clear beginning and an end, such as playing a digital game. Such an event is likely to create *an experience* (Dewey, 1934), which emerges when an event has an impact on the person who is experiencing it. Thus, an experience provides firm



grounds for our study. What constitutes consciousness and how it works in these events determine the fundamental psychological characteristics of an experience (James, 1890). These characteristics make the experience of a particular event or object more understandable and comparable, but they require focusing on consciousness.

1.1.2 Consciousness

Consciousness, like human experience, is a complex concept. However, the concept of consciousness is needed to evaluate the psychological subsystems that are responsible for transforming the multi-channel information from a natural environmental event into knowledge and experience. When classical psychological subsystems are defined and used in a suitable, simplified form, the understanding of any human-environmental interaction becomes possible.

In *Optimal Experience – Psychological studies of flow in consciousness*, Mihaly and Isabella Csikszentmihalyi (1988a) suggested a general overview of the structure and functioning of consciousness. Based on, Pope and Singer (1978), for example, the Csikszentmihalyis argue that consciousness can be divided into three subsystems: 1) **attention,** 2) **awareness** and 3) **memory**. Attention takes into account the information available and guides perceptions of the environment. Awareness can be better understood through its three faculties originally proposed by Moses Mendelsshon in 1795: thinking (cognition), feeling (affection) and will (conation) (Hilgard, 1980). For decades this trilogy of the mind has been considered to concern human cognition, emotion and motivation (Mayer, 2001). In awareness the environmental information is interpreted and, if considered sufficiently relevant, is stored in the memory. In this process, variables such as gender, age and cultural background must be taken into consideration (Figure 2).

When psychological research was focused on the stimulus-response relationships and the information-processing paradigms, consciousness as a whole was typically ignored and the trilogy of the mind was broken down into parts and studied separately (Lubart & Getz, 1998). Cognition as a concept seems to have withstood these years of neglect better than motivation and emotion, which were labelled meaningless mental epiphenomena (Lazarus, 1991a). However, taking cognition, emotion and motivation together provides a useful framework for understanding awareness. Naturally, these three faculties overlap, sometimes making it hard to separate them, but studying them separately makes little sense (Dörner et al., 2006; Lazarus, 1991a). Keeping other relevant sub-

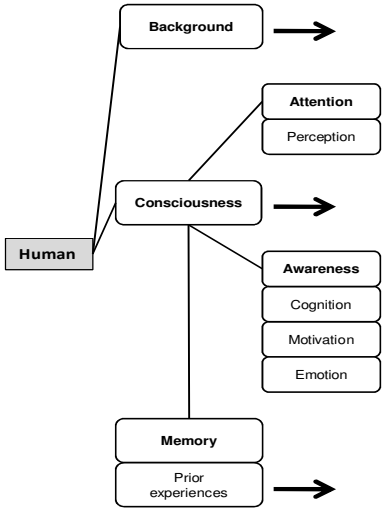


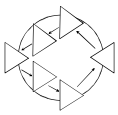
Figure 2. A generic psychological base for an experience, namely the background and the three subsystems of consciousness: attention, awareness and memory. Taken together, these influence the fundamental psychological characteristics of an experience.

systems in mind, namely attention and memory, makes it possible to formulate a coherent whole against which we can understand the psychological mechanisms of our consciousness. Dörner and his colleagues (2006) have put these psychological concepts into a functional model and demonstrated how experience evolves in consciousness. When the process of conscious experience is described, it becomes evident that as long as any of the three subsystems or their parts are ignored, the understanding and evaluation of experience in complex and rich human-environmental interactions remain inadequate.

Although the empirical data presented in this research provide the structure for the experiential framework, a description of the experiential process is needed. Without a synthesis of that process, the orienting content remains something external, while the psychological base is something internal. In western science the separation of the mental from the physical has a long history going back to the days of Descartes (Sheridan, 1999). To avoid such dualism, we follow Heidegger (1978), Winnicott (1971) and Bradley (2005) to present a "third place", a "potential space" or an "intersubjective space" between the outer and inner worlds in which a dynamic experience evolves.

1.1.3 Human-environment interaction

Donald Winnicott (1971) was interested in the role of creative play whenever children struggle with negative feelings caused by separation from their mothers. When he ob-



served how children experience transitional objects, he realized that in order to understand children's experiences, an intermediate area – between the mind and the environment – is needed. Winnicott called this area "potential space", a place to which both inner and outer worlds contribute; he considered this space central to our sense of being alive. It is the place where we live. It is the dimension "in which the deciding moment of a sporting contest captivates a coliseum" (Bradley, 2005, p. 91). Winnicott described this space as a dimension that is highly variable between individuals, whereas he considered both personal and physical locations as being rather constant, the personal being biologically determined and physical reality being "common property" (Winnicott, 1971). Similarly, Martin Heidegger's philosophy integrated external things and the inner world in interaction with the world (Heidegger, 1978). For example, a hammer is a detached thing as long as we do not use it (present-at-hand); however, the activity of hammering constitutes the hammer as a tool (ready-to-hand). Hammering takes place in a potential space in which our goals, intentions and environmental affordances meet, environmental objects and events acquire meaning and mind and body become one. Bradley (2005) believes that experience is created in an *intersubjective* space in the interface between the psychical and the social. This relationship is always more than the sum of the self and others (Gergen, 1994). But how do we describe what takes place in the intermediate area between the psychological base and an environment?

Ulrich Neisser (1976) described the process of human perception as a perceptual cycle (Figure 3). Central to Neisser's cycle were schemas drawn from the memory and used to direct perceptual activities and aid in interpreting both the physical as well as the social world around us. By directing our exploration of an environment, schemas relate us to the environment. Neisser (1976) stated that, in our explorations we sample the information available in our environment and use this information to modify the schemas in our memory. Moreover, we can detach schemas as memory structures from the perceptual cycle and use them, for example, in planning our future behaviours. A perceptual cycle connects the mind to the environment and provides a cognitive process description of how we collect and interpret environmental information based on the representations we have. The perceptual cycle concerns human information-processing, such as learning, understanding and planning. But can we utilize it to understand conscious experience and the "place where we live"?

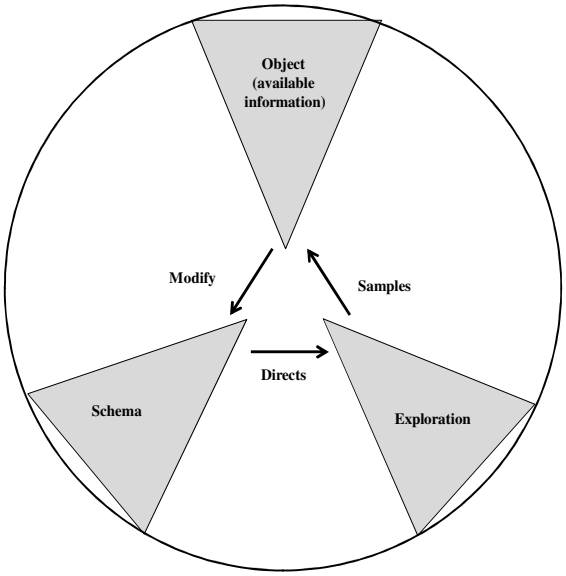


Figure 3. The perceptual cycle (Neisser, 1976).

Aren't our daily experiences filled with willingness, desires and interests as well as a variety of feelings, which are an integral part of the classical psychological base? And how about exceptional or first-time experiences, such as the birth of a first-born or to move to a new home or getting married? It is unlikely that these experiences consist of thinking, planning and understanding only. Neisser did acknowledge the associations with emotions and thinking as well as the role of thinking as a servant of multiple motives (Neisser, 1963). However, the perceptual cycle provided a generic and simple information-processing description of human-environment interaction, albeit lacking the necessary psychological multidimensionality. Neisser's approach narrowed the rich experiential characteristics and makes it hard to evaluate an experience. That is why we integrated the psychological base presented in our theoretical approach into the perceptual cycle. The result was the *experiential cycle*, which takes into account the *energizing*, *striving* and *sustaining* of our perception and cognitive processes as we perceive and experience the world around us. The *Experiential cycle* provides both the theoretical and the methodological requirements for studying conscious experience. In the next section, the *experiential cycle* is described, because being familiar with it makes it easier to follow the development of the methodological framework. Here we also refine the work reported in Studies I, III and V.

1.1.4 The experiential cycle

The *experiential cycle* (Figure 4) starts with motivation, which means releasing a mental source of energy and switching on a pattern of behaviour to satisfy a need (Laming, 2004). Motivation can be triggered by something external, such as a sudden change in the weather, or by something internal, such as a basic need for hunger (Atkinson, 1964). In each case, a cognitive interpretation is needed in order to integrate our needs with the best knowledge available about how to fill these needs. Thus, the situation, expectations, past memories and schemas concerning the knowledge of suitable actions determine the intentional behaviour, that is, what should be done and how in order to achieve certain desired goals (Dörner et al., 2006). Because of the complexity of an environment with multiple stimuli, a person must have a motivational hierarchy of goals. The strength of a motive is based on the expected progress towards the goal and the value of

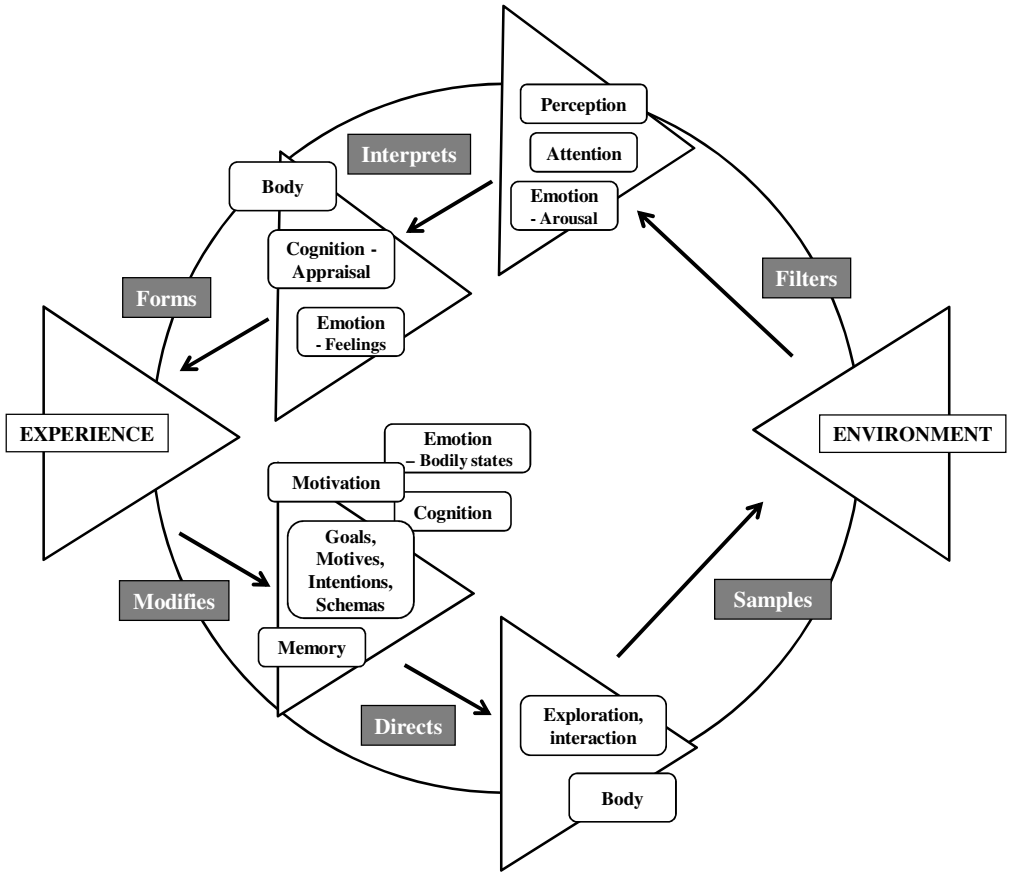
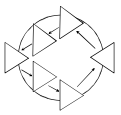
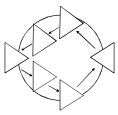


Figure 4. The Experiential cycle.



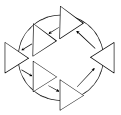
the need satisfaction (Dörner et al., 2006), which simply means the evaluation of the environmental stimuli based on their emotional harm or benefit to the individual (Lazarus, 1991a). Emotions are also crucial in complex or sudden situations in which we lack prior experiences, have no pre-organized plans or schemas, have contradictory goals or limited and uncertain knowledge of possible outcomes of our actions and behaviour (Dörner et al., 2006). In such situations, our cognitive reasoning becomes impaired because it has no emotional reference to that specific situation (Damasio, 1994). An interrupt mechanism arouses emotions, which then occupy our attention and keep the process capacity focused on one particular issue (Oatley, 1992; Simon, 1967). In this way the emotions integrate the diverse parts of consciousness, guide our behaviour and prepare us for actions that have meaningful goals by directing our attention with arousal, that is, by supporting the action readiness (Frijda, 1987). Thus, motivation brings to every interaction the hierarchy of goals and values. Motivation defines the nature, energy and direction of an interaction, or, simply put, what people regard as interesting, important and worth striving for.

Usually, our motives and goals **direct** our environmental interactions and explorations. The stronger the motivation to achieve a goal, the more energy is invested in that goal. Emotional arousal, that is, the degree of activation in an organism, is a well-known indicator of our level of intensity and alertness. Arousal can be described on a continuum from deep sleep to high excitement (Visual Thesaurus, 2004) and is considered an important component of human attention (Posner & Boies, 1971). More specifically, a heightened level of arousal is related to a narrowed attentional span (Easterbrook, 1959). Together, high arousal and a narrow attention span enable us to **sample** our environment and act according to the best practices that would lead to the satisfactory achievement of the goal. Following the motivational hierarchy of goals, the attention-arousal pair guides our perception and keeps the focus on interesting and meaningful stimuli, **filtering** out the irrelevant ones. That is why we perceive and focus our attention on stimuli that motivate and interest us. Without such a mechanism, in the middle of so many environmental stimuli our minds would be chaos (James, 1890). Only relevant and meaningful perceptions are paid attention to and entered into consciousness and thus become **interpreted** representations.



Cognitively, we recognize these representations and relate them to each other and to the goals and schemas stored in our memory (Glenberg, 1997; Loftus & Loftus, 1976). Such an interpretation process is enhanced by emotional labels that are attached to it (Lazarus, 1991a). Fundamentally, cognitive interpretation concerns the significance of the information about what is happening to our well-being. In a broad sense, cognitive interpretation concerns our striving towards goals and is called an appraisal process (Lazarus, 1991a; Lazarus, 1991b). Appraisals include, the effort anticipated in a given situation, the perceived obstacles, the sense of control and goal congruence or incongruence, for example. Depending on the situation and the perceiver, the combination of these cognitive evaluations, either conscious or unconscious, shape the emotional responses attached to particular events (Ellsworth & Smith, 1988). Cognitive theories of emotion state that cognitive interpretations and evaluations of events in the world are important antecedents of emotions (Ellsworth & Smith, 1988; Frijda, 1987; Lazarus, 1991b). Lazarus (1991a, p.353) describes emotions without cognitions as "activation without the directionally distinctive impulses of attacking in anger or fleeing in fear".

However, it would be wrong to consider emotions merely as passive followers of cognitions; emotions also have an effect on motivation and on the cognitive evaluation of new goals and plans (Novacek & Lazarus, 1990). Emotions can interrupt ongoing goals and substitute new ones (Simon, 1967). Thus, motives and goals gain emotional value depending on their importance. In addition to feelings, emotions include physical changes in bodily states called somatic markers (Damasio, 1994). These somatic markers provided by the body affect the *experiential cycle*. In this way the mind of the perceiver is linked to the body of the perceiver (Damasio, 1994). These bodily states also deepen the quality and intensity of the experience itself; they become especially valuable in novel situations in which we lack prior experience. In such cases, emotions provide the "gut-feeling" that determines and energizes our future actions. Proprioceptive senses such as bodily position and posture as well as kinesthetic movement in an environment also provide raw material from the somatic nervous system (e.g. joints and skeletal muscles) for the *experiential cycle.* Such senses are between the external (exteroceptive) and internal (interoceptive) and play a crucial role when experiences related to body image, physical activity or the learning of new motor skills are involved (Legrand & Ravn, 2009). This closes the *experiential cycle* in which experience **forms**. The



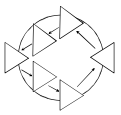
experience occupies the conscious mind, guides behaviours and determines the future experiences by **modifying** new motives.

To sum up, the *experiential cycle* expands the information-processing scope of Neisser's perceptual cycle (Neisser, 1976) and depicts generic human-environment interaction. The cycle is psychologically sustainable and multidimensional, emphasizing all three subsystems – attention, awareness formed by the trilogy-of-mind entity that includes cognition, emotion and motivation, and memory. The *experiential cycle* thus reveals consciousness together with a wide array of fundamental psychological characteristics to advance our understanding of an experience. The *experiential cycle* provides a "dubbed holistic" view of a basic structure, the mechanisms responsible for subjective experience and clear heuristics of what to include if the research paradigm concerns conscious experience. Consequently, the *experiential cycle* guides the selection of the research methods that attempt to examine experiential richness and multidimensionality.

1.2 Empirical evaluation of an experience

According to some authors, it is not possible to understand fully another person's subjective experience (Nagel, 1974). This is especially clear when we attempt to understand the personal experience space (Nyman et al., 2010) without understanding how this personal experience space relates to the body and an environment (Keijzer, 2000). However, if we focus on an experience evolving from an interaction with an environmental event or an object that is a common property, such as a red rose, then an experience may be easier to understand and evaluate. We only need to identify what the relevant environmental aspects are and how they orient the psychological base. One way to do this is to ask a group of people to describe an experience they have just had in a given environment.

The individuals are now forced to make a judgement of the stimuli they encountered. These judgements are based on subjective decisions, which reflect the individual's personal experience space as well as the particular stimuli (Nyman et al., 2010). Soon it will become apparent that there are common denominators in their descriptions (Komulainen, Takatalo, Lehtonen & Nyman, 2008; Nyman et al., 2006; Radun, Virtanen, Nyman & Olives, 2006). In the case of a red rose the common denominators could be beauty and the colour red, for example. If the individuals are able to describe such common aspects, then these aspects provably exist in the world. René Descartes

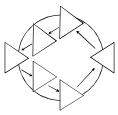


(1644/1984) stated as early as 1644 that if something exists in the world, then it usually exists in some amount: a rose can be less beautiful or very beautiful; it may be light red or dark red. Following Descartes, anything that exists in an amount can be measured. Taken together, the descriptions show how the environmental aspects orient the psychological base or, in other words, what consciousness consists of. These descriptions provide the fundamental psychological characteristics to evaluate the "amount" of an experience.

The classic texts in psychology give the following characteristics to describe and evaluate the "amount" of an experience: **content, quality, intensity, meaning, value and extensity** (e.g. voluminous, a spatial attribute) (James, 1890; Wundt, 1897). These characteristics provide the focus for the research that concentrates on experience, but they are generic enough to preserve the experiential richness and multidimensionality of the phenomena studied. In modern psychology it is too often the case that psychologists conceptualize the experiential phenomena, force them into a methodological framework and even interpret them (Bradley, 2005). In rich human-environment interactions the case should be exactly the opposite: the experiential phenomena and their interpretations should come from the participating people, and both the conceptualizations and the methodological frameworks should be drawn from the content being studied and adjusted accordingly. This requires people to evaluate and interpret their conscious experiences for themselves.

1.2.1 Linear or nonlinear

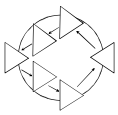
William James (1977) argued against "half-way empiricism", which is based on linear logic, Likert scales and the mathematisation of the subject matter and requires a more direct approach to thick and concrete experience. As a paradox, some critics state that the data obtained in questionnaires with Likert scales are not linear at all (Gardner & Martin, 2007). Although previous findings have shown that even a 5-point rating scale offers a sufficient distribution of responses (Comrey, 1988), a third line of critics maintains that quantitative subjective methods, such as questionnaires and Likert scales, are too "soft" and unscientific. Objective research methods and deeper mathematical analyses are called for. Contrary to James's arguments, mathematisation and linear logic are typically required of a psychological research today in order to endow it with scientific status (Bradley, 2005). Somewhere in the middle of the statistical and psychological



significance are the people who are experiencing. Fortunately, “God loves the .06 nearly as much as the .05” (Rosnow & Rosenthal, 1989, p.1277).

Bradley (2005) suggests mainly subjective methods such as semi-structured interviews, action research and focus groups to obtain first-hand interpretation of the “amount” of the experience. Research in the field of behavioural sciences widely uses subjective methods; for example, the use of questionnaires has proven to be a valid way of assessing the true variance underlying various mental phenomena (Breakwell, 2006; Couper, 2000; Labaw, 1980; Rust & Golombok, 1999). Even with some constraints, the subjective methods holistically regard both the individuals’ experience as well as the environmental content as sources of an experience. Nevertheless, authors collecting subjective quantitative data and utilizing methods such as analysis of variance should always confirm the distributional assumptions related to the multivariate methods. In addition, multiple questions measuring the same concepts should be used, extracted structures should be based on techniques such as factor analysis and weighted factor scores should be favoured over averaged summed scales. Naturally, problems easily occur in studies with small sample sizes and simple scales which have only a few questions. Even if it is time consuming, collecting a large and heterogeneous sample is helpful, since the central limit theorem confers the required statistical properties, such as the normal distribution of the sample. In sum, subjective research methods enable the collection of large data-sets and provide a psychologically rich description of the phenomena related to subjective experiences.

The psychologically-based and content-oriented approach proposed here supports subjective research methods. The idea is that the orienting environmental content can be understood if the measures are adjusted accordingly, within the limits of the psychological base. This contradicts the idea of holding on to a few extremely accurate methods and forcing every explanation and interpretation of interactions and environments to fit. Thus, in a given environment, it is of utmost importance to know what is measured and how. The main interest in this research is to understand the fundamental characteristics of an experience in psychologically-rich entertainment VEs. In VEs the environmental source of the experience is common to everyone, is easy to control and can easily be evaluated. However, before any measurements are taken, it is useful to understand

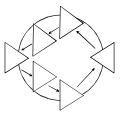


the psychologically relevant aspects of the VEs and how they orient the psychological base.

1.3 Orienting content – virtual environments (VEs)

A VE can be defined as a general impression of a technically created, but real-like environment or space (Hämäläinen, 1998). VEs are interactive, that is, they respond to the user's actions. In addition, the user should autonomously be able to react to events and stimuli provided by the VE. A third requirement is determinability and fidelity, which means that the interaction should not be random in nature (Zeltzer, 1992; Reitmaa, Vanhala, Kauttu & Anttila, 1995). VEs can be created via a host of technologies starting with mobile devices and traditional desktop PCs and ending to more sophisticated set-ups such as CAVEs (Cave Automatic Virtual Environments) (Cruz-Neira, Sandin & DeFanti, 1993). VE applications can roughly be divided into three main categories: 1) entertainment, 2) simulation and 3) visualisation (Monnet, 1995). Digital games and 3D virtual worlds such as Second Life (www.secondlife.com) form the first category. Simulations are widely used in areas such as education, medicine and training. There are also psychotherapeutical applications, such as treating post-traumatic stress disorder experienced by war veterans (Kaplan, 2005). Engineers, architects, chemists and designers, among many other professionals, use VEs for visualisation.

The orienting aspects of all VEs can be evaluated using three components, that is, the mechanics, the narrative and the interface, included in Winn's "Design/Play/Experience" framework for designing digital games (Winn, 2008). **The mechanics** describe the particular game components, such as the rules, the goals and the obstacles, which define what social or physical actions the gamers can take. **The narrative** creates the virtual world, setting the stage for the story. It provides the purpose of the game. Closest to the users is **the interface**, which includes the audio-video output (e.g. 2D or 3D), gamer input (e.g. controls), as well as both the in-game and out-of-game screens, providing gamers necessary information for playing and configuring the game. We can use these three components to illustrate a chemical drug visualisation in a CAVE, for instance. The mechanics of such an application are largely based on the goal of solving a specific, task-oriented problem. Rules and obstacles are taken from real life in order to support this goal. The narrative has a minor role in such a work-related application: the purpose of the VE should be obvious. However, the CAVE provides a



highly immersive 3D interface, which affects the user's experience. As this example shows, the use context is also experientially critical.

The distinctions among the mechanics, the narrative and the interface are not at all clear-cut. For example, experiencing the social aspects of a game can be related to the mechanics that enable social actions or to the narrative that provides a social story and role or even to the interface, which is responsible for how all of this is presented to the user. However, this directional framework guides our evaluation of the entertainment VEs. We began with a CAVE that has simple mechanics and a narrative, but a high quality interface, and proceeded to digital games with rich mechanics and rich narrative, but technologically poorer audio-visual interfaces. Following Juul (2005), we define digital games to be both rules (mechanics) and fiction (narrative), in addition to having a digital interface. This definition rules out board games and web-based gambling such as slots, poker, bingo and lotteries.

1.3.1 Using VEs and playing games

When VEs are used or games are played, various actions and behaviours, or in other words, **dynamics**, emerge from the game mechanics (Hunicke, LeBlanc & Zubek, 2004; Winn, 2008) (Figure 5). Within the game rules and choices, gamers pursue meaningful goals, earn rewards and make decisions when faced with challenging situations. Gamers consistently evaluate their performance in the game, whether consciously or unconsciously; are they reaching the desired goals? Do they have the abilities to meet

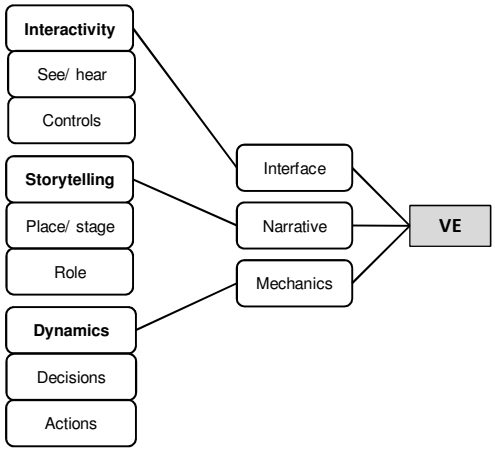
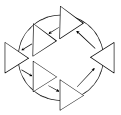


Figure 5. The orienting components of the VEs.

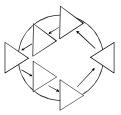


the challenges? When they reach the goals after overcoming obstacles, positive feelings and a sense of competence emerge. Game narrative turns into **storytelling**, which provides a gamer an active role. Curious places draw the gamers' focus to the game world and provide escape from the real world. The gamers become engaged in their role within the game events during which they interact with other agents, adapt and are drawn deeper into the game world. The creation of the game world is also supported by the interface, which provides a VE in which to explore and discover new things. The interface enables **interactivity** between the game and a gamer. It is what gamers actually see, hear, perhaps even feel and it is how they interact with the VE. All this is inseparable from an accompaniment of rich emotions, which are an essential part of playing and experiencing games.

Over the last ten years the popularity of entertainment digital games, that is, PC and console games, has increased to the point that these games have become the fastest-growing field in the entertainment industry (Entertainment Software Association, 2009). This development is apparent in various areas: the entertainment software industry is a major employer in the field of software programming and continues to grow as a source of employment. In Finland only two per cent of boys between 13 and 18 and 12 per cent girls of the same age do not play any digital games (VTT, 2006). Digital games clearly have a new role in our society; they are no longer entertainment for marginal users. For many, games have become a way of life. This development can be seen in studies that investigate the similarities in economic structures between online games and the real world (Giles, 2007). As players generate intense relationships with digital games, psychology plays a central role in developing the game-gamer relationship. The special character of this relationship is the experience games provide (Hunicke et al., 2004; Johnson & Wiles, 2003; Lazzaro & Keeker, 2004).

1.4 Psychological concepts and VEs

In the field of Human-Computer Interaction (HCI), researchers use the term "user experience" (UX) to describe a person's perceptions and responses resulting from the use or anticipated use of a product, system or service (ISO, 2008). Such a broad definition includes the experience within our purview, which results from the use of a VE system or a game product. We consider both "perceptions and responses" to be psychological in nature, but what constitutes them and eventually the UX in a use situation is not clearly

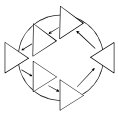


stated. Models have been provided in which UX or the media experience between a user and a technology is considered (Forlizzi & Ford, 2000; Klimmt & Vorderer, 2003; McCarthy & Wright, 2004). Common to most of these models is that they are more strongly orientated towards technology and design than towards psychology. In addition, most of the models are theoretical in nature, without any empirical evidence for their existence. This makes it hard to study the structure of the UX or the relationships within it. Moreover, any experiential inspection in VEs should start from the two psychologically rich and multidimensional characteristics that VEs possess: being within interactive environments, participants act in VEs instead of using them from the outside.

1.4.1 Being and acting in a VE

Both the users and the developers of VEs describe the feelings associated with being and acting by using a number of concepts, such as immersion, absorption, sense of presence, engagement, involvement and flow. There are many overlaps and even contradictions among these concepts. For example, scholars understand the widely-used concept of immersion as both a psychological experience (McMahan, 2003) and as the technological character of the VE (Klimmt & Vorderer, 2003; Slater & Wilbur, 1997). Some authors consider engagement to consist of absorption, flow, presence and immersion (Brockmyer et al., 2009). Others define these concepts very strictly; presence is considered "the sense of being there", while flow is defined as "an optimal experience". All in all, the field would benefit from the standardization of concepts, based on strong empirical evidence.

Without such standardizations, there are numerous challenges to understanding and actually evaluating psychological concepts in VEs. For instance, considering flow as an "optimal experience" by definition (Csikszentmihalyi, 1975) and restricting it to extreme situations only (Jennett et al., 2008) diminishes its applicability to the analysis of the experience in VEs. However, the subcomponents of flow, such as evaluated skills and challenges (Csikszentmihalyi, 1975), provide psychologically valid metrics for evaluating VEs, even if the user never reaches the actual state of "optimal experience". Similarly, in a previous study (Takatalo et al., 2006), we have shown how equal "meta-presence" scores in four different games actually hide clear experiential differences between the games as found in five, measured presence subcomponents (e.g. physical presence, arousal, attention, co-presence, role engagement). In other words, there can be

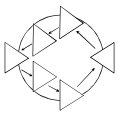


many different psychological reasons for each score obtained. Thus, the study of the experience or the UX in VEs should concentrate on the experiential subcomponents instead of on the concept that has a complex underlying structure (IJsselsteijn, de Kort, Poels, Jurgelionis & Bellotti, 2007). This reduction of a larger concept into smaller measures or subcomponents is an *operational definition* and applicable only to reoccurring processes, in order to assure reliability (Bradley, 2005). Some empirical user-centred studies of digital games support the existence of the potential experiential subcomponents of both being and acting in VEs. Table 1 presents an overview of nine empirical studies showing ten examples of such subcomponents. The sample sizes in these studies vary from a few dozen to thousands, and the number of subcomponents studied varies from three to nine. Conceptually, the subcomponents may overlap, depending on the scope and the method used. The subcomponents listed here can be traced back to the psychological base as well as to the larger concepts of presence, involvement and flow.

TABLE 1. A summary of game-related studies introducing potential empirically-derived UX subcomponents. X indicates that the authors have taken the subcomponent into account. The main scopes (e.g. motivation to play, immersion) and the methods used (e.g. qualitative, quantitative) vary across the studies.

	Method*	Number of participants	Skill, Competence	Challenge	Emotions	Control, Autonomy, Freedom	Focus, Concentration	Physical Presence	Involveent, Meaning, Curiosity	Story, Drama, Fantasy	Social Interaction	Interactivity, Controls, Usability
Jennett et al. (2008)	PC	260		x	x		x		x			x
Poels et al. (2007)	Qu	21	x	x	x	x	x	x		x	x	
Ryan et al. (2006)	QN	927	x		x	x		x		x		x
Sherry et al. (2006)	PFA	550		x	x					x	x	
Ermi and Mäyrä (2005)	PFA, Qu	234		x				x		x		
Lazzaro (2004)	Qu	30		x	x				x		x	
Sweetser and Johnson (2004)	PC, Qu	455				x		x		x		x
Takatalo et al. (2004)	PFA	244	x	x	x	x	x	x	x	x	x	x
Pagulayan et al. (2003)	Qu, QN	thousands		x	x							x

* Method: PFA = Principal Factors Analysis; PC = Principal Components; Qu = Qualitative interview; QN = Quantitative data collection



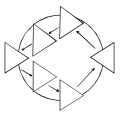
1.4.2 Presence

We use the shortened version of the concept of telepresence, that is, presence, to refer to the subjective feeling of being in a VE. Lombard and Jones (2007) have further defined presence as a psychological state or subjective perception in which the role of technology is not acknowledged when objects and entities are perceived in VEs. The interface, the narrative and the context of use all affect the experienced presence (Lessiter, Freeman, Keogh & Davidoff, 2001). Previous research has associated presence with a spectrum of different media, such as the variety of VEs, films and television (Schuemie, van der Straaten, Krijn & van der Mast, 2001). Unlike many other concepts around VEs, the concept of presence has extensive theoretical and empirical foundation; over 1,800 publications currently make up the presence literature (Lombard & Jones, 2007). Lombard and Ditton (1997) provided the first review of the descriptions found there. In addition, members of a community of scholars interested in the concept have an ongoing discussion in presence-l listserv (International Society for Presence Research, 2010). Although in some of the game studies presented in Table 1 presence is considered a one-dimensional construct, the literature conceptualizes presence as multi-dimensional with numerous interrelated, but distinct subcomponents:

- Presence as transportation, spatial presence, physical presence
- Presence as (psychological) immersion, engagement, attention
- Presence as realism, naturalness, ecological validity

- Social realism
- Co-presence and shared space
- Presence as social actor within medium
- Presence as medium as social actor
- Presence as social richness

IJsselsteijn and his colleagues (2000) further divide these subcomponents into two broad categories: physical and social. The first three points above represent the subcomponents of physical presence, that is, a sense of being physically located somewhere: *spatial awareness*, *attention* and *perceived realism*. Laarni (2003) elegantly des-

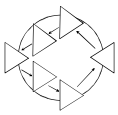


ignated this threesome the "Big Three" spatial presence subcomponents. The remaining five points represent concepts related to social presence, that is, being there together, communicating and acting with someone: *social realism*, *co-presence*, *social actor within medium*, *medium as social actor* and *social richness*.

1.4.2.1 Physical presence

Most of the empirically validated and psychometrically constructed presence questionnaires available today focus on the structure of physical presence. A majority of them have confirmed the existence of the "Big Three" construct of *spatial awareness*, *attention* and *perceived realism*. The MEC Spatial Presence Questionnaire (Vorderer et al., 2004), whose structure is based on the background theory instead of on a statistical analysis such as a factor analysis, also includes measures of spatial awareness and attention. In addition to the "Big Three" subcomponents, the psychometrically-constructed questionnaires available today include measures of interface quality and visual fidelity (Witmer & Singer, 1998), interface awareness, predictability and interaction, exploration, drama and quality of immersion (Schubert, Friedmann & Regenbrecht, 2001) as well as negative effects (Lessiter et al., 2001). The Temple Presence Inventory also measures several types of social presence, such as actor within medium and social richness (Lombard, Ditton, Crane & Davis, 2000). Some authors consider such additional measures confusing, because they mix the possible causes of presence with the actual experience of presence (Slater, 1999). However, Shubert and his colleagues (1999; 2001) have established a clear distinction between the perceptual physical presence experiences, evaluations of the range of interaction (predictability and exploration) and technology characteristics (interface awareness and quality of immersion).

Some scholars regard the sense of presence as being equivalent to interaction (Flach & Holden, 1998; Zahorik & Jenison, 1998). Shubert and his colleagues (2001) found that the sense of being an **active participant** in a VE is an integral part of the presence experience. In addition, Shubert and his colleagues (1999) showed that the evaluated **range of interaction**, such as the ability to explore and predict the impact of one's actions, as well as **technology characteristics,** such as interface awareness, all affect physical presence. Thus, the nature of the studied interaction must be carefully defined. As far as the environmental source, the VE, is concerned, the active participation described and the range of interaction originate from the *game mechanics* and *narrative*:

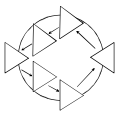


the actions afforded by the VE. On the other hand, the technology characteristics can be traced back to the *interface*, which enables **interactivity**, that is, what the users see and hear, and the VE controls, for example. Jennett and her colleagues (2008) distinguished game factors (e.g. ease of controls and using the controls) from person factors (e.g. attention, transportation). Such game factors or technology characteristics can be regarded as part of the VEs' usability, which is important to study, especially in the earlier, developmental stages of a VE.

1.4.2.2 Social presence

Understanding the relationship between interaction and presence in VEs becomes complex when social aspects are added to the content. For example, just seeing Snoopy in a VE increases the subjects' evaluations of physical presence (Regenbrecht & Schubert, 2002). In addition, prior research has found that both physical and social activity increase emotional arousal (Yerkes & Dodson, 1908; Zajonc, 1965): social situations are more heavily emotionally loaded compared to other situations (Simon, 1967). Thus, it is important to consider social measures in VEs along with physical ones.

The suggested social presence features are thus useful when evaluating VEs. *Social richness* refers to the extent to which a VE is perceived as personal and intimate. *Social realism* refers to the sense of similarity between the real world and the objects, people and events in the VE. *Co-presence* is the feeling of being and acting in a VE together with other agents. Both *social actor within medium* and *medium as social actor* are strongly related to the technology-mediated two-way communication. However, Table 1 (in p. 27) shows that the focus of the empirically studied social issues in game worlds concentrates on general social interaction (e.g. narrative and the engagement with one's own role), story, drama and the fantasy aspects of games instead of the social presence subcomponents identified in the presence research. Although some findings connect the evaluations of *drama* to the *quality of immersion* (the evaluated environmental characteristics) and even to the "Big Three" construct (Schubert et al., 2001), the problem with social measures is the richness of the social interaction in entertainment VEs. A comprehensive study of social presence in socially rich VEs requires concepts such as grounding and the group identity used in communication studies and social psychology to study interpersonal and group phenomena. However, these concepts are beyond the scope of the psychological approach here, and more psychology-oriented social meas-



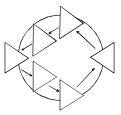
ures are needed. Of the social presence subcomponents presented above, *co-presence* (shared space) is probably the most generic and cross-contextual. It has been found, for example, in games (Poels et al., 2007), television and films (Lombard et al., 2000) as well as in video-conferencing (Harms & Biocca, 2004; Takatalo, Aaltonen, Häkkinen, Nyman & Schrader, submitted for publication).

The multidimensional presence concept provides a useful starting point for evaluating the experiences of being and being there with others in VEs. The presence subcomponents given above cover cognitive-perceptual, attention and socio-cognitive aspects of the experiential cycle and enable evaluations of the content, intensity and extensity of the experience (Takatalo et al., 2006).

1.4.3 Involvement

Prior VE and media studies define the involvement concept in two major ways: 1) as an indication of attention and concentration on the VE (Schubert et al., 2001; Witmer & Singer, 1998) or 2) as an indication of the motivational interest in and the relevance of the VE (Jennett et al., 2008; Wirth et al., 2007). Because the "Big Three" construct of physical presence already concerns attention, involvement is defined here as a motivational continuum towards a particular object or situation (Rothschild, 1984). Involvement concerns the level of relevance based on inherent needs, values and interests attached to that situation or an object (Zaichkowsky, 1985). Thus, involvement indicates the meaning and value of the experience. According to Dewey (1916), the most motivated students are those who are stimulated by their present interests and not by any promise of reward. In VEs, involved participants are likely to interact intentionally and voluntarily with the VE. Our main interest is not in what motivates the users, but in understanding the meaning and personal relevance of the VE used. Our experiential cycle shows that personal meaning has a key role in the way we act, perceive and eventually experience the environment. More specifically, the involvement concept indicates a motivational relationship between the user and the VE.

Involvement is a central and well-established concept both in the fields of buyer behaviour (Brennan & Mavondo, 2000) as well as in mass communication and mass media (Roser, 1990). Involvement includes two distinct, but closely related dimensions: *importance* and *interest* (McQuarrie & Munson, 1992). Importance is predominantly a cognitive dimension having to do with the meaning and relevance of the stimulus,

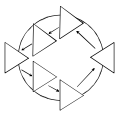


whereas interest is composed of emotional and value-related valences (Schiefele, 1991). Thus, the involvement construct fits in well with the experiential cycle, which accounts for both cognition and emotion in motivation. This definition makes importance similar to the cognitive involvement subcomponent that was identified by Jennett and her colleagues (Jennett et al., 2008). On the other hand, interest is close to Lazzaro's idea of curiosity and the will to find out something new in a game (Lazzaro, 2004). In addition, the MEC Spatial Presence Questionnaire (Vorderer et al., 2004) included two summed scales in which the higher cognitive involvement is similar to importance, and the domain-specific interest resembles interest.

Taken together, presence and involvement indicate the switch between the real world and a VE. In this process, the participants willingly form a relationship with the physical and social scope and scene of the VE. This process can be seen as a voluntary adaptation to the VE and a willingness to "be there". Although we have shown that the range of interaction and being an active participant are integral parts of "being there", we next consider performing in VEs in more detail.

1.4.4 Flow

The psychological base of a user as an active performer is oriented in a new direction, one that strongly affects the experience. One of the earliest descriptions of the connection between performance and psychology was the idea that, as the level of performance increases, so the emotional arousal increases (Yerkes & Dodson, 1908). The researchers further found that, beyond a certain point, elevation of arousal no longer contributes to better performance. Conversely, in a state of over-arousal, the level of performance drops. This phenomenon is also known as the "Inverted-U" theory (Duffy, 1957) and it has been widely studied in connection with athletes, for example. Although the theory seems simple, there are factors beneath the level of arousal that affect the performance. These factors include the complexity of the skills needed, the physical and mental challenges of the task, the importance of goals, the nature of feedback, achievements, disappointments and decisions, to name just a few. For instance, top athletes are familiar with the psychological means of handling these issues and with how to reach the optimal level of arousal associated with superior functioning or "peak performance" (Privette, 1965). In addition to arousal, the experience acquired in such episodes is found to be positive, highly enjoyable and motivating (Csikszentmihalyi, 1975).



Although the goal of the VE is seldom superior functioning, the experiential characteristics associated with these episodes have become design goals, especially for commercial VEs such as entertainment digital games (Hunicke et al., 2004; Johnson & Wiles, 2003; Lazzaro & Keeker, 2004). In order to understand "peak performance" and the experiences associated with it, we need to understand the underlying psychological processes. Mihalyi Csikszentmihalyi provides a useful description based on his studies of artists, athletes and musicians while performing their demanding activities (Csikszentmihalyi, 1975). Csikszentmihalyi called these states of superior functioning "flow" – the state of "optimal experience". He soon realized that flow evolves in situations in which both the challenges and the skills are cognitively evaluated as being high and in balance (Csikszentmihalyi & Csikszentmihalyi, 1988a). Figure 6a shows the balance between challenges and skills, which is referred to as the "flow channel". People in the flow channel experience positive feelings and deep enjoyment beyond boredom and anxiety (Csikszentmihalyi, 1975). Since the introduction of the flow-channel model, Massimini and Carli (Csikszentmihalyi & Csikszentmihalyi, 1988a) expanded it by adding apathy at the opposite end (Figure 6b). This expansion created a four-channel flow model, which shows how different challenge/skill ratios are likely to be related to various emotions. Many researchers have found the four-channel flow model to be useful when studying flow in daily activities, for example (Ellis & Voelkl, 1994; LeFevre,

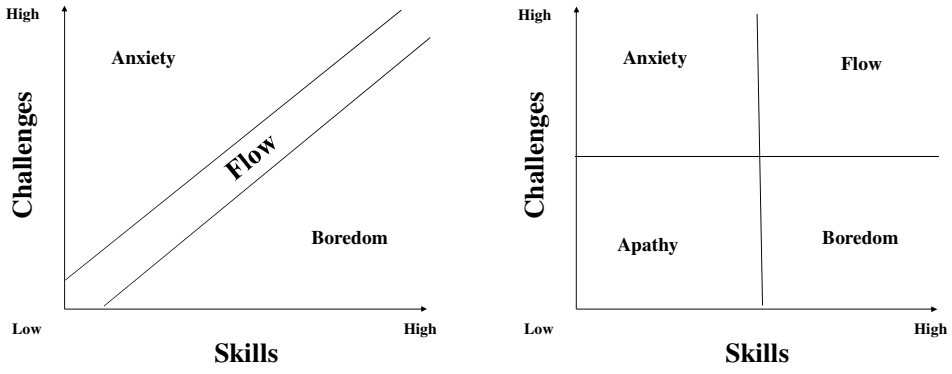
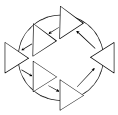


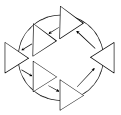
Figure 6. The basic flow channels. (a) Csikszentmihalyi's original (1975) flow model in which the flow state is represented by the diagonal between boredom and anxiety when skills equal challenges.(b) The four-channel flow model (Csikszentmihalyi & Csikszentmihalyi, 1988a), which adds apathy to the lower end of the flow diagonal. The flow state begins from a point above the person's average skills and challenges.



1988). In addition, more complex flow models exist, such as the eight-channel flow model (Massimini & Carli, 1988), which includes intermediate levels of challenges and skills and presents four more channels: worry, arousal, control and relaxation. However, little is known about the value of adding more complex models to the original theory (Nakatsu, Rauterberg & Vorderer, 2005).

Psychologically, the core idea of the flow theory is similar to the cognitive theories of emotion. These theories (Ellsworth & Smith, 1988; Frijda, 1987; Lazarus, 1991b) are based on the idea that cognitive interpretations and evaluations of events, that is, appraisals in the world, are important antecedents of emotions. Such cognitive evaluations include the effort anticipated in a situation, the perceived obstacles and the sense of control, for example. Depending on the situation and the perceiver, the combination of these cognitive evaluations and interpretations shapes the emotions attached to particular events (Ellsworth & Smith, 1988). In the theory of flow cognitive evaluation concerns the challenges provided by the situation and the skills of the perceiver. If the ratio between these two is high and in balance, then an emotionally positive, flow-like experience is likely to occur (Csikszentmihalyi, 1975). In VEs such a cognitive evaluation process mainly concerns the mechanics of the VE. The game studies listed in Table 1 show this clearly: cognitively evaluated challenges and numerous emotional outcomes are the subcomponents found in almost every empirical game study. However, there is relatively little empirical evidence for the composition; moreover, interrelationships between the flow subcomponents in VEs and a validated measurement tool specifically designed to assess flow subcomponents in entertainment VEs such as digital games has not been presented (Cowley, Charles, Black & Hickey, 2008).

In addition to the subjective evaluations of challenge and skill, Csikszentmihalyi's flow theory (1975) considers clear goals and instant feedback to be important features, which are evaluated cognitively in a given situation. Moreover, the theory includes the sense of control, the level of arousal, concentration, time distortion, loss of self-consciousness and the merging of action and awareness as prerequisites or correlates of the flow experience. As already shown in section 1.4.2, the levels of arousal, concentration, time distortion and feedback from one's actions (e.g. interactions) are related to the sense of presence. This theoretical overlap between flow and presence supports the finding that presence is a prerequisite of flow (Novak, Hoffman & Yung, 2000). Previous



studies have shown that losing self-consciousness and merging action and awareness are difficult for respondents to recognize (Rettie, 2001). On the other hand, participants have described the actual flow state as being characterized by feelings of ease of doing, enjoyment and positive valence (pleasure) as well as an absence of boredom and anxiety (Csikszentmihalyi, 1975). There are also studies that relate flow to playfulness (e.g. cognitive spontaneity) (Webster & Martocchio, 1992) and a sense of control (Ghani & Deshpande, 1994; Novak et al., 2000). Moreover, many studies report a wide variety of other feelings, such as pleasantness, strength and the impressiveness of the experience along with amazement and excitement, which are found in games (Lazzaro, 2004; Schubert et al., 2001). To sum up, the concept of flow describes the cognitive-emotional, qualitative direction of an experience in a VE.

1.5 The aim of this research

The aim of this research is to understand and evaluate conscious experience. A theoretical approach is introduced to study psychologically-based and content-oriented experience. The concentration here is on experiences evolving from human-environment interactions. Central to the approach is the *experiential cycle*, in which we connect classical psychology with the orienting environmental content. The experiential cycle is generic and applicable to understanding any human-environment interaction psychologically. Here, we have applied this approach to develop a methodological framework for studying the structure of experience in entertainment VEs. The development of the framework included semi-structured interviews, quantitative subjective data from questionnaires and objective behavioural data. Both the human-centredness and the subjective multidimensionality have guided the developmental process. The framework consists of the sense of presence, involvement and flow, all of which are relevant concepts to understanding the fundamental experiential characteristics of VEs (Figure 7). The empirical data collecting, development and validation of this framework are reported here. Specifically, we 1) studied the structure of experiential components in a CAVE with a high-tech interface, but average mechanics and narrative (Study I); 2) studied the relationships between experiential components and movement patterns (Study II); 3) expanded the found experiential structure to digital games with rich narrative and mechanics (Study III); 4) collected more data and extracted two multivariate measurement

models from the digital games (Studies IV and V); and 5) utilized the revised framework in practice (Study V).

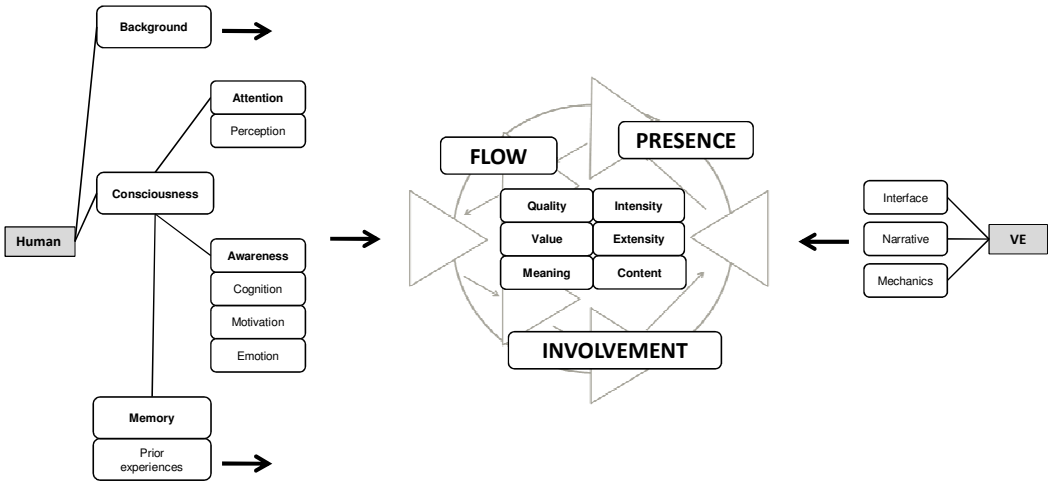


Figure 7. Presence, involvement and flow in a potential space characterizing the experience. On the left is the psychological base and on the right, the orienting content, that is, the virtual environment (VE).

2 Methods

In order to explore the relevant psychological concepts in VEs, subjective research methods have mainly been used. Interviews and feedback from the participants in our studies supported the construction and development of the Experimental Virtual Environment Experience Questionnaire (EVEQ). Different versions of the EVEQ were filled in over 2,400 times, after the participants played/used many different kinds of entertainment VEs. These empirical data provide a strong support for our evaluation framework. The data collection, questionnaire and framework development as well as the publications are summarized in Figure 8. The findings and frameworks based on these empirical subjective data have been validated by quantitative objective behavioural data (Study II), a different interface (Study III), narrative and mechanics (Studies III and V) and qualitative interviews, objective performance data and external criteria from Metacritic.com (Study V).

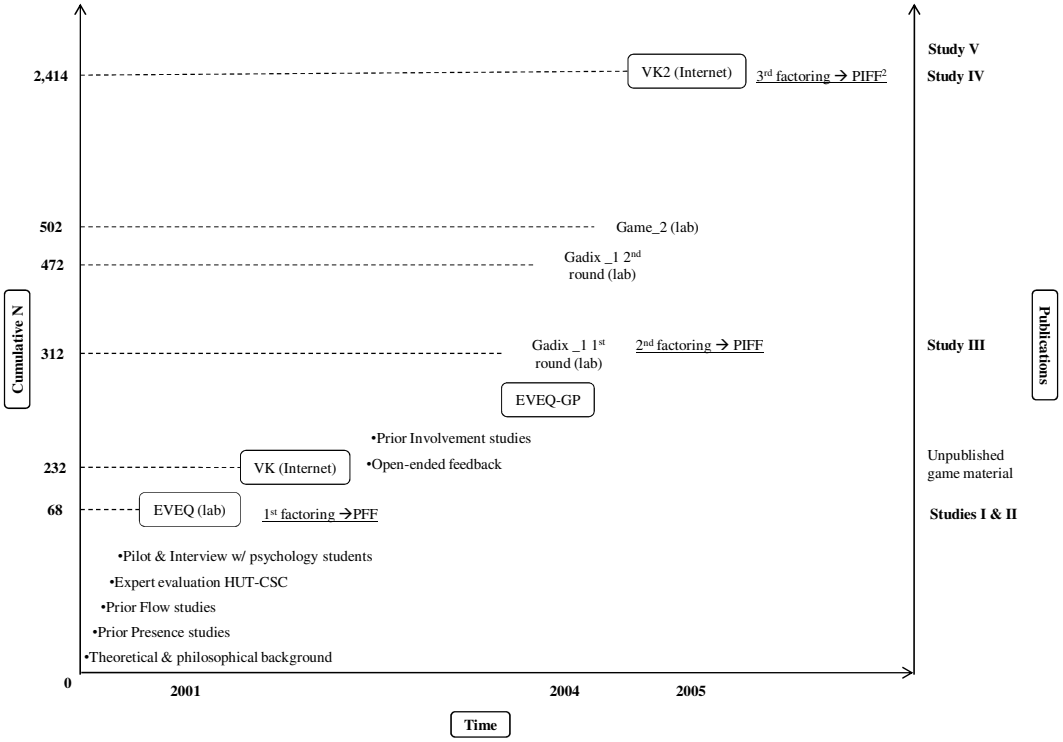
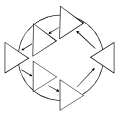


Figure 8. Summary of the questionnaire development, data collection, analysis and publications.

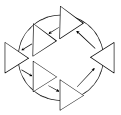


2.1 Participants

In the Experimental Virtual Environment (EVE) CAVE we had 68 participants (43 males and 25 females, with a mean age of 28.2 years and SD=5.5 years). The data are reported in Studies I and II. At the same time we studied EVE, we collected data from 164 gamers' experiences via the Internet. We used this unpublished data to develop the questionnaire further. The enhanced questionnaire was used in three game studies conducted in the laboratory, Gadix_1 1st (N=80, 40 males and 40 females, mean age 24.7 years and SD=3.7 years), Gadix_1 2nd (N=160, 80 males and 80 females, mean age 23.7 years and SD=3.8 years), Game_2 (N=30, all males, mean age 24.1 years and SD=4.4 years) and an Internet survey (VK2; N=1,912, 1,822 males and 90 females, mean age 21.1 years and SD=6.2 years). Altogether, we collected data from 2,414 subjects' experiences in both CAVE and digital games.

2.2 Questionnaire and framework development

The Experimental Virtual Environment Experience Questionnaire (EVEQ) is theoretically and methodologically founded on previous studies of the sense of presence (IJsselsteijn et al., 2000; Kim & Biocca, 1997; Lessiter et al., 2001; Lombard et al., 2000; Schubert et al., 2001; Usoh, Catena, Arman & Slater, 2000; Witmer & Singer, 1998), involvement (Brennan & Mavondo, 2000; McQuarrie & Munson, 1992; Roser, 1990; Rothschild, 1984; Zaichkowsky, 1985) and flow (Csikszentmihalyi, 1975; Csikszentmihalyi & Csikszentmihalyi, 1988b; Della Fave & Massimini, 1988; Fontaine, 1992; Ghani & Deshpande, 1994; Mehrabian & Russell, 1974; Novak et al., 2000; Webster & Martocchio, 1992). From these studies approximately 180 questions were selected, translated into Finnish and transformed either into a seven-point Likert-scale (1 = Strongly Disagree to 7 = Strongly Agree) or into seven-point semantic differentials. Then technology experts at both the CSC–IT Center for Science Ltd and the Telecommunication Software and Multimedia Laboratory (currently, the Department of Media Technology at the Helsinki University of Technology) as well as behavioural experts at the University of Helsinki's Department of Psychology evaluated this set of questions. The questionnaire was modified according to the suggestions made in these evaluations. We designed EVEQ to evaluate a single-person experience of being and acting in a VE. The data collected with EVEQ (N=68) enabled us to extract **the Presence-Flow Framework (PFF)** (Study I). At the same time, we developed another version of the



questionnaire, namely, Virtuaalinen Kyselylomake (**VK**, i.e. Virtual Survey) and collected 164 gamers' experiences through the Internet. All 170 questions in the VK were rephrased so that they concerned the game worlds. The skill questions were pared down to only those dealing with in-game skills, and the skills with which to use the "application" were left out. The CAVE-related questions were replaced by questions assessing the sense of sharing the game world with others, drama content and the gamers' own role in the narrative.

Based on the PFF and user feedback from the open-ended questions included in the VK, we designed the Experimental Virtual Environment Experience Questionnaire-Game Pitkä (i.e. *Pitkä* means long in English) (**EVEQ-GP**, available at www.eveqgp.fi). Enhancements included additional flow questions (Della Fave & Massimini, 1988) and both dimensions of the involvement construct, that is, importance and interest (McQuarrie & Munson, 1992). These modifications increased the number of questions to 180. We focused our research on digital games and utilized the EVEQ-GP in the laboratory experiment called the Game-Display Experience_1 (Gadix_1, N=80). We then integrated all the data (N=312), and in Study III we extracted and reported the first version of the **Presence-Involvement-Flow Framework (PIFF)**.

The laboratory experiments continued (N=160, N=30), and a slightly modified electronic version of the EVEQ-GP, also known as Virtuaalinen Kyselylomake 2 (**VK2**, i.e. Virtual Survey 2) was put on the Internet (N=1,912). All totalled, we had a large and heterogeneous database (n=2,182) with which to explore the structure of the experience in game-related VEs. Because we considered the theoretical and methodological background too heavy to report in one publication, we divided the PIFF framework (Study III) in to two theoretically meaningful subsets – presence and involvement (i.e., adaptation) as well as flow – and studied these parts in two separate, multivariate measurement models (Tarkkonen & Vehkalahti, 2005). Together these two subsets form the revised PIFF, namely the **PIFF^2**.

2.3 Procedure and technology

2.3.1 CAVE

The Experimental Virtual Environment (EVE) (http://eve.hut.fi) is a rear projection-based CAVE, in which the user is surrounded by three screens, each three meters high

and three meters wide (Figure 9). The task in EVE was to enter and explore a virtual house to find objects that would not be found in a normal house. The idea was to provide the 68 participants a meaningful, yet neutral activity in EVE. The whole virtual task took approximately 20-25 minutes. Afterwards the participants were asked to fill in the EVEQ. During their stay in EVE, each participant's movement in the VE was recorded on a computer as a two-dimensional (x, y) path, with time being the third dimension measured.

The resolution of the displays in EVE is 1,024 x 768 pixels. Stereoscopic images are produced and reflected onto the screens by a Silicon Graphics (SGI) Onyx2 computer with two Infinite Reality graphics pipelines and two raster managers, which drive four ElectroHome Marquee 8500 LC Ultra projectors. In order to view the environment in 3D, Stereographics shutter glasses are worn. The projectors produced approximately 1,000 ANSI lumens per eye of which shutter glasses, mirrors and screens diminish almost 90 per cent, leaving approximately 100 ANSI lumens per eye. Shutter glasses also divide the refresh rate of the display (120 Hz) in half (to 60 Hz). The participants were able to interact with the environment by using a Logitech radio mouse, equipped with a six-degrees-of-freedom tracking device by Motionstar.

The software used was a modified version of HCNav by Laakso (2001). The model of the virtual house, in which the test task took place was from the "Friends of performer" collection (misc94/house.dwb). The model was relatively simple with only 4,657 triangles and 31 textures. All the sounds used were from a set of commercial sound-effect compact discs or the SGI software synthesizer's sound library.

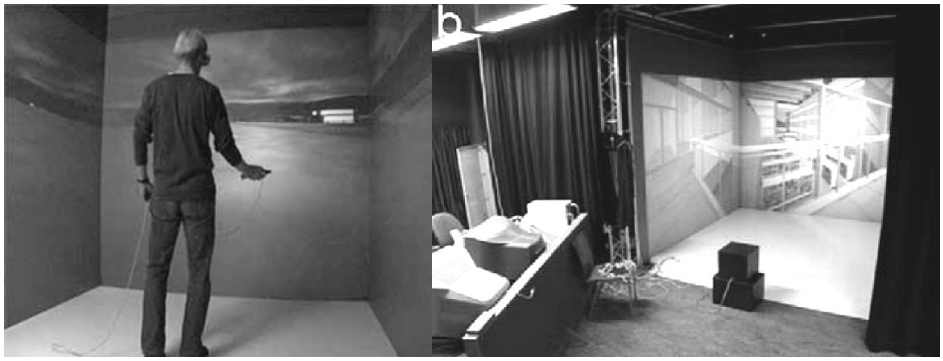
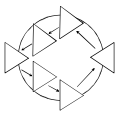


Figure 9. The Experiential Virtual Environment CAVE, used in Studies I and II.



2.3.2 Digital games

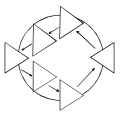
In each round of the Gadix laboratory studies, the participants played two different driving games, *Need for Speed Underground* (Need for Speed Underground, 2003) and *Sliks'n'Slide 1.30d* (Slicks'n'Slide, 1997) with two different displays, the Olympus Eye-Trek FMD-700 near-eye display (NED) and a 21-inch Sony Trinitron GDM-F520 cathode ray tube display (CRT). In these experiments a 2x2 between subject-design was used. Each participant played for 40 minutes, after which the person was asked to fill in the EVEQ-GP questionnaire. After the first round of experiments, minor changes were made to the procedure.

In the second laboratory experiment, namely, Game_2, the participants played two consecutive sessions (2 x 40 minutes) of *Halo: Combat Evolved* (Halo: Combat Evolved, 2002). These participants used a PC offline and a 17-inch monitor. After the second session the participants filled in the EVEQ-GP. During the playing session, physiological data were recorded (e.g. changes in skin conductance and contraction of facial muscles).

In Study V we present some of the results from yet another laboratory experiment (Mechano_1). In this experiment the experiential process of 15 participants (10 males, 5 females) was analysed during their first hour of playing Valve's *Portal* (Portal, 2007) with a PC and a 21.3-inch display. The process was captured by suitably interrupting the gamers twice during the one-hour of play. The third evaluation was made after 60 minutes of playing. During the breaks, the gamers filled in a shortened version of the EVEQ-GP using a touch-screen next to them. These limited data are not included, either in the large data pool reported in Studies IV and V or in Figure 8 summarizing our research.

An online version of the EVEQ-GP (VK2) was used to collect data from the Internet. The instructions directed the participants to focus on one particular gaming session and fill in the questionnaire while keeping that session in mind. The instructions further recommended filling in the questionnaire right after a playing session. The questionnaire was online for one month on the home page of the leading PC gaming magazine in Finland (*Pelit* [Games], www.pelit.fi).

In all of the game data (N=2,182, 1,972 males and 210 females, a mean age of 21.5 years and SD=6.0 years), most of the games played (31.5%) were first-person shooters

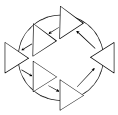


(FPS), either online (15.0%) or offline (16.5%). The second most popular genre (15.0%) was massive multiplayer online role-playing games (MMORPG) and the third most popular (13.1%) were the single role-playing games (RPG). The most popular single game played was *World of Warcraft* (n=265), which is a MMORPG (World of Warcraft, 2004). The participants played 127 minutes (SD=111) on average and 33 per cent of them reported playing daily, 29.6 per cent at least every other day, with 24.5 per cent playing often but not as often as every other day. The average size of the display used was 19.2 inches (SD=4.4). Altogether the data included approximately 320 different games, various displays (HMD, TV, CRT) and contexts of play (online, offline, home, laboratory). Although the majority (85.2%) of the games were played with a PC, the data provide a variety of game mechanics, narratives and interfaces with which to study experience.

2.4 Statistical analysis

We used factor analysis with principal axis factoring (PAF) across the studies to investigate the structure of presence, involvement and flow in VEs. At first, the small number of participants and the large number of questionnaire items analysed caused some challenges, since the desirable variable-to-subject ratio in a PAF is 1:5 (Tabachnick & Fidell, 2001). When we formed the **PFF** framework, we conducted a separate PAF for multiple, smaller sets of variables and computed factor scores with Bartlett's method for each separate experiential subcomponent, for example, arousal or attention. This procedure ensured the uni-dimensionality of each subcomponent used. Then these individual uni-dimensional subcomponents were factored in order to extract the actual PFF framework. The factor solution was rotated using a Varimax rotation in order to obtain a simpler and more understandable factor structure. In the **PIFF** framework (Study III) the uni-dimensionality of each subcomponent was first checked with a similar method, although we used summed scales in the final analysis. The large VK2 data enabled us to form the two-measurement models for presence and involvement as well as the flow subsets (Studies IV, V).

In both measurement models forming the **PIFF^2**, we used PAF, but the rotation method was changed to an oblique direct Oblimin rotation (delta=0). From the theoretical point of view, the experiential factors extracted could not be assumed to be orthogonal. Furthermore, the planned future uses of the factors, such as structural equation



modelling, required correlation between the factors. However, the final structure was still very similar, no matter which rotation method was used.

In Studies I, II and III we used Cronbach's alpha coefficient to estimate the internal consistency of the subcomponents used. The critical value was set to 0.6, which is quite low. Although there were some subcomponents below the desirable level of 0.7, it should be noted that in these studies, alphas were calculated from the summed scales, which do not provide a weighted measure for the alpha. Moreover, the alpha has a tendency to underestimate the measures (Vehkalahti, Puntanen & Tarkkonen, 2009) and a built-in assumption of the one-dimensionality of a measure (Tarkkonen & Vehkalahti, 2005). These factors may lead to biased conclusions and the discarding of suitable questionnaire items or even subcomponents (Vehkalahti, Puntanen & Tarkkonen, 2006). For this reason, in Study V the alpha was changed to Tarkkonen's Rho, which provides a valid way to assess the internal consistency of weighted scales. In these studies, we used weighted factor scores as measurement scales.

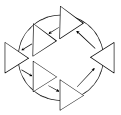
In addition to reliability, we considered the validity of the framework and its subcomponents. The heterogeneous and large sample and the different VEs used (approximately 320 games and CAVE) cover both the external and the ecological validities. We focused on the different aspects of the construct validity as well.

1) Both of the measurement models forming the PIFF^2 were cross-validated by investigating the half-split samples drawn from all the game data. This investigation confirmed the structure of the PIFF^2.

2) The content of the extracted subcomponents was compared with the background studies in VEs and in psychology.

3) The subcomponents have also been related to each other in order to determine whether those subcomponents that should theoretically be related really are related (convergence and concurrent validity) and those subcomponents that should not be related are not related (discriminate validity).

4) The subcomponents are also related to outside criteria, such as the Metacritic scores (Metacritic.com, 2009) and the objective behavioural movement data. Movement in VEs was quantified by using the information entropy approach, which enabled us to identify different movement patterns.

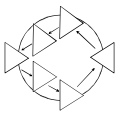


2.4.1 Information entropy

The concept of entropy originates from classical thermodynamics, but in information theory, it measures the amount of information that a data source contains (Weaver, 1963). A data source can be a signal, an event or any other result of measurement that contains information. When calculating entropy from the measurement, the following rule can be applied: the more often you get a specific result, the less new information it gives you. In this case the entropy of the result is also small. In other words, the bigger the entropy of the result of a measurement, the more randomness and new information it contains. In short, the entropy of the result of a measurement tells how much information the result contains.

To the best of our knowledge, movement in VEs has not previously been studied using entropy measures. Entropy measures reveal the regularity and smoothness of movement, which help to discriminate, for instance, between those who move with a fluctuating speed and those who travel at a steady pace. In addition, entropy measures are calculated by using the true occurrence of information in the data, unlike many other estimators, which make assumptions about the distributional properties of the data.

When we analysed the quantitative data collected with different versions of the EVEQ, we inspected the distributional assumptions, such as normality and the homogeneity of variance-covariance matrices crucial for multivariate statistical tests, and the existence of univariate or multivariate outliers. Attention was paid to minimizing missing values when each sub-sample was collected. Any missing values were replaced by the sample mean. We conducted all the statistical analyses in this research with different versions of an SPSS statistical program (11.0-16.0). The entropy measures used were calculated using MatLab R13.



3 Results

Below we present the five studies in which the development and validation of the measurement framework from the PFF to the PIFF^2 were reported. A short description is given of the background, results and main conclusions of each study. The aim is to illustrate the experiential phenomena found in VEs. The exact statistics, such as the F-values, are provided in the original texts (Studies I-V). Only statistically relevant results are presented here, supported by the information supplied in the figures. More detailed results are presented in section 3.5.2, "The four flow channels", which is an unpublished study.

3.1 Presence-Flow Framework - PFF (Study I)

Study I (*Components of Human Experience in Virtual Environments*), published in 2008, is based on exploratory work that was completed in 2002 (Takatalo, 2002). However, it still presents a novel way of studying rich psychology in VEs. Study I expanded the flow study of Novak et al. (2000), which was conducted on the Internet. Our study integrated a multidimensional measure of presence, interaction and a variety of emotions into the flow measures of Novak's research team and concentrated on perceptually rich and more interactive VEs. In contrast to Novak et al., the subcomponents formed were not summed up, but examined with a PAF. The aim was to find both theoretically and psychometrically meaningful subcomponents and then factor these into a framework describing participants' experiences of being and acting in a VE. Technologically, a high-end CAVE was utilized and a simple search task designed to investigate a single person's experience. In order to study the 68 participants in this experiment, we developed the EVE Questionnaire (EVEQ) consisting of approximately 180 questions.

3.1.1 Results of Study I

On the basis of the data collected, we derived nineteen experiential subcomponents. We were able to identify eleven subcomponents central to presence, flow and interaction. Another set of subcomponents consisted of eight emotional feelings. The feeling subcomponents included feelings of "being there" and flow-related feelings of being free, flexible and creative, for example. The physical presence, interaction and flow subcomponents included more of the preconditions or underlying factors related to these con-

cepts, such as spatial awareness and realness in presence as well as skill and challenge evaluations in flow. Because of the limitations of the small sample size, we factored the eleven underlying presence interaction and flow subcomponents into a framework, which we further validated with the eight emotional subcomponents.

A Varimax-rotated PAF yielded a three-factor solution, whose dimensions were called physical presence, situational involvement and competence (Figure 10). The "Big-Three" presence subcomponents formed the **physical presence** dimension with feelings of being active in the VE (action) and arousal. Both cognitive flow subcomponents formed dimensions of their own with relevant companions. **Situational involvement** was composed of evaluated challenge, personal relevance and interaction speed, mapping, range (SMR) and **competence** with skill, control and exploration subcomponents. Previous presence studies (Lessiter et al., 2001; Schubert et al., 2001; Witmer & Singer, 1998) and Novak et al.'s study of flow (2000) supported these findings. How-

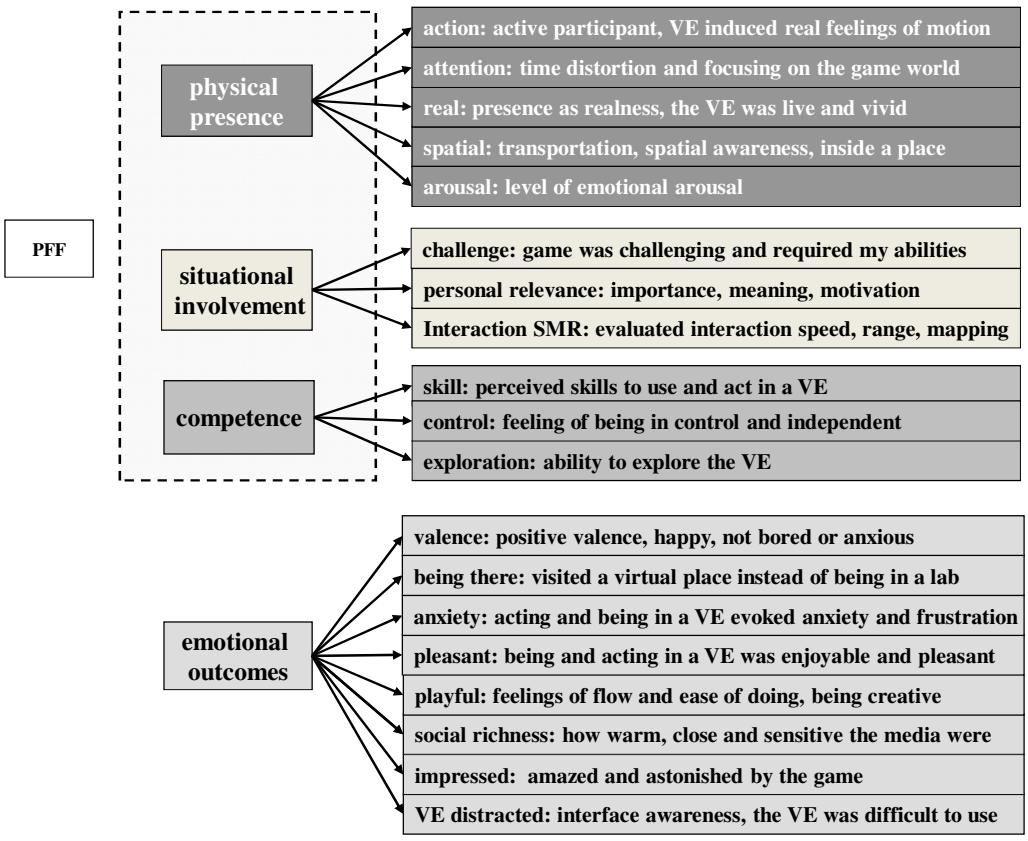


Figure 10. The nineteen subcomponents extracted in Study I: the three dimensions of the PFF and the eight emotional outcomes.

ever, whereas Novak et al. found a close relationship between challenge and arousal, our framework arousal was related to presence. In addition, the interaction SMR double loaded on both physical presence and situational involvement dimensions, despite the orthogonal Varimax rotation used. In any case, the PFF was born, and we tested it against the eight emotional subcomponents.

We grouped the 68 participants according to the eleven subcomponents that formed the PFF. The groups were formed by means of a hierarchical cluster analysis using the Squared Euclidean distance measure. The analysis revealed five different PFF groups, which were further studied with contrasts in the analysis of variance (Figure 11). In Groups 1 and 5 the PFF profiles were regarded as relatively high and steady, and were compared with Groups 2, 3 and 4. In addition Group 3 was compared with Groups 2 and 4. Characteristic of these 'middle' groups was a heightened score in one of the PFF dimensions and lower scores in the other two dimensions. The simple scale radars of these groups were also incoherent. Contrasts suggested that Group 2 was competent, but not physically present or situationally involved. Group 4 was situationally involved, but not competent or physically present. Group 3 scored lower in all three PFF dimensions compared to Groups 1 and 5. However, Group 3 scored highest in physical presence compared to Groups 2 and 4. The results disclosed how participants experienced the VE according to presence, interaction and flow subcomponents and how these larger con-

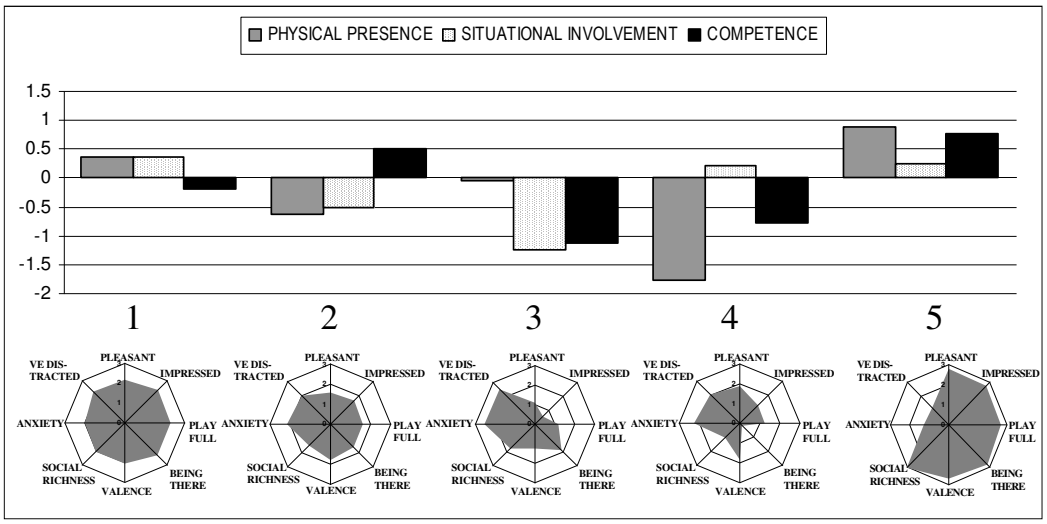
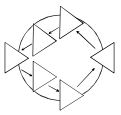


Figure 11. The relationship between the mean profiles of the three PFF dimensions and eight emotional outcomes among the five experiential groups in EVE.



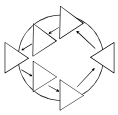
cepts relate to each other and to emotional quality in a VE. We found that high and steady profiles in three PFF dimensions were associated with higher scores in positive emotional subcomponents and with lower scores in negative emotional subcomponents.

3.1.2 Conclusions of Study I

Study I presented a wide variety of psychological subcomponents relevant to VEs and showed how these subcomponents can be empirically extracted from questionnaire data. Although the sample size was modest, testing of the first version of the EVEQ yielded promising results, namely the formation of the experiential subcomponents and a factor-analytically extracted three-dimensional PFF. The structure of the PFF showed the difference between presence (attention and environmental perceptions) and flow (cognitive evaluation of one's own actions). Although the results raised some questions about the measurement of interaction, the connections between the extracted PFF and the emotions experienced further validated the findings. Above all, we showed how common experiential patterns can be found and profiled to advance a better understanding of human-computer interaction.

We considered those participants having high and steady PFF profiles (Groups 1 and 5) to have feelings of being in the VE and being active therein; we also considered the participants to have perceived the VE to be real at a level that drew their attention as well as elevated their level of arousal. Such participants regarded the VE as being personally relevant; they evaluated the VE as being challenging and giving them feedback, thereby involving the participants and motivating them to act. All this was combined with a sense of control over a situation as well as the feeling of having the skill to explore the VE without constraints. The emotional profiles verified the PFF findings. The participants in Groups 1 and 5 experienced the VE as pleasant and playful and were impressed by it. They also considered the VE as a rich medium and felt that they had visited a computer-generated place instead of staying in a laboratory during the test. These participants experienced the VE as being emotionally more involving and providing a qualitatively rich and positive experience. In Group 5 in particular the participants did not feel any anxiety nor were they distracted by the VE. To sum up, the experience of the participants in Groups 1 and 5 included aspects of both presence and flow.

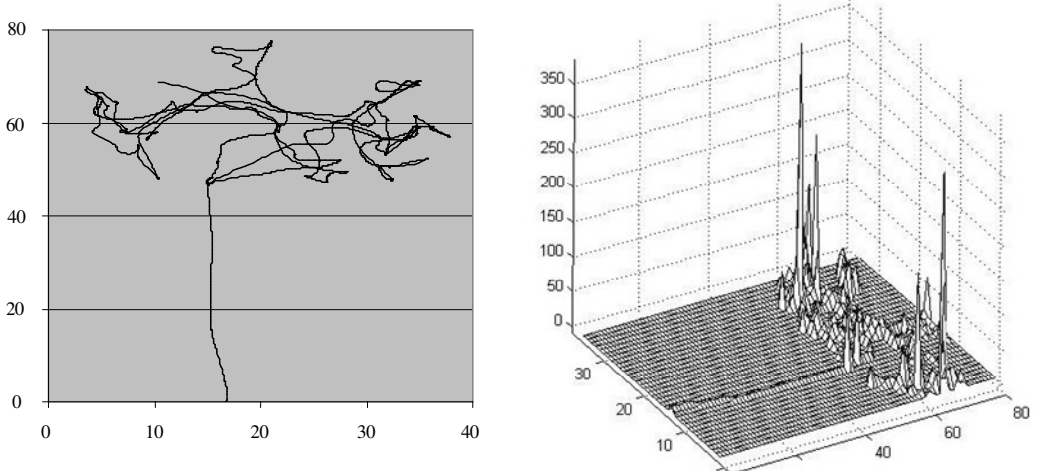
We concluded that being physically present, situationally involved or competent is not enough to create a positive and rich experience in a VE. Those participants who had



an unsteady profile lacked feelings of playfulness and "being there". They did not regard the VE as being an impressive or rich medium. In some cases the experience was unpleasant for the participants, negative in valence and anxiety-producing. Some of them experienced physical presence, but not flow (Group 3), at least to some extent. This indicates the role of presence as a prerequisite of flow in mediated environments, as suggested by a previous study (Novak et al., 2000). This relationship between presence and flow is self-evident: participants need to have the feeling of "being somewhere" before they can experience acting. Before developing the PFF further, we validated some of its presence - and flow-related subcomponents as suggested at the end of Study I, namely by using objective behavioural data.

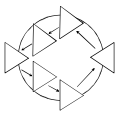
3.2 PFF and movement patterns (Study II)

Study II (*The Movement Patterns and the Experiential Components of Virtual Environments*) showed how different movement patterns are related to the way users experience the VE. Movement during the stay in the VE was recorded on a computer as a two-dimensional (x, y) path, time being the third dimension measured (Figure 12a). Then movement was modelled by combining traditional data, such as the number of stops, with information entropy based-measures. For example, the frequency of times the participant visited different parts of the VE provided a probability that was then used to calculate the location entropy (Figure 12b). With the movement model, we tried to iden-



(a) (b)

Figure 12. (a) The two-dimensional movement path of one participant. (b) The movement path of the same participant on a 3D histogram. The height of the histogram illustrates the number of visits to a certain location.



tify characteristics of fluent movement and compare fluently-moving users with less fluently moving ones. Consequently, it was first necessary to determine whether there are movement patterns that can be identified. Secondly, we hypothesized that fluent movement in VEs would be related to a high sense of physical presence. Finally, we expected fluent movement to be related to high evaluations of skill and challenge, both of which are closely related to flow (Csikszentmihalyi, 1975).

3.2.1 Results of Study II

In order to analyse movement statistically, we needed a way to quantify it. First, we calculated the total time, the number of stops, the time spent being stationary and the mean acceleration for each participant. Next, we calculated three entropy measures for each participant individually: location entropy, the entropy of turning and speed entropy. All entropy measures were continuous variables. Low location entropy illustrates that most of the time the participant moved in a fairly limited part of the VE. In contrast, high location entropy shows that the participant moved evenly in all parts of the VE. A low entropy of turning means that the participant moved by making equal-sized turns, whereas a high entropy of turning shows that the participant moved by using a whole range of different-sized turns. Low speed entropy shows that the participant moved at a steady pace, while high speed entropy means that the participant moved at highly variable speeds. A hierarchic cluster analysis was carried out, in order to see whether the participants had different movement patterns. **Entropy of turning**, **speed entropy**, **acceleration**, **number of stops** and **time spent being stationary** were selected as clustering variables. Ward's method was chosen as a clustering method and squared Euclidean as a distance measure. After careful examination we selected a four-cluster solution.

The first group had values close to the sample mean in all movement variables except the number of stops and the time spent being stationary, both of which were quite low. In other words, the participants in Group 1 moved rather fluently most of the time. Therefore, Group 1 was called *fluent movers*. Conversely, the participants in Group 2 moved in a very similar way, except that they had more stops and spent more time being stationary in the VE. Hence, Group 2 was called *stationary fluent movers*. Groups 1 and 2 were by far the largest groups in the data. By contrast, the participants in the third group executed many different-sized turns and had the greatest variability in the speed of their movements. Also, they had the largest mean acceleration rate and they made

stops far more often than any other group. Despite the large number of stops, the participants in Group 3 were almost constantly in motion. As a consequence, Group 3 was called the group of *low control*. Finally, the participants in Group 4 made mostly equal-sized turns, had the least variability in speed, made numerous stops and had a high mean acceleration rate. In addition, they spent more time being stationary than did the participants in the other groups. Thus, the Group 4 was called the *stationary* group.

We examined differences between the four groups' backgrounds and the fifteen subcomponents presented in Study I. Based on the findings in Study I, all the other central PFF subcomponents (related to presence, interaction and flow) were included with the exception of personal relevance. In addition, five of the eight emotional outcomes (valence, playfulness, being there, anxiety and pleasant) were included. At that time, the role of the impressiveness subcomponent was unclear, so it was not used in the analysis. We were concentrating on the comparison of the two most divergent groups: the *fluent movers* and the *low control* groups (Figure 13). This approach permitted an examination of how fluent movement in the VE, or the lack of it for that matter, affects the experience. The comparison was made by using contrasts in the analysis of variance. The results indicate difference in most of the measured experiential subcomponents and provided insight into the relationship between skill and challenge.

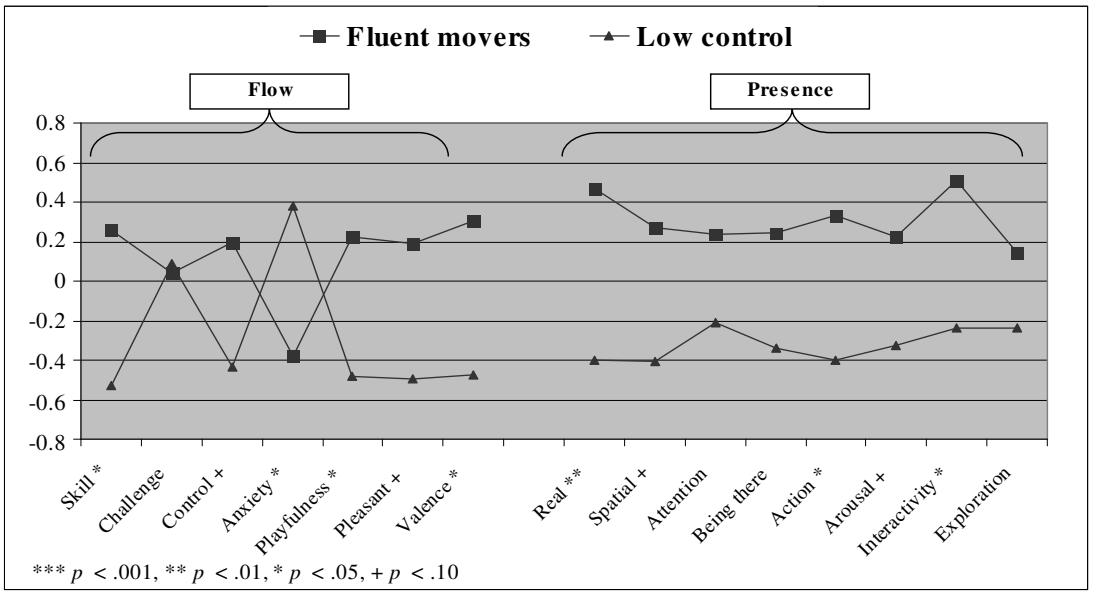
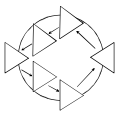


Figure 13. The experiential profiles of fluent movers and the low control group. The experiential components are roughly classified as part of a flow or a presence construct. The distinction is based on the findings in Study I. The subcomponents are connected to each other in order to create a profile and to enhance the readability of the results.

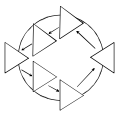


3.2.2 Conclusions of Study II

The information entropy analysis offered a novel and valid way to identify different movement patterns and analyse movement statistically in VEs. The analysis revealed connections between movement patterns and experiential subcomponents. As we had hypothesized, fluent movement in a VE was connected with high presence evaluations. Fluently moving users experienced the VE as evoking more presence, that is, as realistic and interactive, with themselves being more active as compared with non-fluently moving users. This finding lends support to and also expands, previous findings in the literature, namely that interaction and active participation are connected with heightened presence (Novak et al., 2000; Schubert et al., 2001; Witmer & Singer, 1998).

The second hypothesis was that fluent movement is connected with users' evaluations of high skills and challenges. This notion was only partly supported by our data: the participants from both the fluent movers and the stationary groups evaluated themselves as being more skilled than the other two movement groups, but there were no statistically significant differences in challenge between the groups. This is seen in Figure 13, which also shows a noteworthy difference in the balance between **skill** and **challenge** in both the *fluent movers* and the *low control* groups and how this difference is related to different profiles in emotional outcomes. High skills and challenges in fluently-moving participants were accompanied by playfulness, pleasantness and a positive valence. Low skills and high challenges in the low control group were associated with negative emotions (heightened anxiety, negative valence, low playfulness and low pleasantness). Thus, it is not the high level of the challenge that matters, but rather how it is related to the level of the skills required. Prior research into flow (Csikszentmihalyi, 1975) and the close relationship between cognitions and emotions (Ellsworth & Smith, 1988; Frijda, 1987; Lazarus, 1991a) support these findings.

Thus, we established a connection between an objective behavioural criterion and fifteen PFF subcomponents. Next, we expanded the framework towards visually rich and socially interactive game worlds. The current PFF and the game data gathered with Virtuaalinen Kyselylomake (VK) were helpful in planning the first laboratory experiment, the Game-Display Experience_1 (Gadix_1).



3.3 Presence-Involvement-Flow Framework - PIFF (Study III)

The aim of Gadix_1 was twofold: to investigate how different displays affect the playing experience and to develop and validate the measurement framework by comparing two different driving games. In addition, a new version of the questionnaire, namely EVEQ-GP (which was still called EVEQ in Study III: *The Experiential Dimensions of Two Different Digital Games*), was developed. In Gadix_1, the participants played two different driving games: an elaborate first-person *Need for Speed Underground (NFS)* game (Need for Speed Underground, 2003) and a simpler third-person game *Sliks'n'Slide 1.30d (Slicks)* (Slicks'n'Slide, 1997), with either an NED or a CRT display. We developed the enhanced four-dimensional Presence-Involvement-Flow Framework (PIFF) by integrating new Gadix_1 data (n=80) into the already existing data (Study I, n=68 and VK, n=164). Thus, the PIFF was a hybrid framework that included both CAVE and digital games.

3.3.1 Results of Study III

Although the data had increased, we still had an undesirable variable-participant ratio (146:312), which only enabled the factoring of the subcomponents instead of individual questions. Thus, we first derived 23 subcomponents similar to Study I from the 146 EVEQ-GP questions. The data enabled PAF for all 23 of the subcomponents elicited. This unpublished Varimax-rotated PAF provided a foundation for the four dimensions of the PIFF (Figure 14). Although the PIFF dimensions were based on the PAF, the summed scales for both the subcomponents and the four dimensions were used in Study III.

The **Physical presence** dimension measured the suppression of the surrounding environment and the participant's being an active part of the game world and its story. It was similar to the physical presence dimension in the PFF, expanding it with new subcomponents: *drama* and being *enclosed* as well as *being there*, which were not included in the PFF. The *Arousal* subcomponent moved from the physical presence to the situational involvement dimension. The **Emotional involvement** dimension consists of the emotional subcomponents that were left out of the actual PFF. This dimension measures the emotional involvement in the game content and both the intensity and the quality of the experience. The new subcomponents, *involvement of the played game* and *innovative,* were among the seven subcomponents included in the emotional involvement

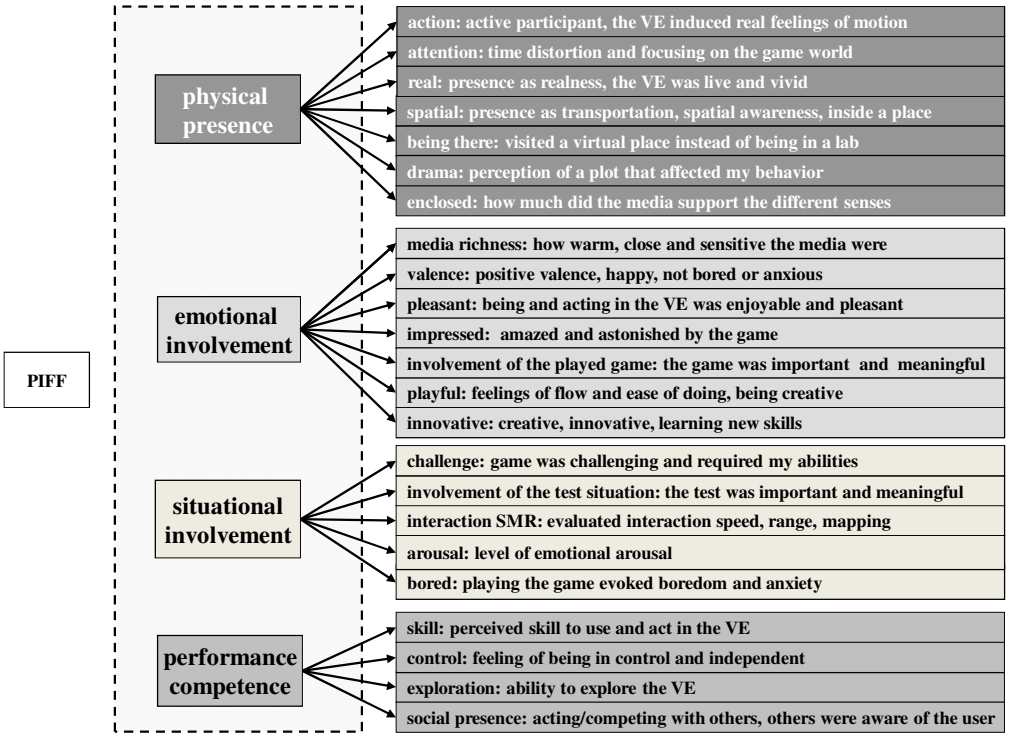


Figure 14. The PAF extracted four dimensions from the Presence-Involvement-Flow Framework.

dimension. The *social richness* subcomponent was renamed *media richness*, in order to describe the content of the subcomponent better. The *anxiety* and *VE distracted* subcomponents were integrated into a *bored* subcomponent, which was included in the Situational involvement dimension. The *bored*, *involvement of the test situation* and *arousal* subcomponents were the only modifications made to the **Situational involvement** dimension between the PFF and the PIFF. In the PIFF the situational involvement measures the smoothness and intuitiveness of the interactions as well as the demands required by the game world. The **Performance competence** dimension, that is, the sense of control, competence to perform, advancement, competition and skill development, was similar to the competence dimension in the PFF, except it included a new *social presence* subcomponent. In the unpublished Varimax-rotated PAF the *social presence* subcomponent loaded on every dimension except emotional involvement and was included in the performance competence in order to enhance its poor internal consistency (Cronbach's alpha still .62). In order to validate the PIFF construct and its subcomponents, we examined the differences between the two driving games and two displays.

Figure 15 shows the PIFF profiles of the two driving games and the differences found between the first-person *NFS* and the third-person *Slicks* in both display conditions. The first-person interface in *NFS* provided a more complete transfer to the game world and thus a higher sense of physical presence. *NFS* was emotionally more involving and offered a more intensive playing experience. Those playing *NFS* experienced the game world more realistically, and they felt that the game responded more naturally and intuitively to their actions. *Slicks* was less involving, decreasing the experienced meaning of the whole situation. The two games did not differ in the performance competence dimension. However, *NFS* evoked more social feelings towards the other drivers (competitors) and feelings of the other drivers' awareness of the user. This indicates that the social presence subcomponent behaves in a way that is similar to the physical presence subcomponents.

In addition, the games were compared within the display conditions (NED – CRT). Within the CRT condition, the gamers of the *NFS* experienced more physical presence and emotional involvement than the *Slicks* gamers. However, within the NED condition the *NFS* gamers experienced more physical presence, emotional involvement and situational involvement compared with the *Slicks* gamers.

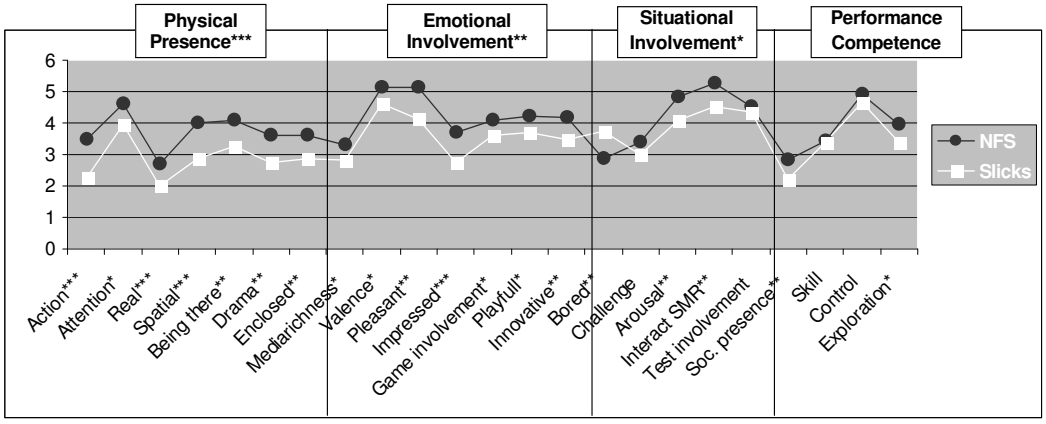
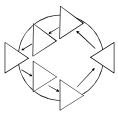


Figure 15. The PIFF profiles of the NFS and Slicks 'n' Slide (***indicates <.001, ** p<.01, * p<.05). The subcomponents are connected to each other in order to create a profile and to enhance the readability of the results.

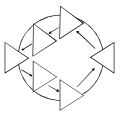


3.3.2 Conclusions of Study III

The difference between the two games studied is obvious: *NFS* is a fast-paced three-dimensional first-person racing game, whereas *Slicks* is a simple, two-dimensional third-person racing game that resembles simple electronic or mobile games. However, in Study III we were actually able to present these multidimensional experiential differences between the two games and to disclose a psychological profile of the driving-game genre. Difference in the game content due to the interface can be seen in the *physical presence* dimension, which shows that the first-person view of *NFS* was perceptually higher in extensity (e.g. voluminous). Although *NFS* and *Slicks* are both driving games, they differed also in their narrative and mechanics, which further deepens the experiential gap between the two games.

NFS provides gamers an elaborate city scene and the role of a tough driver with several nice cars, whereas *Slicks* gamers are just given an aerial view of a gray track and a few coloured cubes with tires. These differences in narrative can be seen in both the *physical presence* as well as in the *emotional involvement* dimensions: *NFS* evoked motivationally, cognitively as well as emotionally more valuable, meaningful and qualitatively rich experiences. In addition, the mechanics of the *NFS* afforded a wide variety of fast-paced actions, such as finding shortcuts, which increased the experiential intensity seen in the *situational involvement* dimension. However, the cognitive evaluations of skill and challenge did not differ between the games. This can be explained by the fact that both games are easy to learn, and the participants in the experiment were carefully selected through background questionnaires and were equally experienced in playing driving games.

The results validated the PIFF structure and supported our multidimensional approach to the study of game experience. If only presence had been measured, then the added value of the NED to the experience would have gone unnoticed. Compared to the CRT condition the NED condition also created difference between the two games in situational involvement. This is an important dimension, because it evaluates perceived and evaluated environmental affordances. If developers understand and even are able to control such an experiential dimension, then they can increase the intensity and meaning of their game.



The PIFF integrated emotional subscales into the framework and deepened the understanding of the involvement concept. Although in 2004 the PIFF was innovative and ahead of its time (see Table 1), at the end of Study III we noted that the developmental process of the PIFF continues. We also observed that the biggest challenge was establishing the structure of the framework. This is why we continued with the Gadix experiments and put a digital version of the EVEQ-GP, that is, VK2, on the Internet in the spring of 2005. By the autumn of 2005 we integrated all the data collected with the VK2 and the Gadix experiments into one pool of data, which consisted of 2,182 participants' filled-in questionnaires about various digital games. Thus, the focus of the revised version of the PIFF is on the experiences acquired in the game worlds.

3.4 PIFF^2 (Studies IV and V)

The revised version of the PIFF, that is, the PIFF^2, was intended to simplify and confirm both the structure and the terminology used in our previous exploratory frameworks. For instance, the emotional and situational involvement dimensions were replaced by psychologically more unambiguous concepts, such as cognitive evaluation and emotional outcomes. A simpler structure with generic concepts would also simplify the reporting of the results in future studies utilizing the PIFF^2. The increased sample size enabled factoring of all the EVEQ-GP questions in a single analysis. After a series of tentative analyses, a 12-factor solution became evident. Although the aim of the PAF is to compress data, it should not compromise the multidimensional nature of the concepts studied. Limiting the number of subcomponents from the 23 used in the PIFF to 12 seemed to threaten the validity of the framework, for example, the involvement concept. In order to support the validity, we divided the 163 EVEQ-GP questions into two subsets and studied them separately. The division resulted in 15 subcomponents (Figure 16) and was based on 1) the background theories of the concepts studied (presence-involvement-flow), 2) the use of the questions in the original studies and 3) our own previous findings and uses of the questionnaire items in Studies I, II and III. An **EVEQ-Adaptation** subset is related to presence and involvement, and **EVEQ-Flow** is related to cognitive evaluations and emotional outcomes.

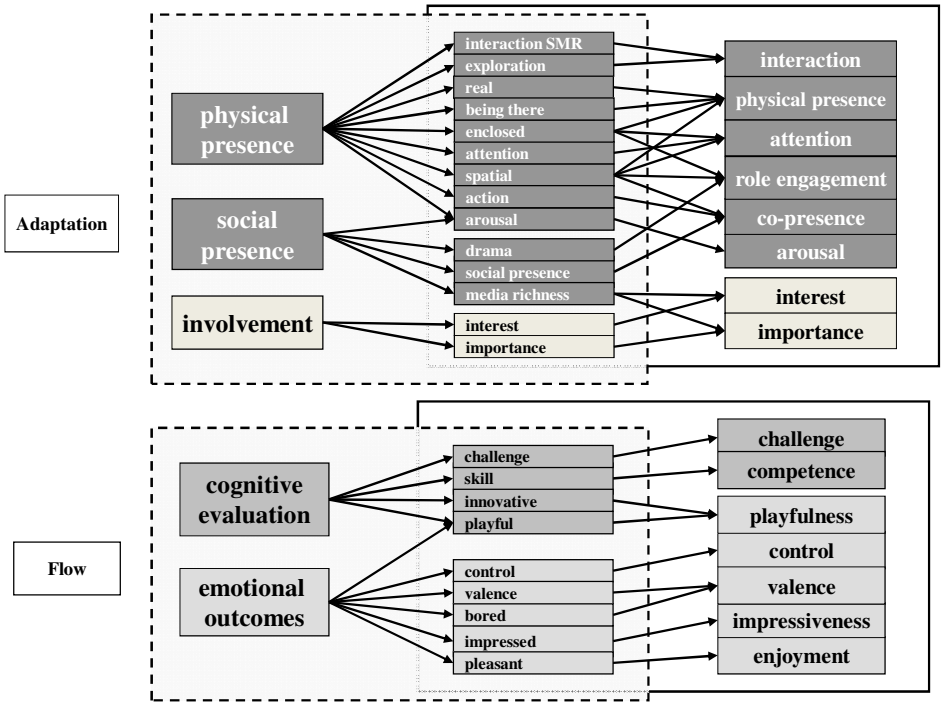
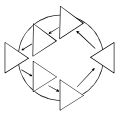


Figure 16. The adaptation and flow measurement models that form PIFF^2. On the left, the measured latent variables in five boxes. In the middle, 139 measured questions (observed variables) represented in 23 boxes as used in PIFF (Study III). On the right, 15 factor-analytically (PAF) extracted experiential subcomponents.

From the point of view of the *experiential cycle*, the EVEQ-Adaptation subset represents motivation, perceptual-attentive aspects and the way a person interacts with the world. Based on the findings in Study I, such an adaptation process is needed to form a relationship with the environment. When there is interest in an environment, meaningful interaction between a participant and a VE occurs. This draws the attention and provides a sense of being and acting. Consequently, an individual's performance is cognitively evaluated or appraised, which leads to different emotions and even to a state of flow (Csikszentmihalyi, 1975; Lazarus, 1991a). Although the EVEQ-Flow subset describes this process, the emotional outcomes it provides reflect being in a VE as a whole. Thus, taken together, both the EVEQ-Adaptation subset and the EVEQ-Flow subset provide a psychologically meaningful, four-dimensional framework for evaluating games: involvement, presence, cognitive evaluation and emotional outcomes. Both of these subsets are theoretically and methodologically self-contained and can be used either together, in order to form the PIFF^2 gamer profile, or separately, to examine more detailed research questions in digital games.



3.4.1 Forming and confirming PIFF^2

We analysed both subsets independently with a PAF, using an oblique direct Oblimin rotation (delta=0). After a series of PAFs in both subsets consisting of the 163 questions, 15 theoretically meaningful subcomponents were reliably derived from the 139 highest-loading questions. We used the following criteria in these analyses:

1) Both pattern and structure matrices were examined, and question items with .32 structure loadings or above were considered relevant to a given factor (Tabachnick & Fidell, 2001).

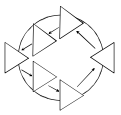
2) The consistency of both the factor solutions was confirmed by randomly splitting the whole sample (n=2,182) into two samples of equal size (n=1,091 in each) and factor loadings from the pattern and structure matrix were used to compare the factors between sample 1 and sample 2 (Appendix A). The similarity of the magnitudes of structure loadings was examined using the Pearson r. The coefficient of Congruence (r_c) was used to analyse the similarity between the structure-loading configurations. Patterns of loadings were analysed with Cattell's Salient Similarity Index (s). Using at least two different methods for comparing factor pairs derived from two independent samples is recommended procedure (Cattell, 1978).

3) The number of factors chosen was based on the theoretical meaningfulness, our previous findings and the internal consistency of the factor.

4) Reliabilities were estimated with Tarkkonen's rho (ρ) (Vehkalahti et al., 2006), which is interpreted in the same way as Cronbach's alpha: values above .70 indicate that the questions forming a subcomponent measure the same phenomenon.

5) Factor scores with Bartlett's method (Tabachnick & Fidell, 2001) were computed from the PIFF^2 subcomponents and used as measurement scales. The factor-score intercorrelations are provided in Appendix B.

We have reported on the theoretical and methodological background of the PIFF^2 in our previous studies (Takatalo, Häkkinen, Kaistinen & Nyman, 2007; Takatalo, Häkkinen, Kaistinen & Nyman, 2008) and sharpened it in Study V (*Involvement, Presence and Flow in Digital Games*). Next, we give a short description of both subsets and each of the subcomponents forming the subsets. Since the EVEQ-Flow subset is not individually dealt with in any previous publication, it is presented here in more detail.



3.4.2 Adaptation: presence and involvement

The EVEQ-Adaptation subset included 93 questions previously used to evaluate both physical and social presence (Kim & Biocca, 1997; Lessiter et al., 2001; Lombard et al., 2000; Schubert et al., 2001; Usoh et al., 2000; Witmer & Singer, 1998) and involvement (McQuarrie & Munson, 1992). In Study III the majority of these questions were used to form 13 out of 23 PIFF subcomponents (Figure 16). More specifically, we included involvement of the game subcomponent (both interest and importance), seven physical presence subcomponents and one social presence subcomponent. Involvement of the test situation subcomponent was removed. Because interaction is related to both presence and flow, we tested the questions forming the two interaction subcomponents in a tentative analysis on both subsets. The questions formed a more coherent dimension of their own in the EVEQ-Adaptation subset, and thus, they were retained. In these analyses we removed questions that assessed the quality of the display and the interaction device (e.g. interface awareness). Rather, the emphasis was placed on both action and interaction, but not on the usability of the VE. Questions involving the arousal subcomponent were also included in the EVEQ-Adaptation subset because of the close theoretical coupling of emotional arousal and attention, which is a part of the "Big Three" construct (Laarni, 2003). Social/media richness questions were challenging; they did not fit in either subset very well, but supported fairly well the involvement construct in the EVEQ-Adaptation subset; thus these questions were retained. After a series of analyses, the 83 highest-loading questions formed a coherent eight-factor solution, which accounted for approximately 42 per cent of the total variance (see Appendix A in Study V).

3.4.2.1 The eight adaptation subcomponents

Table 2 presents the eight adaptation subcomponents that were extracted. Five of these were related to the sense of presence. More specifically, two subcomponents measure social presence. **Co-presence** concerns the feeling of sharing a place with others and being an active participant in that place. **Role engagement** is being part of the story: how captivated the gamers were by the role the narrative provided. The three remaining subcomponents assess physical/spatial presence. The **physical presence** subcomponent integrates the sense of being and transportation into a place or space (e.g. "spatial" in Figures 14–16) with a sense of that place or space being realistic and vivid (e.g. "real"

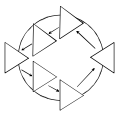
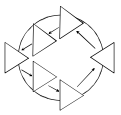


TABLE 2. The end result of the method development: the fifteen PIFF[2] subcomponents including eight adaptation and seven flow subcomponents. Although interaction was extracted in an Adaptation measurement model it is included here among the cognitive evaluations related to flow.

	Name and number of items		ρ	Description	Sample question
ADAPTATION					
Presence	Role Engagement	12	.80	Enclosed by the role and place provided by the story	"I felt that I was one of the characters in the story of the game".
	Attention	12	.88	Time distortion and focusing on the game world	"I was not aware of my 'real' environment".
	Co-Presence	14	.89	Feeling of sharing a place with others	"I felt that I was in the game world with other persons".
	Arousal	5	.70	Level of emotional arousal	"I was stimulated – I was unaroused".
	Physical Presence	17	.82	Feeling of being in a real and vivid place	"In the game world everything seemed real and vivid".
Involvement	Interest	6	.72	Value-related valences towards the game	"The game was exciting".
	Importance	8	.89	The meaning and relevance of the game	"The game mattered to me".
FLOW					
Cognitive evaluation	Competence	11	.86	Skilled with positive feelings of effectiveness	"I felt I could meet the demands of the playing situation".
	Challenge	5	.76	Game was challenging and required my abilities	"Playing the game felt challenging".
	Interaction	9	.72	Speed, range and mapping of the interaction	"The game responded quickly to my actions".
Emotional outcome	Valence	10	.77	Positive valence, happy, not bored or anxious	"I felt happy – I felt sad".
	Impressiveness	9	.79	Amazed and astonished by the game	"I was astonished and surprised at the game world".
	Enjoyment	7	.77	Playing was pleasant and somewhat special	"I will recommend it to my friends" .
	Playfulness	9	.78	Feelings of flow and ease of doing	"I felt innovative".
	Control	5	.74	Feeling of being in control and independent	"I was dominant – I was submissive".

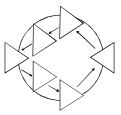
in Figures 14–16). The third physical/spatial presence subcomponent of the "Big Three" (Laarni, 2003), namely **attention** to the game world instead of to the real world, formed a subcomponent of its own. A subcomponent measuring emotional **arousal** was also related to the rest of the presence subcomponents. In the same PAF we extracted a subcomponent of the evaluated interaction in the game world and the two dimensions of involvement, namely importance and interest. The **interaction** subcomponent combined the distinct interaction measures used in Study III: interaction speed, range, mapping and exploration. This integrated subcomponent includes participants' evaluations of the reciprocal action in a VE: how well the VE gives feedback and responses to the participants' actions. Does it enable them to control events and anticipate the consequences of their actions? **Interest** is composed of emotional and value-related valences, while **importance** is largely a cognitive dimension indicating how meaningful, relevant and personal the game was.



In the further analysis presented in Study IV, we showed a clear distinction between the dimensions of presence and involvement. This empirical finding has also received theoretical support (Wirth et al., 2007). The distinction provided a theoretically and statistically meaningful higher-level dimensionality, which proved useful, for example, when the EVEQ-Adaptation subset was used to evaluate different PC-games and displays (Takatalo, Häkkinen, Särkelä, Komulainen & Nyman, 2006; Takatalo, Häkkinen, Komulainen, Särkelä & Nyman, 2006a; Takatalo et al., 2006). However, the interaction subcomponent did not fit in with either of these higher-level dimensions. This finding is similar to that of Shubert and his colleagues (2001); they explained their results by the fact that interaction is more of a cognitive evaluation of a range of interactions, such as reciprocity and feedback from a participant's actions in a VE, rather than a subjective perceptual experience, such as being in a game. On the other hand, interaction is not a measure of the usability of the technology or of interface awareness. As presented in Appendix B, interaction is correlated with co-presence, but also with the cognitive-emotional flow subcomponents. Thus, we have reported interaction in our studies among the other cognitive evaluations extracted in the EVEQ-Flow subset. We consider interaction in the PIFF[2] in more detail as we further validate the framework.

3.4.3 Flow

The EVEQ-Flow subset included 70 questions, which were used to assess both cognitive evaluations and emotional outcomes in VEs and games. We included previously used questions that assessed cognitively evaluated flow antecedents (*challenges*, *skills*) (Novak et al., 2000) and *clear goals* (Della Fave & Massimini, 1988). Since there are different views on measuring and operationalizing skills and challenges (Chen, Wigand & Nilan, 1999; Ellis & Voelkl, 1994), questions that measured skills and challenges independently (e.g. "I consider myself skilled at playing this game" and "Playing this game challenged me") and as dynamic counterparts (e.g. "I felt I could meet the demands of the playing situation") were included. Emotional questions included positive feelings (e.g. *enjoyment*, *valence*) (Della Fave & Massimini, 1988; Mehrabian & Russell, 1974), negative feelings (e.g. *boredom*, *anxiety*) (Della Fave & Massimini, 1988; Mehrabian & Russell, 1974), flow-like feelings (e.g. *vibrant* and *alive*) (Fontaine, 1992) and a set of questions assessing both *the sense of control* (Mehrabian & Russell, 1974) and *playfulness* (Webster & Martocchio, 1992).The game-related emotions included

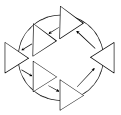


exceptional and extraordinary feelings (e.g. *excitement*, *amazement* and *impressiveness*) (Hunicke et al., 2004; Lazzaro, 2004; Lessiter et al., 2001; Nakatsu et al., 2005; Schubert et al., 2001).

In a tentative analysis based on Study III, we included seven questions assessing social/media richness and four questions assessing general feelings in the playing situation. However, social/media richness questions were conceptually inconsistent and thus were excluded from the EVEQ-Flow subset and analysed in the EVEQ-Adaptation subset. Questions measuring general feelings were statistically incoherent (loadings < .32), and these were excluded from the EVEQ-Flow subset. In these analyses three other questions measuring the learning of new skills and feelings of effortless acting also failed to load acceptably (>.32) on any of the subcomponents; they were removed. As a result, 56 questions were included on the final EVEQ-Flow subset. In Study III these questions formed the nine flow-related cognitive-emotional subcomponents (Figure 16). Of the 56 highest-loading questions, a coherent seven-factor solution was extracted, which accounted for approximately 41 per cent of the total variance (see Appendix B in Study V).

3.4.3.1 The seven flow subcomponents

The extracted seven subcomponents included the two central flow predecessors: challenge and competence (Table 2). **Challenge** provides a measure of the abilities required to play the game as well as how challenging the gamer felt it was to play, whereas **competence** combines the measures of user skills and positive feelings of effectiveness. Competence also includes questions that assessed clear goals and questions that evaluated both demand and competence. Furthermore, we extracted five subcomponents with emotional content. Hedonic **valence** is the bipolar subcomponent having pleasure on one end and displeasure on the other. It was composed of semantic differentials, such as "I felt happy/ I felt sad". The **enjoyment** subcomponent included positive aspects such as pleasantness and enjoyment. Playing was also considered somehow special. Questions forming the original **playfulness** scale (Webster & Martocchio, 1992) formed a subcomponent of their own. Questions measuring actual feelings of flow, such as ease of doing, loaded on the playfulness subcomponent as well. **Control**, that is, being dominant and independent, formed one subcomponent composed of semantic differen-



tials. Feelings of being amazed and astonished formed the **impressiveness** subcomponent.

When we utilized the flow subset to report results, we divided the above subcomponents into cognitive evaluations and emotional outcomes. This division is theoretically supported by the theory of flow (Csikszentmihalyi, 1975) and cognitive theories of emotion (Ellsworth & Smith, 1988; Frijda, 1987; Lazarus, 1991a). Keeping cognitive evaluations as a dimension of their own is also beneficial when the direction of flow experience is examined, since it is the challenge-competence ratio that is crucial. Next, we validate the PIFF^2 in practice and provide previously unpublished supplemental results that validate the EVEQ-Flow subset.

3.5 PIFF^2 – further validation (Study V)

The three-dimensional PFF structure was validated with emotional subcomponents in Study I and with objective behavioural data in Study II. Furthermore, the four dimensions of the PIFF were validated in Study III, which compared a first-person and a third-person driving game. The full PIFF^2 profile was already used to analyse different driving games (Takatalo et al., 2007), different displays (Takatalo, Häkkinen, Kaistinen & Nyman, 2010), gender differences in games (Takatalo et al., 2008) and different use contexts (Takatalo et al., 2008). We now present the full PIFF^2 profiles of two different first-person shooters (FPS) (Study V), which are related to two external criteria retrieved from Metacritic.com (Metacritic.com, 2009), namely the expert reviewer's critics (METASCORE®) and user ratings. Unlike the more validated EVEQ-Adaptation subset, we have applied the EVEQ-Flow subset only to a small data pool and validated it with the interviews and objective performance data in Study V. In section 3.5.2 more detailed results are provided about the relationship between the EVEQ-Flow subset and the Csikszentmihalyis' original four-channel flow model (Csikszentmihalyi & Csikszentmihalyi, 1988a).

3.5.1 PIFF^2 in two different FPS (Study V)

Study V (*Involvement, presence and flow in digital games*) includes the PIFF^2 profile analysis of two first-person shooters (FPS). It shows the added value of the multidimensional PIFF^2 profile by comparing the PIFF^2 profiles with the METASCORE® and the user ratings of the games provided by Metacritic.com (Metacritic.com, 2009). The data

included 109 expert male gamers, who played either Valve's *Half-Life 2* (*HL2*; n=62) (Half-Life 2, 2004) or *Counter-Strike: Source* (*CS*; n=47) (Counter-Strike: Source, 2004), which both run on the same Source® game engine. This makes the interface in the two games studied exactly the same. However, there were differences in the game mechanics and in the narrative between *HL2* and *CS*: "*CS* modifies the multiplayer aspects of '*Half-Life'* to bring it a more team-oriented game-play. *CS* provides the player with an experience that a trained counter-terrorist unit or terrorist unit experiences" (Metacritic.com, 2009). After finishing the playing of either *HL2* or *CS*, each gamer filled in an Internet survey (VK2).

HL2 has received a METASCORE® of 96/100, while *CS* has a score of 88/100 (Metacritic.com, 2009). The users rated *HL2* 9.3 [9.3]/10 (3,487 [3,975] votes) and *CS* 9.2 [9.0]/10 (7,532 [8,897] votes) (retrieved 22 March 2009 [updated 26 April 2010]). Figure 17 shows the different levels of *Adaptation* between the games (Wilk's Lambda = .70, $F(8,100) = 5.46$, $p < .001$, partial $\eta^2 = .30$). The gamers considered *HL2* more *interesting* (**value**) than *CS*. The presence profiles of the games were also very different. *CS* was higher in *co-presence* and *arousal*, whereas *HL2* was higher in *role engagement* and *physical presence*. The gamers considered both games equally *important* and capable of holding their *attention*. These differences show how the narrative affects the experience: *HL2* builds on a large and realistic game-world (**extensity**) and provides a

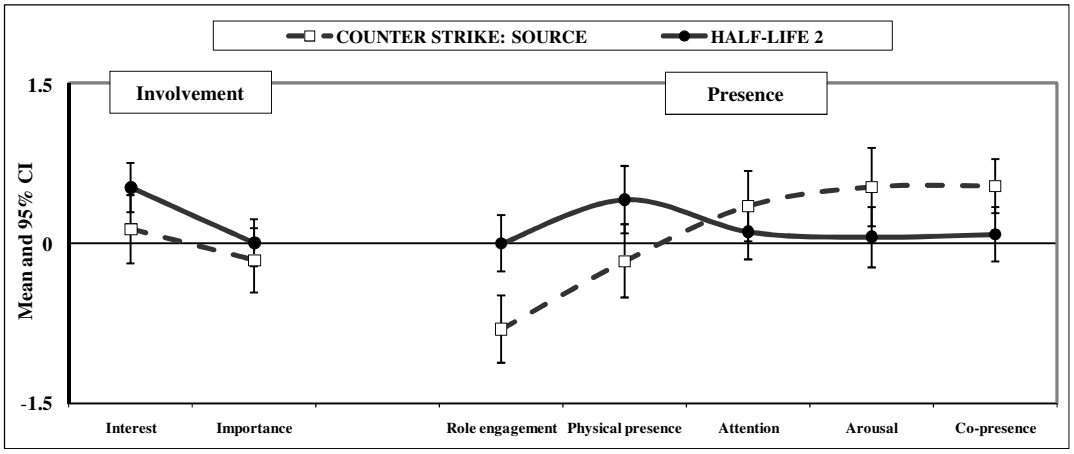


Figure 17. Group means in involvement and presence subcomponents in *Half-Life 2* and *Counter-Strike: Source*. The subcomponents are connected to each other in order to create a profile and to enhance the readability of the results. The error bars represent a 95% confidence interval. An overlap by half the average arm length of the error bar indicates a statistical difference between the groups ($p \approx .05$). If the tips of the error bars just touch, then the difference is $p \approx .01$. A gap between the error bars indicates $p < .001$.

clear role for the individual gamer through storytelling (**meaning**). With a similar interface, *CS* provides a more restricted scene and a role as part of a team fighting **intensively** against other teams. Naturally, the difference in the game narrative is closely linked to the game mechanics, which are revealed by the flow subcomponents.

Figure 18 shows the differences between *HL2* and *CS* measured by seven flow subcomponents and the interaction subcomponent (Wilk's Lambda = .59, $F(7,101) = 10.10$, $p < .001$, partial $\eta^2 = .41$). Gamers evaluated *CS* as more *challenging* and *interactive* and themselves as more *competent* to play. However, the emotional **quality** of their experience was somewhat "thinner" compared to *HL2*, which provided greater *valence* (pleasure), *enjoyment*, *playfulness* and *impressiveness*. The game mechanics that provide straightforward competition and cooperative performance make the action more reciprocal and simpler to evaluate cognitively, but they are also the most likely cause of the flattened emotional profile in *CS*. On the other hand, multiple actions afforded to an individual hero in a rich environment are less intensive, but they heighten the quality of the experience in *HL2*. However, *CS* is still far from being negative or boring. Heightened attention and arousal and highly appreciated cognitive and social features in the game are enough to keep gamers in *CS* for hours.

To sum up, a METASCORE® indicated a difference between *HL2* and *CS*, which contradicts the very similar user ratings between the two games. Gamers rated both *HL2*

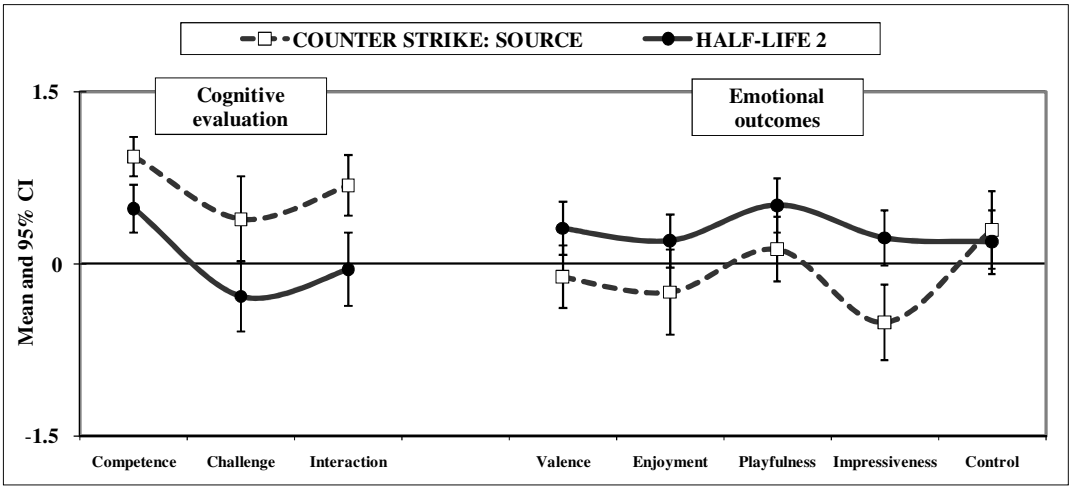
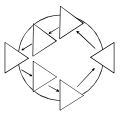


Figure 18. Group means in flow subcomponents in *Half-Life 2* and *Counter Strike: Source*. The subcomponents are connected to each other in order to create a profile and to enhance the readability of the results. The error bars represent a 95% confidence interval. An overlap by half the average arm length of the error bar indicates a statistical difference between the groups ($p \approx .05$). If the tips of the error bars just touch, then the difference is $p \approx .01$. A gap between the error bars indicates $p < .001$.



and *CS* similarly, but clearly for different reasons, which were beyond the single METASCORE® given. The multidimensional PIFF^2 profile presented the experiential similarities and differences between these two games. These results provide a useful demonstration of the strengths of the approach presented in this research: the PIFF^2 reveals fine nuances and the psychological depths in the experiences of gamers. Such multidimensional subjectivity cannot be attained by an outside observer or an expert evaluator.

3.5.2 The four flow channels (unpublished study)

The Csikszentmihalyis' four-channel flow model (Csikszentmihalyi & Csikszentmihalyi, 1988a) provides a well-established frame of reference for validating the EVEQ-Flow subset. According to the theory and the original model, different levels of cognitively evaluated competences and challenges should be related differently to the emotional outcomes. More specifically, high levels of competence and challenge should provide an emotional profile characterizing flow in digital games. This was already demonstrated with a small database in Study II.

In order to form and study the four channels of the flow model (Csikszentmihalyi & Csikszentmihalyi, 1988a), we divided the whole sample (n=2,182) into four groups by dividing both the *challenge* and the *competence* subcomponents in half. This division produced four groups, which represent the four flow channels: **apathy** (n=541) had both low *challenge* and *competence*; **anxiety** (n=388) had high *challenge,* but low *competence;* **boredom** (n=627) had low *challenge,* but high *competence,* and both *challenge* and *competence* were high in the **flow** channel (n=626) (Figure 19). Since the cognitive evaluations in these four channels effectively represent the four-channel flow model (Csikszentmihalyi & Csikszentmihalyi, 1988a), the emotional outcomes of these channels were examined further.

3.5.2.1 Results of the four flow channels

A 2 x 2 between-subjects MANOVA was performed on five emotional subcomponents (*impressiveness*, *enjoyment*, *playfulness*, *valence* and *control*). The independent subcomponents were *challenge* (low and high) and *competence* (low and high). Both *challenge* (Wilk's Lambda = .95, $F(5,2174) = 23.60$, $p < .001$, partial $\eta^2 = .05$) and *competence* (Wilk's Lambda = .92, $F(5,2174) = 37.23$, $p < .001$, partial $\eta^2 = .08$), as well as their interaction (Wilk's Lambda = .99, $F(5,2174) = 4.01$, $p < .01$, partial $\eta^2 = .01$) significantly affected the five emotional subcomponents. The univariate results of the main

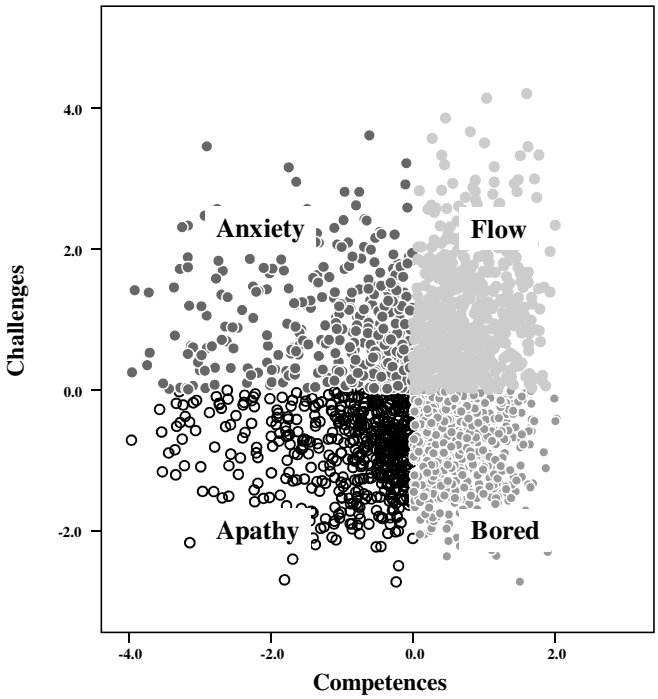


Figure 19. The four flow channels. Based on subcomponents measuring different levels of challenges and competences, the data were classified into groups representing channels of apathy, anxiety, flow and boredom. The division is based on a four-channel flow model (Csikszentmihalyi & Csikszentmihalyi, 1988a).

effects showed that gamers with high *competence* reported higher scores in all five emotional subcomponents ($p < .001$), while gamers with high *challenge* reported higher scores in *impressiveness*, *playfulness* and *enjoyment* ($p < .001$). These main effects can also be seen from the PIFF[2] factor-score intercorrelations (Appendix B). However, the main interest here was on the interaction between *challenge* and *competence*, which is central to the flow theory and the four flow channels.

Figure 20 presents differences between the four flow channels in five emotional subcomponents. An interaction effect was found in both *impressiveness* (ANOVA, $F(1, 2182) = 5.90$, $p < .05$, partial $\eta^2 = .003$) and *enjoyment* (ANOVA, $F(1, 2182) = 10.17$, $p < .01$, partial $\eta^2 = .005$). High *challenge* and *competence* in the **flow** channel were related to the highest level of *impressiveness*. On the other hand, low *challenge* and low *competence* in the **apathy** channel were significantly related to an absence of *enjoyment*. No interaction effect was found in *playfulness*; however, based on the main effects, *playfulness* can be experienced if either *challenge* (as shown by the **apathy** channel) or *competence* (as shown by the **boredom** channel) is high. As shown in Figure 20,

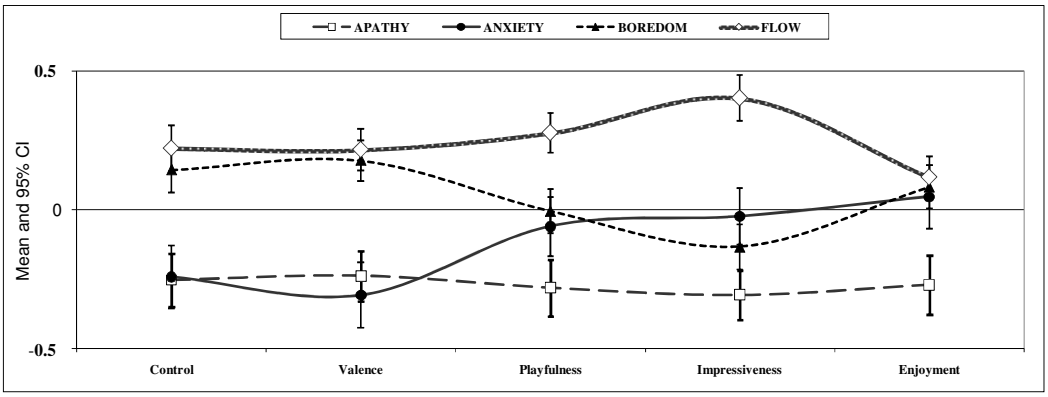


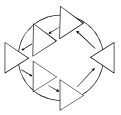
Figure 20. The means of the four flow channels in five emotional subcomponents. The subcomponents are connected to each other in order to create a profile and to enhance the readability of the results. The error bars represent a 95% confidence interval. An overlap by half the average arm length of the error bar indicates a statistical difference between the channels ($p \approx 0.05$). If the tips of the error bars just touch, then the difference is $p \approx 0.01$. A gap between the error bars indicates $p < 0.001$. The 0 line stands for the sample mean.

the **flow** channel in which both the *challenge* and *competence* were high also had the highest score in *playfulness*. Clearly, being at the negative end of the *playfulness* subcomponent indicates being unimaginative and formal, for example. This was the case in the **apathy** channel.

No interaction effect was found in either *valence* or *control*. Thus, only high *competence* was related to these two as was also the case in the **flow** and **boredom** channels. Since the *control* and *valence* subcomponents are both bipolar in nature, the **apathy** and **anxiety** channels' scores not only indicate a low sense of control and low pleasure, but also a sense of being uncontrolled, of displeasure and of frustration and anxiety. To summarise, both the **flow** and **boredom** channels scored higher than the **apathy** channel in every subcomponent and the **anxiety** channel had the most controversial emotional profile, which shared similarities with each of the other channels.

3.5.2.2 Discussion of the four flow channels

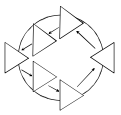
The EVEQ-Flow subset fit well within the four flow channels (Csikszentmihalyi & Csikszentmihalyi, 1988a): both ends of the original flow channel (Csikszentmihalyi, 1975), namely **flow** and **apathy**, were found. However, it appears that the channels labelled **boredom** and **anxiety** need to be reconsidered. All three positive emotions (*valence [pleasure], enjoyment* and *playfulness*) were high in the **flow** channel (high *challenge* and *competence).* Previous studies of the four flow channels in other contexts have reported similar findings (Ellis & Voelkl, 1994; LeFevre, 1988). By contrast, the



three positive emotions were very low in the **apathy** channel (low *challenge* and *competence).* In addition to the three positive emotions, the sense of *control* and *impressiveness* (i.e. exceptional feelings of being amazed and astonished by the game) were low in the **apathy** channel and high in the **flow** channel. Although the emotional feelings of the participants in the **apathy** channel were the lowest of all the groups, the label of this channel may make too strong a statement. After all, the participants were voluntarily playing entertainment digital games that should be fun. Instead of being apathetic, the participants seemed more as if they were untouched and impassive. Also the two additional channels, **boredom** and **anxiety**, should be renamed.

In the **boredom** channel (low challenge – high competence) two of the three positive feelings, *valence* and *enjoyment,* were high, whereas in the **anxiety** channel (high challenge – low competence), only *enjoyment* was considerably high. However, the two channels were equally high in *playfulness, impressiveness* and *enjoyment;* thus their emotional profile does not quite support the names of the channels. Earlier studies have yielded the same finding, namely that the **boredom** channel is characterized by being more positive, in control and relaxed (Ellis & Voelkl, 1994). Positive emotions in this channel seem to come easily, without intensive challenges. Although negative feelings, anxiety and feelings of being uncontrolled were experienced in the **anxiety** channel, the gamers still enjoyed the challenges, were impressed by the game and felt quite playful. It appears that, despite a lack of competence, the participants in the **anxiety** channel enjoyed heightened challenges, which made them feel more overwhelmed and impressed than anxious.

Impressiveness and *enjoyment* were the only subcomponents that were affected by the interaction of both *challenge* and *competence*. However, *enjoyment* was high in all but the **apathy** channel, which had low scores in both *challenge* and *competence*. Being impressed has been less often studied alongside flow, yet it seems a promising game-specific measure of flow. Although we found only the main effects of both *challenge* and *competence* in *playfulness*, being playful was characteristic of the **flow** channel. Being playful, cognitively spontaneous and innovative are feelings to which previous studies have related flow in different contexts (Webster & Martocchio, 1992). However, participants in the **anxiety** and **boredom** channels also felt at least somewhat playful. Taken together, *impressiveness*, *enjoyment* and *playfulness* were the most characteristic



three features of the flow channel, suggesting that these emotional outcomes are related to flow in digital games.

In addition to validating the EVEQ-Flow subset, these results present a general overview of the fundamental flow dynamics in games. They provide useful insight both for those game designers interested in increasing and creating flow for gamers and for those interested in understanding the relationship between the subcomponents of flow and learning (Garris, Ahlers, & Driskell 2002; Wilson et al., 2009), as well as for repetitive behaviours, customer loyalty or even addictions to digital games (Ting-Jui Chou & Chih-Chen Ting, 2003; Wan & Chiou, 2006). Complementing such a cognitive-affective framework with gamers' background information and game components, especially game mechanics, would provide a rich source of information for more detailed research as will be shown in the next example.

3.5.3 Flow in the first hour of play (Study V)

In Study V the EVEQ-Flow subset was used in a qualitative way to show how experience and the learning curve evolve during the first hour of play. Many authors consider the first hour of play to be critical, because it should convince the gamer to keep playing instead of suffocating an evolving enthusiasm (Davis, Steury & Pagulayan, 2005). Two male gamers, Mr. 1 (21 years old, average playing time 300 minutes) and Mr. 2 (30 years old, average playing time 60 minutes), were analysed during their first hour of playing Valve's *Portal* (Portal, 2007). *Portal* is a single-player game that provides "chambers" filled with physical puzzles and challenges. Following the four-channel flow model (Csikszentmihalyi, 1975) and the flow-grid (W. IJsselsteijn & K. Poels, personal communication to the author, 24 April 2008), a *flow-space* was formed from the *challenge* and *competence* subcomponents (Figure 21b). The participants evaluated *flow-space* three times during the first hour; during each break they marked the point in the flow-space that best corresponded to their evaluations in that particular 20-minute game period. The third evaluation was made after 60 minutes of playing. At the same time the gamers reported each of the emotional subcomponents (*pleasure/valence, control, enjoyment, impressiveness, playfulness*). These five individual scores were summed up and used as a composite score of emotional outcomes (Figure 21a). While the gamers were filling in the questions, they were interviewed by the instructor, who probed for greater detail. The objective performance measure was obtained from the

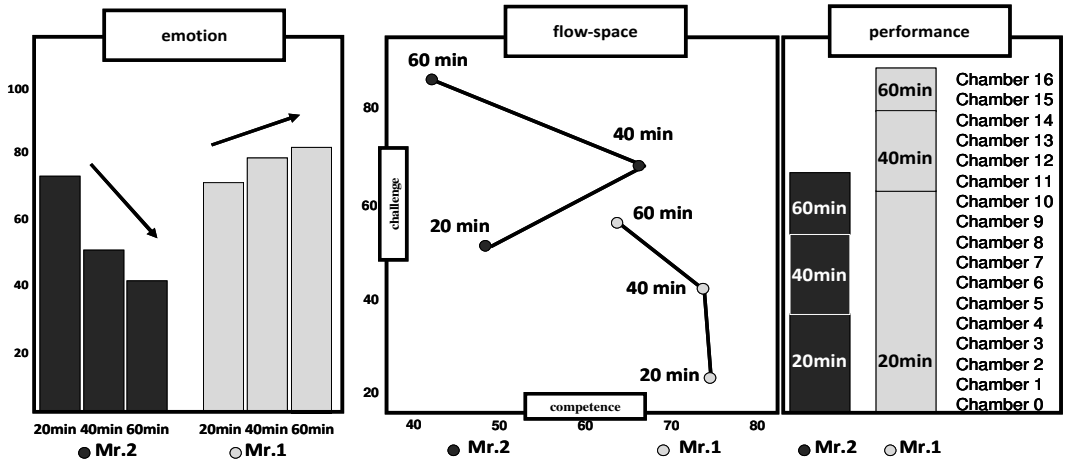
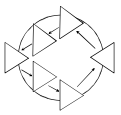


Figure 21. (a) Composite measure of emotions of two gamers during the first hour of play. (b) Flow-space and evaluations of challenge and competence of two gamers during the first hour of play. (c) The number of chambers finished by two gamers during the first hour of play. Each measure was taken after 20, 40 and 60 minutes of playing.

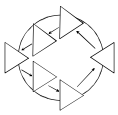
number of chambers the gamers finished in each of the approximately 20-minute game periods (Figure 21c).

The results show how differences in the gamers' background (such as age) affect their expectations, cognitive evaluation and performance after the first 20 minutes of play. The gamers' cognitive evaluations started from different points, and Mr. 2 completed only four chambers compared to Mr. 1's ten. However, the composite emotional measure of the two gamers was on the same level after 20 minutes of playing. The gamers had the same level of emotions for different reasons. After 40 minutes of play, Mr. 1 had completed only four more chambers, which is shown in the flow space as increased challenge and stagnation in competence. However, Mr. 1's positive feelings continued to increase. Mr. 2 completed the same number of chambers in the first two 20-minute periods; after 40 minutes he considered himself competent and the game more challenging. Yet although his competence increased, his feelings about the game changed dramatically. In the interview afterwards he said that his level of arousal had decreased, he felt tired and the game no longer felt novel. This indicates a clear mental collapse, seen both in his cognitive evaluations and the poor performance in his last period. By the end of the game, he said, he lost the logic of it and could not understand what was going on. By contrast, Mr. 1 was just getting warmed up. In the last period he managed to finish only two more chambers, but he considered the game challenging and was more and



more impressed by it. Although his evaluations of competence dropped somewhat in the last period, he was learning to play the game and was confident about continuing.

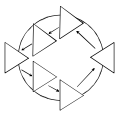
This example demonstrates how the PIFF^2 can be utilized in a more qualitative manner to support a specific design problem related to game mechanics. The cognitive-emotional flow subcomponents show how the learning curve, the difficulty of the game and the quality of experience evolve and change during the critical first hour of play. Utilizing the PIFF^2 in this way instead of the full profiling gives specific information about the scope of the specific issues.



4 Discussion

People today are transforming from information seekers to experience seekers. Consequently, the search for experiences guides behaviour and the choices people make. If general experiential laws are known, then behaviour becomes more predictable. Although interest in the study of conscious experience is on the increase, there is not yet a consensus on what should be included in such a study, either theoretically or methodologically. Psychology should be at the core of conscious experience, but the topic has been avoided in mainstream psychology because of the unscientific and complex nature of the subject. When experience is taken up within the scope of other fields, such as the research on HCI or digital games, it is naturally conceptualized on a basis different from the basis on which psychology rests. However, keeping the subjective and multidimensional nature of the experience in mind and respecting this nature when empirical data are collected will yield a holistic picture of conscious experience.

This research proposes a theoretical approach to psychologically-based and content-oriented experience. The approach is both subjective and multidimensional, and it contributes to the understanding and evaluation of experiences evolving from human-environment interactions. Central to this approach is the experiential cycle, which integrates psychology into an orienting environmental content. The approach is generic, and it provides psychological heuristics that can be applied to multiple human-environment interactions. In addition, it provides a psychological taxonomy of characteristics that indicate the "amount" of experience. Here the approach is applied to developing a methodological framework to study experiences in entertainment VEs. This candidate framework integrates classical psychological subsystems into modern technology environments and reveals the structure of experience in entertainment VEs. The structure presented here and the relationships within it show the complexity of the phenomena studied. Nevertheless, general experiential laws were found, which provide useful guidelines for understanding both entertainment VEs and conscious experience. By disclosing the experiential richness, researchers can better predict the consequences of using VEs. After all, VEs are a part of many peoples' lives, and many different outcomes, such as enjoyment, learning and even addiction, are related to them. This makes VEs socially important and psychologically fruitful to study.



4.1 Psychologically-based and content-oriented experience

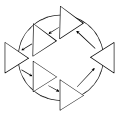
4.1.1 Multidimensionality

Experience is important because it is the mediator between people and a complex, natural environment. A multidimensional and rich subjective experience reveals the true drivers of our behaviour in regard to a given environment and context. If we understand the origin and fundamentals of an experience, then we can predict and even modify behaviour. However, both mathematisation and objectivism are required for science (Bradley, 2005), and such a multidimensional approach to experience as we propose here can be criticized for the generic view it provides. We can argue that if daily life and the quality of experience in natural environments are needed for understanding, then something more than objective, unidimensional, albeit accurate measures are required. Experience is more than its parts; "dubbed holism" reveals the bigger whole.

A good example of this is emotional arousal, mentioned many times in this research. Emotional arousal is an essential part of our *experiential cycle;* it occupies human attention (Oatley, 1992), energizes and intensifies our motives, guides perception and has a strong impact on our performance (Yerkes & Dodson, 1908). In our study we considered arousal as part of presence, although arousal naturally plays a role in involvement and flow as well. Our results show that arousal heightens in a first-person driving game and in an online first-person co-ops shooter. In our previous studies, we showed that arousal is also elevated in extreme laboratory conditions (Takatalo et al., 2008). Thus, arousal is an important part of experience, but if it is evaluated alone, then it becomes hard to interpret. A subjective multidimensionality is required to reveal the source of its true variations. Only then does arousal bring added value to the study of experience.

4.1.2 The experiential cycle

Because of the complex nature of the phenomena studied, we began by presenting our theoretical approach first and defining the concepts. Our psychologically-based and content-oriented approach has been developed gradually along with the empirical work. The experience in scope – *an experience* – evolves in environmental interactions, which have a clear beginning and an end (Dewey, 1934). In these interactions the environmental (exteroceptive) perceptions become the consciously processed content of our consciousness (James, 1890). The concept of consciousness includes attention, awareness and memory. Furthermore, awareness consists of the trilogy-of-mind entity includ-

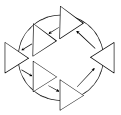


ing cognition, emotion and motivation. This trilogy has served as a psychological base for our approach.

We then introduced the *experiential cycle*, which describes the experiential process between a person and an environment. Previous researchers (Bradley, 2005; Winnicott, 1971) have called this the potential or intersubjective space in which we live and experience the world around us. The *experiential cycle* demonstrates how the environmental turns into the mental: the motivation to act, the interaction in an environment, the attention to and perception of relevant environmental aspects as well as the cognitive evaluation and emotional outcomes related to these perceptions. The *experiential cycle* is generic enough to be utilized in multiple, human-environment interactions, it covers a multidimensional set of classical psychological subsystems and it reveals multiple experiential characteristics that describe the "amount" of experience, such as content, quality, intensity, meaning, value and extensity (James, 1890; Wundt, 1897).

In this study, we applied the psychologically-based and content-oriented approach to entertainment VEs, which are defined as computer-generated, interactive spaces or places (Hämäläinen, 1998; Reitmaa et al., 1995; Zeltzer, 1992). Entertainment VEs have three major components – the interface, the narrative and the mechanics (Winn, 2008) – which affect the psychological base. In a broad sense, the complex equivalents to these components can be found in real life as well: we interact in different contexts, in different roles and with different agendas, and we are motivated by various goals and follow multiple rules. However, in life the "programming" of these components is not in the hands of a software designer.

The *experiential cycle* provides psychologically sustainable heuristics of what to include if the research paradigm concerns conscious experience. The cycle stresses that both the psychology and the environmental content need to be considered when evaluating experience. Although we do not present the actual experiential process in our results, the structure and framework we extracted are based on the approach we presented. For example, in section 3.5.3, "Flow in the first hour", the structure we discovered facilitates an understanding of the experiential process that takes place between cognition and emotions. Similarly, the direction of the wind (process) can be forecast by measuring the air temperature in different locations (structure). When cool air rises, it creates a high -pressure area; when hot air descends, it creates a low -pressure area. When the air



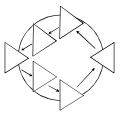
flows from high pressure areas to low pressure areas, it creates wind. When such general laws are established, they can be used anywhere: either to predict wind or flow. On the other hand, the mind is not composed of boxes working as a simple linear system. Thus, the *experiential cycle* is more a way of thinking than a rigid model: it provides a holistic view of the mechanisms responsible for subjective experience.

4.2 Presence-Involvement-Flow Framework

Following the *experiential cycle,* we studied concepts that are both psychologically and technologically meaningful, that is, the sense of presence, involvement and flow in entertainment VEs. VEs provide what is probably the best laboratory condition anywhere in which to study experiences: VEs are interactively rich and psychologically meaningful and both the participants and the content can easily be controlled (Germanchis et al., 2005). We developed a questionnaire and collected empirical data (n=2,414) both in CAVE and numerous digital games. Self-reporting methodology allowed the participants themselves to interpret crucial aspects of their subjective experience related to that particular environment. Although the subjective methods worked well, there are some who oppose their use.

4.2.1 Measurement issues

Those who object to subjective methods argue that such methods are cognitively mediated, that the participants may forget what they experienced or may even give false descriptions of their experiences (Sweeney, Maguire & Shackel, 1993), for example. Our *experiential cycle* implies that human experience is indeed strongly affected by cognitive processing: plans and motives to achieve goals are cognitive in nature; perception is considered a fundamental cognitive act, a cognitive interaction between an organism and its environment (Neisser, 1976). Moreover, perceptions are cognitively appraised in a cognitive-emotional appraisal process and our social interaction requires cognitive processing. When participants report these experiential aspects, representations from memory and from past experiences are naturally utilized, and the information is again cognitively processed (Loftus & Loftus, 1976). Naturally, unconscious processing of information does affect the experience. With subjective methods, we can only reach the part of experience that participants are able or willing to report. Crucial here is how we see the outcome of overall human information processing and communications skills: 1)



participants randomly produce answers to the questions given because they do not remember, they lie, they want to present themselves in a socially desirable way, or 2) they report those aspects most meaningful to themselves within the limits of their memory. Randomly given answers or lying would produce random or biased structures when analysed statistically. Similarly, if statistical structures are claimed to be based on random answers or lying, then in large data sets lying or randomness should appear to be somehow coordinated, clustered or synchronous phenomena. This is clearly not the case in the present research.

In addition, questions about subjective experience are different from attitudinal questions and thus difficult to answer in socially desirable ways and also difficult to forget. The participants go through their experience in the VE and report what they just experienced; there are no socially desirable right or wrong answers. If something is forgotten, then it probably had no meaning or relevance to the participant. Consequently, based on the large and heterogeneous amount of subjective data, we developed an empirical evaluation framework to study experiences in VEs.

4.2.2 From PFF to PIFF^2

Table 3 shows that we started with a small data pool in a CAVE, which provided the PFF (Study I). In the PFF the causes of both presence (e.g. real, spatial) and flow (e.g. skill, challenge) were integrated in to a single framework, and the outcomes or actual feelings (e.g. being there, valence) were omitted because of the limitations related to the small amount of data. Based on these findings, in Study II we attempted to integrate causes into outcomes. For example, under presence we included subcomponents such as real, spatial and being there; under flow we classified subcomponents such as skill, challenge and valence. However, the main purpose of Study II was to show the connection between subjective experiences and objective behavioural measures. Study III introduced new game data and 23 subcomponents, which were divided into four dimensions in the PIFF. The increased amount of data enabled us to factor-analytically integrate both causes and outcomes of the experiential concepts. The large amount of data collected after Study III allowed us to investigate statistically meaningful relationships between all the individual questions, extract 15 subcomponents and form four experiential dimensions of the PIFF^2.

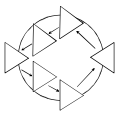


TABLE 3. The development of the PFF into the PIFF^2 in Studies I–V

Study	Framework	Context	N	Number of questions	Number of subcomponents	Dimensions	Subcomponents
I	PFF	Laboratory/ CAVE	68	124	19	Physical presence	Spatial, Action, Attention, Real, Arousal
						Situational involvement	Challenge, Personal relevance, Interaction SMR
						Competence	Exploration, Control, Skill
						Emotional outcomes	Valence, Playful, Being there, Impressed, Pleasant, Social richness, Anxiety, VEdistracted
II	PFF	Laboratory/ CAVE	68	97	15	Presence	Spatial, Action, Attention, Real, Arousal, Being there, Interactivity (SMR), Exploration
						Flow	Skill, Challenge, Control, Anxiety, Playfulness, Pleasant, Valence
III	PIFF	Laboratory/ CAVE/ Games	312	146	23	Physical presence	Spatial, Action, Attention, Real Enclosed, Being there, Drama
						Emotional Involvement	Media richness, Valence, Playful, Impressed, Pleasant, Innovative
						Situational involvement	Involvement: played game Challenge, Involvement: test situation, Interaction SMR, Arousal, Bored
						Performance Competence	Exploration, Control, Skill, Social presence
IV-V	PIFF^2	Games	2,182	139	15	Presence	Role engagement, Arousal, Co-presence, Attention, Physical presence
						Involvement	Importance, Interest
						Cognitive evaluation	Competence, Challenge, Interaction
						Emotional outcomes	Valence, Impressiveness, Control Playfulness, Enjoyment

The PIFF^2 subcomponents presented in Studies IV and V show that many of the original PFF subcomponents extracted from CAVE, such as arousal, attention, playfulness and valence can be statistically extracted from game data. Some of the PIFF^2 subcomponents combined both causes and outcomes, such as physical presence (real and being there), and some subcomponents were combined into one subcomponent, such as bored and anxiety on the negative end of valence. These combinations indicate the nature of the statistical method used (PAF) to compress data as well as the experiential phenomena in a large data pool.

During the development of the framework, some of the subcomponents were renamed; for example, the subcomponent enjoyment in the PIFF^2 includes a majority of the questions that constituted the subcomponent called pleasant in the PIFF. We also clarified the role of the interaction subcomponent during the developmental process. In Study I *interaction SMR* double-loaded on both the *physical presence* and the *situational involvement* dimensions. In Study II fluent movers evaluated interaction in a VE

as being higher than stationary movers. In Study III interaction in the first-person driving game was higher compared to the third-person driving game, whereas in Study V, interaction in online FPS was higher than offline FPS run by the same game engine. In Study IV interaction did not load on either the *presence* or *involvement* dimensions. Among the fifteen subcomponents, interaction is most strongly related to competence, control, enjoyment and co-presence (Appendix B). These findings support the current position of interaction among the cognitive evaluations of reciprocal action in VEs (challenge, competence). Moreover, the evaluated interaction is different, both from the experience of being active in the VE, which is related to co-presence, and from the evaluated usability of the VE's controls, which we excluded from this study.

4.2.3 Summing up

The structure of the subcomponent set forming the PIFF^2 is stable; it changed relatively little from CAVE to the game worlds, supporting an almost universal structure for presence, involvement and flow in entertainment VEs. The PIFF^2 fits well in the potential space; presence, involvement and flow represent both the psychological base and the orienting VEs well and reveal an important research window (Figure 22).

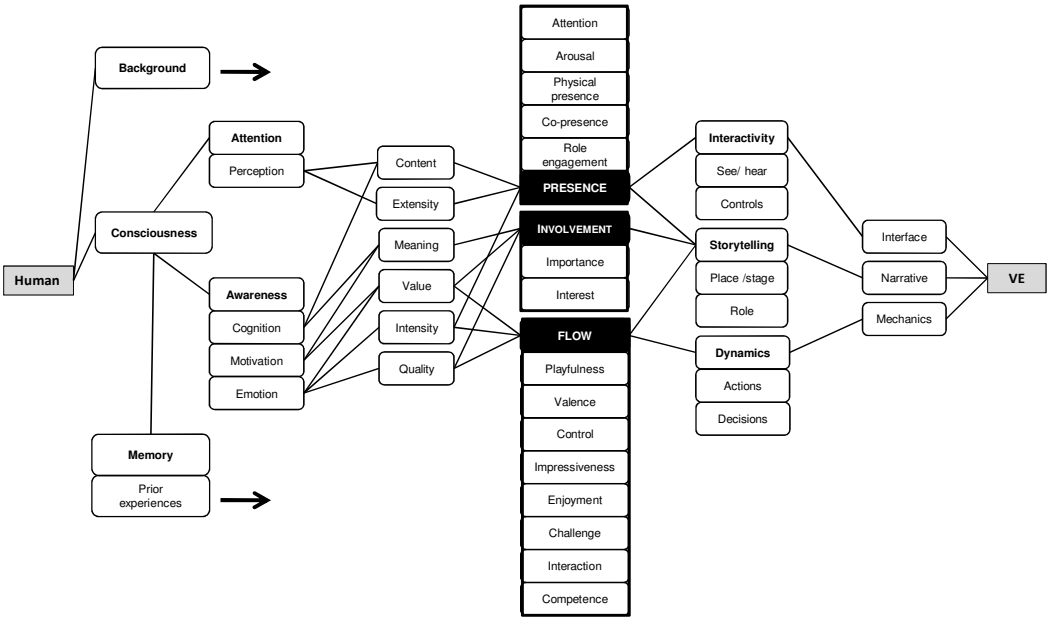
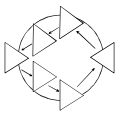


Figure 22. The PIFF^2 – between a human and an environment. Controls creating interactivity are evaluated by usability metrics and were excluded from this study.

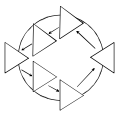


In general, **the interface**, that is, the way a VE is presented to the participants, is related to the sense of (physical) presence, in which the psychological factors of attention, perception and cognitive evaluation of the realness and spatiality of the VE are taken into consideration. These psychological factors in turn involve experiential content, intensity and extensity. **The narrative**, which sets the stage for the storytelling elicits (social) presence and involvement and affects emotional outcomes. These factors are psychologically related to social cognitions, motivation and emotions and give the experience its quality, intensity, meaning and value. **The mechanics**, which define actions below the dynamics of the VE, affect the cognitive evaluations and emotional outcomes related to an appraisal process. These factors give the experience its intensity, quality and value and sometimes even create flow.

However, a distinction between the game components is difficult to make. In a broad sense, actions defined by mechanics are also responsible for both social and physical presence. Thus, we considered game components as being interconnected layers; mechanics form the foundation, the narrative forms the frame, and the interface provides the outer core. In addition, at the very least, user background, prior experience and use context need to be considered in order to understand the true causes of experiential variation. However, studying experience in VEs raises yet another question: how meaningful or real are the experiences reported by the participants?

4.3 Virtual versus real

Although our aim in this research was not to compare the virtual and the real, before closing it is useful to dedicate a few thoughts to the *paradox of fiction.* Simply stated, the paradox is that emotional responses to fictional content are irrational (Radford, 1975). Thus, participation in fictitious interactions in VEs does not elicit genuine emotions. On the other hand, the *media equation* contradicts this paradox; it states that interactions with various communication technologies, such as computers and television, are equivalent to our real-life social interactions (Reeves & Nass, 1996). Our theoretical approach was based on the idea that the psychological base should be relevant in any context – there are always motives that guide our actions, perceptions and attention, subjective cognitive evaluations, appraisals and emotions. The *experiential cycle* does not differentiate between the real and the fictional. However, the bodily interaction in physical situations provides additional sense modalities, such as a proprioceptive sense

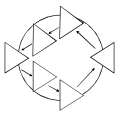


of kinesthetic movement, bodily position and posture as compared to the mainly audio-visual perceptions in VEs. On the other hand, bodily interaction in physical situations does not always play a crucial role, as may be the case in playing chess, for instance.

Consequently, both the type of physical interaction and the real context need to be considered in order to understand the orienting aspects of a particular real environment. Another challenge is to define a real-world experience so that it only concerns one particular event instead of a larger concept such as an everyday or life experience. For example, if we compare the experience of playing a football video game with being part of a real team in an actual football match, we find that both events are strongly affected by prior experiences. Buying a CD-ROM in order to get on a team provides a very different starting point for evolving experience compared to the years of practice that are required to earn a position on the starting line-up of a real team.

4.3.1 Presence, involvement and flow in football

Let's first consider involvement and flow in playing football in a VE versus in reality. In both cases, involvement and motivation are naturally present, but the levels of importance and interest are heavily influenced by prior efforts to learn football and by the future goals of the team and the individual. The motives to play in the first place differ, giving new, context-dependent meaning to importance and interest. When the participant is physically playing, the physical interaction and multimodal feedback from the body and the environment shape the experience. However the dynamics of flow – cognitively evaluated challenges, experienced competence and emotional outcomes – are valid in both contexts. Some of the emotional outcomes are likely to be cross-contextual (e.g. a sense of control) whereas context-dependent feelings are also likely to arise. For example, when a player is actually surrounded by big crowds and psyched-up teammates at night under the lights while breathing the fragrance of real grass, the feeling of scoring is incomparable and tackles really hurt. These perceptions are likely to elicit strong additional feelings, which cannot be felt on the couch at home. However, suggesting that the feelings associated with advancing to the next level in a digital football game after hours of play are irrational is exaggerated. The feelings are real, and they stem from the same continuum as the feelings related to having a winning season with a real team, although they perhaps are located on different parts of this continuum and



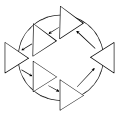
have special nuances of their own. In both cases, the feelings emerge from a willingness to participate and cannot therefore be irrational.

Both involvement and flow are thus cross-contextual phenomena having varying emphases. But understanding the sense of presence in a real world presents certain difficulties. People tend to use different language and different attributes to describe being physically present in a virtual world as opposed to a real world. Instead of evaluating rather obvious realness and spatiality in a real situation, participants often report task characteristics and environmental details (Häkkinen et al., 2010). Similarly, sharing a place with others (co-presence) and experiencing a storyline (role engagement) are likely to turn into various interpersonal and group phenomena present in real-world settings. The third of the "Big Three" physical/spatial presence subcomponents, namely attention, still seems to be a valid measure to indicate on what the mind is focused. In the real world the focus must work harder in order to maintain concentration. Physical situations are intense, we have less control over them, and the stakes can be higher.

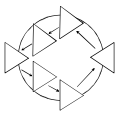
Whether a real or a virtual environment is at stake, the approach presented here makes individual behaviour more predictable and understandable, revealing the drivers, experiential outcomes and personal meanings in a given environmental interaction. Thus, following Young (2010), we can say that emotions in VEs are valid, although one-to-one comparisons to the real world are not always fruitful. Crucial in both cases is understanding the way in which the environment orients the psychology and the ways of grasping this subjectivity.

4.4 Future

Based on our empirical findings in Studies I–V, we can conclude that both our theoretical approach and the methodological framework work. For example, in addition to entertainment VEs, we have already applied the approach to technology-mediated communication experience (Aaltonen et al., 2009; Häkkinen et al., 2010; Takatalo et al., submitted for publication). We have our sights set on other, more complex everyday life situations, for example, understanding energy behaviour and tax compliance. These require deepening the theoretical background of our approach. Another line of research continues with the "Psychology of Digital Life" and especially with entertainment VEs and digital games. Now that we have a generic framework, we can study its individual parts more closely as demonstrated in section 3.5.3 (*Flow in the first hour of play*). In



addition, we are expanding our study cross-culturally: collaboration with Japanese researchers has provided promising results that support our findings concerning the PIFF^2 and 3D stereoscopic displays. As we widen the scope of our research towards new display technologies and bodily interfaces, we will lessen the gap between the real and the virtual even more. The further development of the PIFF^2 and its integration into a product-development process are appropriate continuations of the research presented here. This research provides valuable grounds for future activities and supports our quest to understand how the environmental turns into the mental.



5 Conclusions

The aim of the present study has been to understand and evaluate conscious experiences. First, we introduced our psychologically-based and content-oriented approach to understanding experience evolving from human-environment interactions. Central to our approach has been the *experiential cycle*, which connects psychology with orienting environmental content. Then we applied this classic psychological approach to developing a methodological evaluation framework to study experience in modern entertainment VEs. Studies I–V report subjective data collection, development and validation of this Presence-Involvement-Flow framework. The major conclusions of these studies are as follows:

1) Distinct subcomponents for the causes and feelings related to presence and flow can be empirically extracted. We formed a three-dimensional Presence-Flow Framework (PFF) from the causes and used it to profile participants in CAVE (Study I).

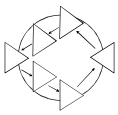
2) A high and steady PFF profile was associated with feelings related to presence and flow (Study I) as well as to fluent movement patterns operationalized with an entropy approach (Study II) in CAVE. Presence precedes flow.

3) Including involvement and feelings related to presence and flow in the PFF provided a usable framework for analyzing digital games. The four-dimensional PIFF provided more insight for studying game interfaces and display technologies compared to studying presence alone, for example (Study III).

4) Presence in digital games is composed of five subcomponents, which are distinct from the two involvement subcomponents. Together they describe adaptation, that is, how gamers willingly form a relationship with a game (Study IV). Narrative and interface have a particularly important effect on adaptation. The range of interactions is related to flow subcomponents.

5) Flow in games is characterized by two cognitive evaluations (challenge and competence) and three emotional outcomes (enjoyment, impressiveness and playfulness). A high and steady challenge and competence are related to positive emotional outcomes, which validated our flow model and connected it to Csikszentmihalyis' four-channel flow model (Study II, Study V, and one unpublished study). Flow subcomponents are related to game mechanics and narrative.

6) The fifteen subcomponents of the PIFF^2 provided a psychologically valid and reliable tool with which to assess entertainment VEs.



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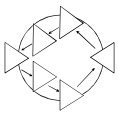
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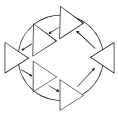
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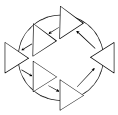
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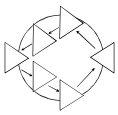
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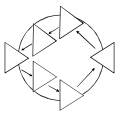
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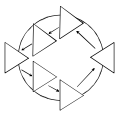
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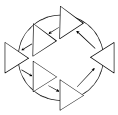
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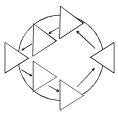
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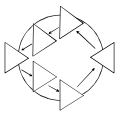
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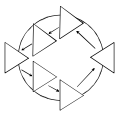
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Appendix A:

The comparison of both the EVEQ-Adaptation and EVEQ-Flow subcomponents in two sub-samples. The similarity of the compared factors was examined using Coefficient of Congruence, Salient Similarity Index and a Pearson correlation. The Reliabilities of the factors in each sub-sample were estimated with Tarkkonen's rho (ρ).

EVEQ-Adaptation

	Compared Factors		Tarkkonen's ρ		Coefficient of Congruence	Salient Similarity Index			Pearson Correlation	
Factor Name	Sample 1	Sample 2	Sample 1	Sample 2	Value (r_c)	Value (s)	% hp Count	*P*	Value (r)	*P*
Role Engagement	1	1	.79	.80	.98	0.67	86	< 0.001	.97	< 0.01
Attention	2	2	.88	.88	.99	0.55	86	< 0.001	.99	< 0.01
Co-Presence	5	5	.89	.89	.99	0.95	88	< 0.001	.99	< 0.01
Arousal	7	6	.70	.72	.98	0.18	93	< 0.05	.97	< 0.01
Physical Presence	8	8	.83	.83	.99	0.78	86	< 0.001	.99	< 0.01
Interaction	6	7	.72	.70	.98	0.92	92	< 0.001	.97	< 0.01
Interest	3	3	.74	.72	.91	0.75	93	< 0.001	.92	< 0.01
Importance	4	4	.88	.88	.99	0.40	90	< 0.001	.99	< 0.01

EVEQ-Flow

	Compared Factors		Tarkkonen's ρ		Coefficient of Congruence	Salient Similarity Index			Pearson Correlation	
Factor Name	Sample 1	Sample 2	Sample 1	Sample 2	Value (r_c)	Value (s)	% hp Count	*P*	Value (r)	*P*
Valence	3	1	.77	.80	.99	0.91	79	< 0.001	.99	< 0.01
Impressiveness	2	2	.79	.80	.98	0.95	80	< 0.001	.97	< 0.01
Competence	6	3	.86	.86	.99	1.00	82	< 0.001	.99	< 0.01
Challenge	4	6	.77	.77	.98	0.80	89	< 0.001	.96	< 0.01
Enjoyment	1	5	.73	.76	.98	0.82	82	< 0.001	.98	< 0.01
Playfulness	5	7	.80	.76	.99	0.91	89	< 0.001	.98	< 0.01
Control	7	4	.74	.72	.97	0.89	91	< 0.001	.96	< 0.01

Appendix B:

Factor intercorrelations (Pearson's r) among the fifteen PIFF[2] subcomponents.

		Role Engagement	Attention	Interest	Importance	Co-Presence	Interaction	Arousal	Physical Presence	Valence	Impressiveness	Competence	Challenge	Enjoyment	Playfulness	Control
Role Engagement	Pearson Correlation	1	.19	.01	.25	.30	.14	.13	.35	.13	.55	.16	.21	.18	.15	.02
	Sig. (2-tailed)		.00	.73	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.27
	N	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182
Attention	Pearson Correlation	.19	1	-.10	.09	.18	.12	.29	.30	-.03	.27	.03	.36	.09	-.05	-.03
	Sig. (2-tailed)	.00		.00	.00	.00	.00	.00	.00	.18	.00	.14	.00	.00	.01	.13
	N	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182
Interest	Pearson Correlation	.01	-.10	1	.31	.17	.13	.02	-.03	.51	-.01	.39	-.07	.35	.38	.29
	Sig. (2-tailed)	.73	.00		.00	.00	.00	.39	.14	.00	.75	.00	.00	.00	.00	.00
	N	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182
Importance	Pearson Correlation	.25	.09	.31	1	.39	.19	.09	.31	.37	.45	.41	.22	.32	.39	.20
	Sig. (2-tailed)	.00	.00	.00		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	N	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182
Co-Presence	Pearson Correlation	.30	.18	.17	.39	1	.26	.12	.36	.19	.40	.32	.22	.30	.36	.12
	Sig. (2-tailed)	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	N	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182
Interaction	Pearson Correlation	.14	.12	.13	.19	.26	1	.11	.11	.22	.07	.40	.21	.33	.24	.34
	Sig. (2-tailed)	.00	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00	.00	.00	.00
	N	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182
Arousal	Pearson Correlation	.13	.29	.02	.09	.12	.11	1	.17	.04	.20	-.02	.31	.26	.04	.11
	Sig. (2-tailed)	.00	.00	.39	.00	.00	.00		.00	.09	.00	.37	.00	.00	.08	.00
	N	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182
Physical Presence	Pearson Correlation	.35	.30	-.03	.31	.36	-.11	.17	1	.12	.55	.12	.35	.05	.20	-.02
	Sig. (2-tailed)	.00	.00	.14	.00	.00	.00	.00		.00	.00	.00	.00	.02	.00	.41
	N	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182
Valence	Pearson Correlation	.13	-.03	.51	.37	.19	.22	.04	.12	1	.08	.33	.01	.15	.35	.23
	Sig. (2-tailed)	.00	.18	.00	.00	.00	.00	.09	.00		.00	.00	.50	.00	.00	.00
	N	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182
Impressiveness	Pearson Correlation	.55	.27	-.01	.45	.40	.07	.20	.55	.08	1	.16	.23	.04	.15	-.04
	Sig. (2-tailed)	.00	.00	.75	.00	.00	.00	.00	.00	.00		.00	.00	.06	.00	.05
	N	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182
Competence	Pearson Correlation	.16	.03	.39	.41	.32	.40	-.02	.12	.33	.16	1	.05	.15	.22	.26
	Sig. (2-tailed)	.00	.14	.00	.00	.00	.00	.37	.00	.00	.00		.01	.00	.00	.00
	N	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182
Challenge	Pearson Correlation	.21	.36	-.07	.22	.22	.21	.31	.35	.01	.23	.05	1	.12	.16	.04
	Sig. (2-tailed)	.00	.00	.00	.00	.00	.00	.00	.00	.50	.00	.01		.00	.00	.04
	N	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182
Enjoyment	Pearson Correlation	.18	.09	.35	.32	.30	.33	.26	.05	.15	.04	.15	.12	1	.20	.21
	Sig. (2-tailed)	.00	.00	.00	.00	.00	.00	.00	.02	.00	.06	.00	.00		.00	.00
	N	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182
Playfulness	Pearson Correlation	.15	-.05	.38	.39	.36	.24	.04	.20	.35	.15	.22	.16	.20	1	.24
	Sig. (2-tailed)	.00	.01	.00	.00	.00	.00	.08	.00	.00	.00	.00	.00	.00		.00
	N	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182
Control	Pearson Correlation	.02	-.03	.29	.20	.12	.34	.11	-.02	.23	-.04	.26	.04	.21	.24	1
	Sig. (2-tailed)	.27	.13	.00	.00	.00	.00	.00	.41	.00	.05	.00	.04	.00	.00	
	N	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182	2182