



## Understanding the most satisfying and unsatisfying user experiences: Emotions, psychological needs, and context <sup>☆</sup>

Timo Partala <sup>\*</sup>, Aleksi Kallinen

Unit of Human-centered Technology, Tampere University of Technology, Finland

### ARTICLE INFO

#### Article history:

Received 24 January 2011  
Received in revised form 5 September 2011  
Accepted 20 October 2011  
Available online 29 October 2011

#### Keywords:

User experience  
Emotion  
Psychological need  
Context

### ABSTRACT

The aim of this research was to study the structure of the most satisfying and unsatisfying user experiences in terms of experienced emotions, psychological needs, and contextual factors. 45 university students wrote descriptions of their most satisfying and unsatisfying recent user experiences and analyzed those experiences using the Positive and Negative Affect Schedule (PANAS) method for experienced emotions, a questionnaire probing the salience of 10 psychological needs, and a self-made set of rating scales for analyzing context. The results suggested that it was possible to capture variations in user experiences in terms of experienced emotions, fulfillment of psychological needs, and context effectively by using psychometric rating scales. The results for emotional experiences showed significant differences in 16 out of 20 PANAS emotions between the most satisfying and unsatisfying experiences. The results for psychological needs indicated that feelings of autonomy and competence emerged as highly salient in the most satisfying experiences and missing in the unsatisfying experiences. High self-esteem was also notably salient in the most satisfying experiences. The qualitative results indicated that most of the participants' free-form qualitative descriptions, especially for the most unsatisfying user experiences, gave important information about the pragmatic aspects of the interaction, but often omitted information about hedonic and social aspects of user experience.

© 2011 British Informatics Society Limited. Published by Elsevier B.V. All rights reserved.

### 1. Introduction

User experience as a discipline is still young and the concept of user experience is evolving (Law et al., 2009). Nevertheless, the field of user experience has already had a significant influence on the development of many different kinds of technology products ranging from different physical artifacts to software products and social media. The main practical activities in this area are user experience design and evaluation. To guide these important activities, user experience is evolving into an influential research area, which studies the users' experiences with technology using systematic research methods. Even though user experience is increasingly studied from a research perspective, there are still plenty of possibilities for new research both in applied research and basic research, which aims at understanding fundamental issues underlying the users' experiences with technology. A more systematic understanding of the users' experiences also contributes to user experience design. More information is needed on which kind of research and evaluation methods are the most effective in capturing

the nature of different kinds of user experiences, and how the users' experiences are typically structured. In the current research, the aim is to understand the structure of most satisfying and unsatisfying user experiences by qualitatively analyzing written descriptions related to those experiences and also by systematically applying a three-part quantitative questionnaire method to study the related contexts, emotions, and psychological needs.

In order to make a contribution to the field of user experience, some of the advances in this research area need to be understood. An important contribution was made, when Hassenzahl et al. (2000) distinguished between pragmatic quality (the usability of the product, which addresses the underlying human need for security and control) and hedonic quality, which refers to quality dimensions with no obvious relation to task-related goals such as originality and innovativeness. Hedonic quality addresses, for example, the human needs for novelty or change and social power. He found that these two quality factors together determine the appealingness of a software product for the user. Hassenzahl (2003) divided hedonic aspects further into three classes: stimulation, identification, and evocation. In this model stimulation refers to the fulfillment of the needs for stimulation, novelty, and challenge, which are a prerequisite for personal development. For example, a mobile phone with a new kind of visual design could provide its user with hedonic stimulation. Identification refers to the human need for expressing oneself through objects. This

<sup>☆</sup> This paper has been recommended for acceptance by Jeffrey Bardzell.

<sup>\*</sup> Corresponding author. Address: Unit of Human-centered Technology, Tampere University of Technology, P.O. Box 589, FI-33101 Tampere, Finland. Tel.: +358 40 849 0855; fax: +358 3 3115 5532.

E-mail address: [timo.partala@tut.fi](mailto:timo.partala@tut.fi) (T. Partala).

self-presentational function is entirely social, as the users of products want to be seen in specific ways by others. For example, the user might want to use an expensive mobile phone in order to identify him/herself with a group of business managers. Evocation refers to the symbolic meaning of the product and the potential to provoke personal memories. In the current study, Hassenzahl's model is used as a framework for analyzing the qualitative user experience descriptions received.

As suggested by Hassenzahl and Tractinsky (2006), psychological needs are an important component of user experience. Different theories of human psychological needs have been suggested in the literature, the most famous probably being the hierarchy of needs by Maslow (1943), which classifies needs to five levels: physiological, safety, love/belonging, esteem, and self-actualization needs. Currently, one of the most widely appreciated need theories is the self-determination theory (Deci and Ryan, 2000; Ryan and Deci, 2000). Psychological needs related to the self-determination theory include autonomy (to actively participate in determining own behavior without external influence), competence (to experience oneself as capable and competent in controlling the environment and being able to reliably predict outcomes), and relatedness (to care for and be related to others). These three needs are now seen as important determinants for the well-being of an individual (e.g. Deci and Ryan, 2000; Reis et al., 2000).

By elaborating on the three needs suggested in self-determination theory (Ryan and Deci, 2000) and the hierarchy of needs by Maslow (1943), Sheldon et al. (2001) presented a model of 10 candidate psychological needs. By also including psychological needs suggested by other researchers they formed a group of 10 candidate psychological needs: autonomy, competence, relatedness, self-actualization-meaning, physical thriving, pleasure-stimulation, money-luxury, security, self-esteem, and popularity-influence. They also presented a questionnaire method for studying the level of satisfaction for the 10 needs using 30 statements (three statements for each need) and applied the method in three studies on the most satisfying and unsatisfying experiences of college students in two different cultural settings. Their results supported the self-determination theory, as they found that autonomy, competence, and relatedness were consistently among the four most important needs, when their subjects reported the degrees of need-satisfaction in the context of most satisfying and unsatisfying life events. Self-esteem and security were also rated highly salient in satisfying events, whereas self-actualization-meaning, physical thriving, popularity-influence, and money-luxury were found to be of moderate salience. The questionnaire method by Sheldon et al. (2001) is used in the current study with minor amendments to study the psychological needs related to the reported most satisfying and unsatisfying user experiences.

Besides need-related aspects, emotions are also an integral part of user experience and their measurement consequently becomes central in the empirical research conducted in the field of user experience (Agarwal and Meyer, 2009). In the field of human-computer interaction, research on emotions originally focused largely on physiology-based measures for studying affective interactions (e.g. Picard, 1997; Partala and Surakka, 2003, 2004; Partala et al., 2006) utilizing, for example, the user's facial expressions in affective human-computer interaction. Lately, more attention has been paid to the cultural, social and experiential dimensions of emotions (e.g. Boehner et al., 2005). The measurement of subjective emotional experience alone is currently regarded as an important activity in user experience evaluation and research.

The field of user experience has mostly focused on positive experiences (Hassenzahl and Tractinsky, 2006). In Hornbæk's (2006) review of 180 studies of computing system usability, he identified 70 measures of specific attitudes assessed by self-report. Of these, only 13 measures addressed explicitly negative

emotional or physiological states. While positive affect has been found to have many kinds of positive consequences on cognition, for example, enabling more effective decision making (Isen, 2006), this kind of unidirectional measurement provides only a partial view on the user's emotions. In the field of user experience understanding negative experiences and the conditions in which they arise may prove very important in order to further develop products iteratively based on the user experience evaluations. Studying the full range of emotional experiences has already been found very useful in a number of user experience and usability studies including Hazlett and Benedek (2007) and Partala and Kangaskorte (2009).

A widely used instrument in the evaluation of experienced emotions is the Positive and Negative Affect Schedule (PANAS) method by Watson et al. (1988). This method consists of 10 psychometric scales for both positive and negative emotions, including emotions such as scared, hostile, inspired and proud. This method enables balanced research on emotions on the positive-negative dimension. PANAS has also been found to be a reliable and valid measure of the 20 emotions it is intended to assess (Crawford and Henry, 2004). Consequently, PANAS was selected as the emotion assessment method for the current research.

It has been long known that the context of use is an important factor in human-computer interaction (e.g. Suchman, 1987; Nardi, 1995). In order to fully understand different kinds of user experiences, it is also generally considered important to understand the use context of those experiences (Hassenzahl and Tractinsky, 2006; Law et al., 2009). The effects of context become especially prominent in the use of mobile systems. Use contexts can be modeled, for example, using the framework by Jumisko-Pyykkö and Vainio (2010). They analyzed existing models related to contexts of use, and based on that analysis divided use contexts into five main classes: physical context, temporal context, task context, social context, and the technical and information context. The physical context may include, for example, spatial location, functional place and space, and sensed environmental attributes (e.g. temperature), while the temporal context includes, for example, the duration of interaction, and time of day, week, and year. The task context may include aspects related to multitasking, interruptions, and the task domain, while the social context includes the effects of other persons present and the related interpersonal interactions. Finally, the technical and information context may include other systems and services and their interrelations. Based on this framework, a set of rating scales for analyzing context was prepared for the current research.

Despite about a decade of research in the user experience field, systematic empirical studies concentrating on which emotions and needs are underlying most satisfying and unsatisfying user experiences are still sparse. Hassenzahl (2008) reported a study on the structure of positive experiences with technology. He used the PANAS system for studying emotions and the levels of satisfaction for three self-determination theory related needs, autonomy, competence, and relatedness, were also measured. According to his results, competence was the most salient psychological need in positive user experiences, followed by autonomy and relatedness. In a larger study on the same topic (Hassenzahl et al., 2010), the authors found that relatedness, stimulation, and competence were the most salient needs in positive user experiences, when autonomy and self-esteem were excluded from analysis. Emotions such as active, strong, proud, alert, and determined were found to correlate with fulfillment of needs and perceived hedonic and pragmatic qualities of the products in the context of most satisfying experiences with technology. The authors also presented a conceptual model, in which need fulfillment and positive emotions were seen as important determinants of the perceived hedonic quality of products.

The current study aims at contributing to this research direction by giving new information on the structure of personal user experiences by taking a holistic approach and systematically studying emotions, psychological needs and contextual factors, as well as analyzing qualitative descriptions of user experiences. The goal is to study the relative importance of different emotions and psychological needs in most satisfying and unsatisfying user experiences and the effects of different contextual variables in those experiences. Thus, the current research spans different levels from lower level physiology-related constructs such as emotional responses to higher-level constructs such as self-actualization or self-esteem. Moreover, the goal is to study what kind of qualitative information (e.g. on pragmatic vs. hedonic aspects of user experience) can be obtained when the users are asked to freely describe their user experiences. By experimenting with quantitative and qualitative methods for studying user experiences, we also aim at producing a new kind of methodological insight into how different kinds of information about user experiences can and should be gathered.

The current approach of studying most satisfying and unsatisfying user experiences was inspired by Sheldon et al. (2001), who concentrated on studying most satisfying and unsatisfying life events. Their model of 10 candidate psychological needs and the related questionnaire was used in the current research to study psychological needs in the context of user experiences. By using mostly similar methods as in Sheldon et al. (2001), we might also gain some insight into how most satisfying and unsatisfying user experiences are similar to or different from most satisfying and unsatisfying life experiences. The PANAS system with 10 positive and 10 negative emotions was used in analyzing emotions related to the experiences. Thus, unlike many existing user experience studies, the current research also focused on unsatisfying experiences and negative emotions in order to cover the full range of emotions on the emotional valence scale. Finally, a set of 10 contextual questions was developed based on existing theoretical work on use contexts. For the current research, these methods were structured to a three-part questionnaire studying context, emotions, and psychological needs, respectively.

## 2. Method

### 2.1. Participants

Forty five participants (29 male and 16 female university students) completed all three phases of the research with satisfactory responses. Thirty seven participants fell into the 21–30 years age group, six participants into the 31–40 years age group, and two participants into the 41–50 years age group.

### 2.2. Procedure

The current research was carried out in the context of the university level course “User experience: evaluation and design” at Tampere University of Technology, Finland. The participants included Master’s level students and doctoral students. By using university students as participants we aimed at improving the validity of the results. The students were assumed to have the required skills for analyzing user experiences using introspective methods and also capabilities for understanding all the scales used in the current study. All the participants signed up for the current study in the Moodle online learning environment, and they were identified using their university network IDs.

The research was carried out using questionnaire methods in the web questionnaire system Webropol. Instead of one very long questionnaire, the students participated in the research in three phases so that they could concentrate on each evaluation phase

(context, emotions, psychological needs) independently of each other and possibly also provide more thoughtful responses, as the number of evaluations carried out at one time was smaller. They received course credit (equivalent to three weekly exercises) for their participation. The participants were provided links to each research phase in Moodle, and they had about 10 days to respond in each phase, before the questionnaires were closed. Each participant was instructed to carry out the questionnaire independently, and in the analysis phase the IP addresses and submission times of the responses were monitored to rule out potential teamwork. A qualitative analysis of the reported user experiences confirmed that the experiences were unique for each participant.

All the participants were familiar with the basic concepts in the fields of usability and user experience. Individual questionnaire responses were anonymous, even though the researchers had access to the list of names of the students, who responded to the survey. This was achieved in practice so that after the participants had submitted each phase of the research anonymously, they were automatically forwarded to a different Webropol survey, in which they were prompted to enter their names and student numbers. This way we were aware of the participants who had responded to the survey, but the individual responses were still anonymous.

### 2.3. Tasks and materials

In response to the first questionnaire, the participants wrote descriptions about their most satisfying and unsatisfying user experiences and answered a set of demographic and contextual questions. The participants were instructed to think about their user experiences during the past 6 months. They were instructed to think of what kind of different systems or products they had used and what kind of experiences they had had. They were especially prompted to identify the single most satisfying experience and the single most unsatisfying experience that they had encountered. For the purposes of this research, user experience was defined simply as “your experience related to a single event, in which your usage of a technological system formed a substantial part”.

The participants were told that their responses were completely anonymous. The descriptions were instructed to be about 5–20 sentences long. The participants were told to save the descriptions of their most satisfying and unsatisfying experiences to a file on their computers and review the experiences before starting each phase of the research. In the first phase of the questionnaire, the participants were first instructed to choose their sex and age from the alternatives presented. To further promote anonymity, we did not ask the participants’ exact ages (because in theory we might have recognized some students based on that information), but they were instructed to choose a correct age range (less than 21 years, 21–30 years, 31–40 years, 41–50 years, or more than 50 years).

On the next page, the most satisfying user experiences were documented. First, the participants were prompted to write the description of their most satisfying recent user experience into a text field at the top of the page. Next, they analyzed the reported experience by evaluating 10 statements, which studied the context of the user experience. The statements were developed specifically for this experiment based on the context framework by Jumisko-Pyykkö and Vainio (2010) to cover the most common contextual aspects found in existing literature: physical context, temporal context, task context, social context, and the technical and information context. There were three questions, in which the participants entered numerical information: “How many days you had used the system before the experience? (time since you first tried the system)”, “How many persons were there physically present besides you, in the same situation?”, and “How many persons were

**Table 1**  
The seven questionnaire items studying context.

Item	Anchor texts
At the time of the experience I had:	1 = A big hurry 9 = Plenty of time
The environment that I was in was:	1 = Very unfamiliar 9 = Very familiar
Other people influenced the situation:	1 = Not at all or very little 9 = Very much
The task or interaction I was carrying out was for me personally:	1 = Not at all or very little important 9 = Very important
Multitasking: could you concentrate on the task at hand?	1 = I could fully concentrate on one task or issue 9 = I had many different tasks or other issues in my mind
Technical problems were involved in this event:	1 = Not at all or very little 9 = Very much
Usability problems were involved in this event:	1 = Not at all or very little 9 = Very much

there virtually present besides you, in the same situation? (e.g. via Internet or phone connections)". In addition, there were seven items, which probed the context of the participants' experiences using 1–9 scales. Each scale was accompanied by a statement and anchor texts denoting the opposite ends of the scale. They are presented in Table 1 below. On the next and final page of the first phase, the most unsatisfying user experiences were studied using exactly the same methods as the most satisfying user experiences.

In the second phase of the research, the participants' emotions during the most satisfying and unsatisfying user experiences were studied. They were told to evaluate to which extent they experienced emotions in the user experiences they reported as the most satisfying and the most unsatisfying using 1–9 scales (1 = not at all or very little, 9 = very much). 20 emotions to be evaluated (10 positive and 10 negative emotions) were taken from the PANAS system (Watson et al., 1988) and presented in the original mixed order. The positive emotions were: determined, alert, inspired, attentive, active, interested, excited, enthusiastic, proud, and strong. The negative emotions were: upset, hostile, ashamed, nervous, afraid, distressed, irritable, scared, guilty, and jittery. For both emotions and psychological needs we used nine point scales as opposed to the five point scales used in the original methods in order to achieve a more fine grained conception of the respondents' emotions and psychological needs related to their user experiences and to avoid problems related to response interpolation (see e.g. Fins-tad, 2010).

In the third phase of the research, the participants evaluated the salience of different psychological needs in their reported most satisfying and unsatisfying user experiences. The model of 10 candidate psychological needs by Sheldon et al. (2001) was used for that purpose and their questionnaire method consisting of 30 questions (three questions for each psychological need) was used almost as such in the current questionnaire. The statements used for studying psychological needs in the current study can be found in Appendix A. The 10 psychological needs were: autonomy, competence, relatedness, self-actualization-meaning, physical thriving, pleasure-stimulation, money-luxury, security, self-esteem, and popularity-influence. The definitions of the needs, which were not presented to the participants, can be found in Appendix B. The respondents gave their answers using 1–9 scales from 1 = not at all to 9 = very much. For the most satisfying experiences, all the statements started with "During this user experience I felt" instead of "During this event I felt" used in the original questionnaire by Sheldon et al. (2001). For example, the first evaluation

was: "During this user experience I felt that my choices were based on my true interests and values." (autonomy). For the most unsatisfying experiences, the participants evaluated what was missing from the experience, what was the reason it was not satisfying from 1 = not at all the reason to 9 = very much the reason using the negative versions of the same 30 questions as in Sheldon et al. (2001), e.g. "During this user experience I did not feel that my choices were based on my true interests and values".

#### 2.4. Data analysis

For the quantitative data, Friedman's rank tests were used to compare the ratings of all the PANAS emotions and the 10 psychological needs for significant differences and Wilcoxon's matched pairs signed ranks tests were used in all the pairwise comparisons, except gender differences were studied using the Mann–Whitney U test. These tests were selected due to the nonparametric (distribution-free) nature of the gathered data. Cronbach's Alpha scores were calculated to estimate the reliability of the ratings for the psychological needs.

The qualitative descriptions of the most satisfying and unsatisfying user experiences were analyzed by the two authors of this research. First, they analyzed and classified the data independently, after which disagreements were resolved by discussion between the two authors and as a result of this process, consensus was reached on the classification of each qualitative description. Following Hassenzahl's (2003) model (as defined in the introduction of this paper), each description was coded into one of three categories: pragmatic, hedonic (stimulation), or hedonic (identification) based on the number of related issues raised by the participants in their descriptions. If there was a tie, the classification was decided based on the overall tone of the description. Evocation (Hassenzahl, 2003) was left out, because none of the descriptions seemed to match that category in the preliminary analysis. Each description was also coded into one of the following categories: exceeded the user's expectations, met the user's expectations, failed to meet the user's expectations, or not applicable. Finally, the objects of the reported user experiences were categorized to two categories: devices and applications. This more trivial categorization was carried out by the first author alone.

### 3. Results

The results are based on 45 descriptions of most satisfying experiences and 45 descriptions of most unsatisfying experiences. They are described below in separate sections for contextual factors, emotional experiences, psychological needs, and gender differences. Finally, the qualitative findings are presented.

#### 3.1. Contextual factors

The subjects reported having used the system for 22.4 days (range 0–800 days) on average before the reported most satisfying experiences and 82.1 (range 0–700) days before the reported most unsatisfying experiences. They reported that on average 0.8 other persons were present at the time of the reported positive user experience and 1.5 other persons at the time of the negative user experience. They also reported that on average 1.0 other persons were virtually present during a positive experience and 0.1 other persons during a negative experience.

The participants' ratings using 1–9 scales indicated that they typically were not especially hurried in the most satisfying experiences, but had a moderate level of hurry in the most unsatisfying experiences (averages 6.2 and 4.5, respectively). They also evaluated that their environment was relatively familiar in both most

**Table 2**  
Positive emotions, negative emotions, and affect balance.

	Positive emotions	Negative emotions	Affect balance
Most satisfying experience	6.1	1.8	4.2
Most unsatisfying experience	4.9	4.2	0.7

satisfying and unsatisfying experiences (averages 7.7 and 7.0, respectively), and that other people had relatively little influence on their most satisfying and unsatisfying user experiences (averages 3.5 and 3.0, respectively). For both most satisfying and unsatisfying experiences the tasks at hand were evaluated as relatively important for the participants personally (averages 6.6 and 6.9, respectively). The ratings for multitasking indicated that the users could concentrate on the task at hand relatively well (averages 3.4 and 4.2, respectively). Finally, for the most satisfying experiences they reported that different technical problems (average 2.1) and usability problems (average 2.2) did not have an important role. In contrast, for the most unsatisfying experiences, the ratings for the technical and usability problems were 6.4 and 7.0, indicating that both types of problems were typically involved.

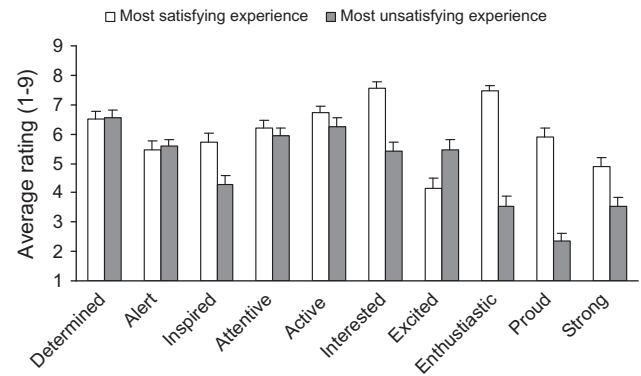
The statistical analyses showed that for most the satisfying experiences, the subjects reported significantly less time from starting using the product as compared to the most satisfying experiences  $Z = 2.6$ ;  $p < 0.01$ . The subjects also reported a bigger level of hurry for the most unsatisfying experiences than the most satisfying experiences  $Z = 3.3$ ;  $p < 0.01$ , more technical problems for the most unsatisfying than the most satisfying experiences  $Z = 5.2$ ;  $p < 0.001$  and more usability problems for the most unsatisfying than the most satisfying experiences  $Z = 5.5$ ;  $p < 0.001$ . The pairwise differences between the other contextual variables (number of persons present; familiarity of the environment; influence of other people; importance of the task at hand; and multitasking) were not statistically significant. However, for multitasking the difference approached statistical significance  $Z = 1.9$ ;  $p = 0.06$ , indicating a tendency of more distractions for the unsatisfying experiences.

### 3.2. Experienced emotions

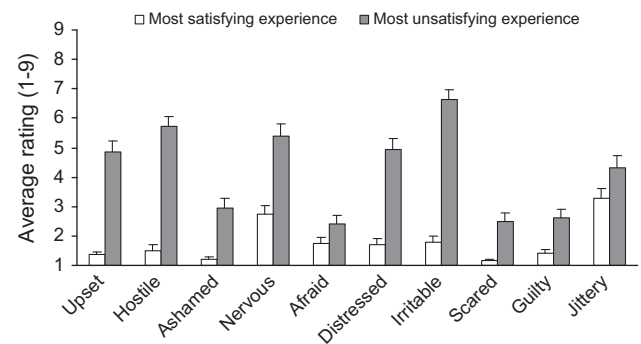
Average ratings for the 10 positive PANAS emotions experienced by the participants during the most satisfying and unsatisfying experiences are presented in Fig. 1. Statistical testing confirmed that the participants' ratings for the different positive emotions varied significantly for both the most satisfying experiences  $\chi^2_F = 120.1$ ,  $p < 0.001$  and the most unsatisfying experiences  $\chi^2_F = 163.8$ ,  $p < 0.001$ .

Average ratings for the 10 negative PANAS emotions experienced by the participants during the most satisfying and unsatisfying experiences are presented in Fig. 2. Again, statistical testing confirmed that the participants' ratings for the different emotions varied significantly for both the most satisfying experiences  $\chi^2_F = 116.7$ ,  $p < 0.001$  and the most unsatisfying experiences  $\chi^2_F = 161.3$ ,  $p < 0.001$ .

When the ratings for the different emotions were compared pairwise between the most satisfying and unsatisfying user experiences, statistical differences were found for 16 of the 20 emotions. For 15 of these emotions the differences were in the expected direction (positive PANAS emotions got significantly higher scores for the most satisfying than the most unsatisfying experiences and the ratings of negative PANAS emotions were significantly higher for the most unsatisfying than the most satisfying experiences). Interestingly, differences in ratings of the following



**Fig. 1.** The salience of positive PANAS emotions in the most satisfying and unsatisfying user experiences (mean and standard error of the mean).



**Fig. 2.** The salience of negative PANAS emotions in the most satisfying and unsatisfying user experiences (mean and standard error of the mean).

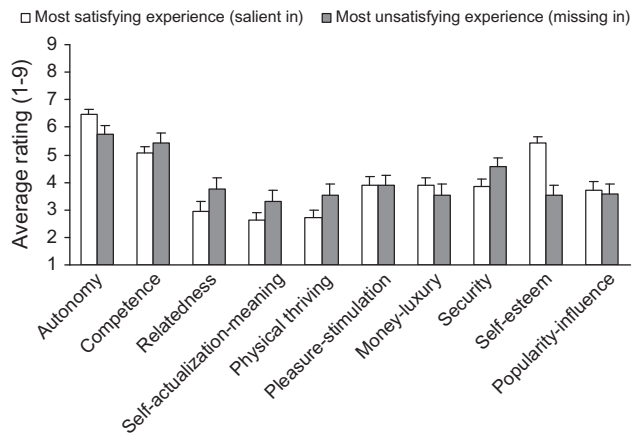
PANAS emotions were not significant: determined  $p > 0.9$ , alert  $p > 0.6$ , attentive  $p > 0.3$ , and active  $p > 0.1$ . The ratings for excitement suggested that the participants actually experienced significantly more excitement in the most unsatisfying experiences than in the most satisfying experiences  $Z = 2.4$ ,  $p < 0.05$ , even though excited is classified as a positive emotion in the PANAS system.

Next, averages were calculated for each participant's ratings of the 10 positive and the 10 negative emotions for the most satisfying and unsatisfying experiences. Affect balance scores were also calculated separately for each participant by subtracting the rating for the negative emotions from the rating for the positive emotions. Finally, these scores were averaged over participants. These averages are presented in Table 2.

The statistical analysis showed that participants reported significantly more positive emotions in the most satisfying user experiences than in the most unsatisfying user experiences  $Z = 4.4$ ,  $p < 0.001$ . They also reported significantly more negative emotions in the most unsatisfying user experiences than the most satisfying user experiences  $Z = 5.7$ ,  $p < 0.001$ . The affect balance score was also significantly higher for the most satisfying than the most unsatisfying user experiences  $Z = 5.6$ ,  $p < 0.001$ .

### 3.3. Psychological needs

Averaged ratings for the satisfaction of the 10 candidate psychological needs by Sheldon et al. (2001) as experienced by the participants during the most satisfying and unsatisfying experiences are presented in Fig. 3. The statistical analyses showed significant variation among both the ratings for the salience of the 10 different psychological needs in the most satisfying user



**Fig. 3.** The satisfaction of psychological needs for the most satisfying and unsatisfying experiences (mean and standard error of the mean).

experiences  $\chi^2_F = 171.2$ ,  $p < 0.001$  and the ratings for the absence in the fulfillment of the 10 different psychological needs in the most unsatisfying user experiences  $\chi^2_F = 68.6$ ,  $p < 0.001$ .

The ratings for the salience of different psychological needs in the most satisfying experiences were also compared pairwise to the ratings for the absence of the corresponding needs in the most unsatisfying user experiences. These tests indicated a significant difference for self-esteem between the most satisfying and unsatisfying user experiences  $Z = 3.7$ ,  $p < 0.001$ . The difference in the ratings of autonomy in the most satisfying and the most unsatisfying user experiences was not significant, but approached statistical significance  $Z = 1.9$ ,  $p < 0.065$ . The other pairwise differences were not significant.

To address the reliability of the instrument developed by Sheldon et al. (2001) in the context of user experience research, we calculated Cronbach's Alpha scores for each of the psychological needs and both the most satisfying and unsatisfying experiences. The scores for the most satisfying experiences were as follows: autonomy .60, competence .40, relatedness .93, self-actualization-meaning .91, physical thriving .91, pleasure-stimulation .82, money-luxury .72, security .84, self-esteem .81, and popularity-influence .93. The scores for the most unsatisfying experiences were: autonomy .79, competence .85, relatedness .98, self-actualization-meaning .97, physical thriving .95, pleasure-stimulation .90, money-luxury .92, security .87, self-esteem .95, and popularity-influence .97. These results indicated satisfactory levels of internal reliability, except for competence (most satisfying experiences), for which the respective questionnaire items may need to be rephrased for user experience research.

### 3.4. Gender differences

All the quantitative variables (the 10 questions about context, the twenty PANAS emotions, and the 10 psychological needs for both most satisfying and unsatisfying user experiences) were tested for gender differences. Significant gender differences were found for only four out of the 80 analyzed variables. The context data showed that female participants (average 8.2) were in a more familiar environment during their most unsatisfying experiences than males (average 6.3),  $p < 0.05$ . Male participants (average 4.8) reported more multitasking than female participants (average 3.2) during their most unsatisfying experiences,  $p < 0.05$ . For the emotion data, the only significant difference was that male participants (average 2.9) reported being more afraid than female participants (average 1.7) during the most unsatisfying experiences,  $p < 0.05$ . For the psychological needs, male participants (average

5.4) reported a higher level of satisfaction for competence needs than female participants (average 4.5),  $p < 0.05$  in the most satisfying experiences.

### 3.5. Qualitative findings

The objects of the reported user experiences were categorized to devices or applications. For the most satisfying experiences, 34 out of 45 descriptions described primarily experiences of different devices (e.g. mobile phones, digital cameras, digital set-top boxes, a washing machine, a drink vending machine, and a library book loan machine), whereas 11 descriptions described experiences of applications or services (e.g. web stores, a music streaming service, a new web browser, and a new operating system). For the most unsatisfying experiences, 24 out of 45 described primarily experiences of different devices (e.g. different mobile phones, digital set-top boxes, car appliances, a microwave oven, and even a ship steering system). 21 descriptions were primarily about applications or services (e.g. different web sites, a text processing program, a spreadsheet program, and a university student portal).

Following the model by Hassenzahl (2003), the descriptions of most satisfying and unsatisfying user experiences were also categorized into three categories: pragmatic, hedonic (stimulation), and hedonic (identification). The descriptions categorized as pragmatic highlighted the usability and utility aspects of user experiences. The experiences categorized as hedonic (stimulation) highlighted aspects related to sensory stimulation, novelty, or challenge. The experiences categorized as hedonic (identification) emphasized social aspects, self-expression, or group identification through using a certain kind of product. The findings from this analysis suggested that most of the descriptions written were primarily pragmatic in nature. Of the descriptions of the most satisfying experiences, 35 descriptions were classified as emphasizing mostly pragmatic aspects. Seven descriptions were classified into the hedonic (stimulation) category, and three descriptions were classified into the hedonic (identification) category. Of the descriptions of the most unsatisfying experiences, 41 descriptions were classified as emphasizing mostly pragmatic aspects. Two descriptions were classified into both the hedonic (stimulation) category and the hedonic (identification) category. Examples of the given descriptions for the three categories and the most satisfying and unsatisfying experiences are presented in Appendix C. In practice, some of the descriptions contained elements that could have been classified into more than one category. Pragmatic (e.g. usability or ergonomics related) aspects affecting the user experience were mentioned in almost all of the descriptions. In all, the results showed that pragmatic aspects were the most prominent in the qualitative descriptions, especially for the most unsatisfying experiences.

#### 3.5.1. Expectations

Of the 45 descriptions of the most satisfying user experiences, the user's expectations could be inferred from 25 descriptions. The experiences exceeded the user's expectations in 16 cases and met the user's high expectations in nine cases. The results for the most unsatisfying experiences indicated that expectations could be inferred in 15 cases, in 14 cases the experiences failed to meet the user's expectations and in one case the user experience met already low expectations.

## 4. Discussion

The current quantitative results revealed significant differences in experienced emotions, fulfillment of psychological needs, and contextual factors between the participants' most satisfying and unsatisfying recent user experiences. For the most satisfying

experiences, the users reported higher than moderate levels of positive emotions, and only low levels of negative emotions. For the most unsatisfying experiences, the participants still reported moderate levels of positive emotions and slightly less than moderate levels of negative emotions. These results seem to be in line with the notion that human appetitive and aversive motivation systems (related to positive and negative emotions, respectively) can be relatively distinct and independent of each other (e.g. Lang, 1995). Only in the context of most unsatisfying user experiences, the aversive motivation system is typically activated to produce negative emotions clearly visible in the subjective evaluations. In contrast, it seems that the activation of the appetitive system remained relatively high for both most satisfying and unsatisfying experiences.

The biggest differences between most satisfying and unsatisfying experiences in the ratings of positive emotions were for “enthusiastic”, “proud”, “interested”, and “inspired”, all of which seem to have a connection to motivational factors. Enthusiasm, for example, can be regarded as related to the stimulation dimension of user experience and pride can be regarded as related to the identification dimension using the model by Hassenzahl (2003). In contrast, the biggest differences in the ratings of negative emotions were for “irritable”, “hostile”, and “upset”, which seem to be more direct emotional responses, possibly as a result of pragmatic difficulties, as indicated by the qualitative descriptions. Surprisingly, the participants reported higher levels of excitement in the most unsatisfying than in the most satisfying experiences. It may be possible that the participants associated excitement with physiological arousal, which in turn might again stem from pragmatic problems. Taken together, these results suggest a potential difference in the way the most satisfying and unsatisfying user experiences are formed: the most satisfying user experiences are more often related to personally meaningful aspects of user experiences, e.g. stimulation and identification, while the most unsatisfying user experiences are more often accompanied by more direct emotional responses, typically to pragmatic problems. This was supported by a finding from the evaluation of the psychological needs: fulfillment of self-esteem needs was rated as highly salient in most satisfying experiences, but the participants did not report very much lack of self-esteem in conjunction with the unsatisfying experiences.

Generally, the current results for the fulfillment of psychological needs in the context of most satisfying and unsatisfying user experiences are in line with self-determination theory (Deci and Ryan, 2000), according to which autonomy, competence, and relatedness are the single most important psychological needs. Sheldon et al. (2001) found that the satisfaction of these three needs and self-esteem was consistently most salient in satisfying life experiences and missing from unsatisfying experiences. Hassenzahl et al. (2010) found that relatedness, stimulation, and competence were the most salient needs in positive user experiences, when autonomy and self-esteem were excluded from the analysis. The current results on psychological needs are largely in line with the results by all these authors, as autonomy, competence, and self-esteem (for the most satisfying experiences) emerged as the most salient psychological needs. Thus, the current results suggest that the most important psychological needs underlying general life experiences are also the most important in the context of user experiences. Relatedness was an exception: it did not emerge as a salient need as strongly as in previous research. Social aspects were also mostly missing from the qualitative descriptions – Hassenzahl et al. (2010) also found that the majority of descriptions of positive user experiences were not social. These results suggest that the users conceptualize user experience typically as ‘one-to-one’ interaction with the product or service and special attention may need to be paid to methods for eliciting information on social aspects in

future user experience research. It is possible that the users do not typically conceptualize social experiences, which occur in the context of using a system or a product, as user experiences.

The quantitative results for the context showed some differences for the most satisfying and unsatisfying experiences. The most satisfying experiences were more often related to first-time usage, whereas for the most unsatisfying experiences the participants reported a longer period of usage before the experience. These results as well as the qualitative descriptions highlighted the importance of novelty and surprise effects as well as exceeding the user’s expectations in creating very satisfying user experiences. The results also suggest that most unsatisfying experiences may typically occur in a more hurried context when compared to most satisfying user experiences. In addition, the clear differences in the ratings of technical and usability problems between the most satisfying and most unsatisfying user experiences suggest that the central role of these aspects should not be forgotten, when studying user experience.

One important main focus of the current research was methodological: the aim was to experiment with different methods for understanding the user’s experiences related to the use of products, especially the private aspects related to emotions and the fulfillment of psychological needs. As seen before, the quantitative psychometric methods gave important information about emotions and psychological needs. The findings seemed quite robust and it should also be noted that the vast majority of findings were independent of gender. However, the qualitative descriptions were not as successful in giving information about the hedonic or social aspects of user experiences, when the participants were given a chance to freely describe their experiences. These results suggest that in the context of qualitative research, structured, semi-structured, or mixed-method approaches may need to be employed in order to gain rich qualitative information about the hedonic and social aspects of user experiences.

It should also be noted that the psychometric instruments used in the current study were applied outside the context, in which they were originally developed (psychological research). This experience suggests that well-designed quantitative scales can be very useful in order to gain a systematic understanding of introspective processes related to user experiences, especially in cases, in which extensive qualitative information is difficult to gather. Understanding, for example, the users’ emotions and psychological needs systematically in relation to their user experiences of a particular product can give designers valuable feedback, which is difficult to obtain using other methods. Understanding needs and emotions also contributes to the general understanding of user experiences beyond traditional measures of usability, focusing on the users’ true needs. Such generalized knowledge on user experience can be very beneficial to designers worldwide. Answering psychometric questionnaires developed based on prevailing theories may also develop the reflection skills of the users by giving them conceptual tools.

When the users were provided with frameworks and conceptual tools such as the PANAS framework of emotions in the current study, they could evaluate their experienced emotions in detail. This was evidenced in the current study by the significant variations in the quantitative ratings of experienced emotions. Some researchers such as Wilson and Dunn (2004) hold that a large proportion of mental processes, related to, for example, goal-setting and decision-making, are inaccessible to self-reflection. In the current research, however, the participants were able to reflect on psychological needs and emotions, when they were provided with structured frameworks and conceptual tools for that purpose. Similarly, frameworks based on psychological research could guide qualitative reflection on personal user experiences in a structured manner.

However, a possible limitation lies in the accuracy with which it was possible for the participants to recall the experiences evaluated

in this study. Arrangements were made to ensure that the participants would be able to remember the reported experiences with a satisfactory accuracy. A time window of past 6 months was used in order to guide the participants to report relatively recent user experiences, which they can be assumed to still remember in detail. It was also assumed that the objects of evaluation – the most satisfying and unsatisfying experiences – can be quite memorable, and they can probably be recalled better than, for example, average everyday user experiences. The majority of the qualitative descriptions were quite detailed, which supported the view that the participants indeed remembered the reported experiences well. However, the current results could have been affected by the recency effect, which means that it is possible that the participants reported the first satisfying and unsatisfying experiences they could recall (typically the most recent ones) instead of going through all the experiences from the 6 months period and choosing the most satisfying and the most unsatisfying of those experiences.

When making inferences based on the current results, one should also acknowledge that the current participants were undergraduate and graduate university students. This is a limitation in the generalisability of the results to the wider population, which typically has less education and familiarity with user experience related issues. The current pool of participants with more or less background in human–computer interaction might also have been more sensitive to or reflective about the pragmatic and usability issues than the hedonic aspects. On the other hand, it is reasonable to believe the current sample understood the different scales and assignments well and were also sensitive to the scales used in the current study, which might have enhanced the internal validity of the results. The experiences described were unique for each participant and the anonymity of the participants was protected, which gives reason to believe that a valid enough data set could be obtained using the current methods.

In all, the current results suggest that variations in the emotional and need-related aspects of user experiences can be effectively measured using psychometric methods readily available in literature. Applying those methods in a basic research setting already gave a more detailed understanding of how emotions and psychological needs might be typically related to their most satisfying and unsatisfying experiences. These kinds of measurements can give important insight into the users' reflective processes related to their user experiences. However, quantitative measurements alone are not very informative for designers on how a particular system or product could be improved. In line with this, the current qualitative results highlight the need for further developing systematic methods for qualitative reflections on personal experiences. The results suggest that new methods are needed especially for eliciting qualitative information on hedonic and social aspects.

### Acknowledgements

The authors would like to thank the participants of the current study for participation and the reviewers for their thoughtful comments. This research was supported by Tampere University of Technology.

### Appendix A. The statements for studying the satisfaction of psychological needs

The statements for studying the satisfaction of psychological needs are presented in the table below. The beginnings of the statements are presented in the first row of the table. The endings of the statements are originally from Sheldon et al. (2001). The labels of the psychological needs (on the right) were not presented to the participants.

“During this user experience I felt ...” (most satisfying user experiences)	
“During this user experience I did NOT feel ...” (most unsatisfying user experiences)	
“... that my choices were based on my true interests and values” “... free to do things my own way” “... that my choices expressed my “true self””	Autonomy
“... that I was successfully completing difficult tasks and projects” “... that I was taking on and mastering hard challenges” “... very capable in what I did”	Competence
“... a sense of contact with people who care for me, and whom I care for” “... close and connected with other people who are important to me” “... a strong sense of intimacy with the people I spent time with”	Relatedness
“... that I was “becoming who I really am”” “... a sense of deeper purpose in life” “... a deeper understanding of myself and my place in the universe”	Self-actualization-meaning
“... that I got enough exercise and was in excellent physical condition” “... that my body was getting just what it needed” “... a strong sense of physical well-being”	Physical thriving
“... that I was experiencing new sensations and activities” “... intense physical pleasure and enjoyment” “... that I had found new sources and types of stimulation for myself”	Pleasure-stimulation
“... able to buy most of the things I want” “... that I had nice things and possessions” “... that I got plenty of money”	Money-luxury
“... that my life was structured and predictable” “... glad that I have a comfortable set of routines and habits” “... safe from threats and uncertainties”	Security
“... that I had many positive qualities” “... quite satisfied with who I am” “... a strong sense of self-respect”	Self-esteem
“... that I was a person whose advice others seek out and follow” “... that I strongly influenced others' beliefs and behavior” “... that I had strong impact on what other people did”	Popularity-influence

### Appendix B. Definitions of psychological needs

Definitions of the 10 psychological needs as in Sheldon et al. (2001):



1. *Autonomy-independence*: Feeling like you are the cause of your own actions rather than feeling that external forces or pressures are the cause of your actions.
2. *Competence-effectance*: Feeling that you are very capable and effective in your actions rather than feeling incompetent or ineffective.
3. *Relatedness-belongingness*: Feeling that you have regular intimate contact with people who care about you rather than feeling lonely and uncared for.
4. *Self-actualization-meaning*: Feeling that you are developing your best potentials and making life meaningful rather than feeling stagnant and that life does not have much meaning.
5. *Security-control*: Feeling safe and in control of your life rather than feeling uncertain and threatened by your circumstances.
6. *Money-luxury*: Feeling that you have plenty of money to buy most of what you want rather than feeling like a poor person who has no nice possessions.
7. *Influence-popularity*: Feeling that you are liked, respected, and have influence over others rather than feeling like a person whose advice or opinions nobody is interested in.
8. *Physical-bodily*: Feeling that your body is healthy and well-taken care of rather than feeling out of shape or unhealthy.
9. *Self-esteem-self-respect*: Feeling that you are a worthy person who is as good as anyone else rather than feeling like a “loser.”
10. *Pleasure-stimulation*: Feeling that you get plenty of enjoyment and pleasure rather than feeling bored and understimulated by life.

**Appendix C. Excerpts from the descriptions for the most satisfying and unsatisfying user experiences (descriptions2–6 translated from Finnish).**

Category	Description
Pragmatic, most satisfying experience	“(…) Well anyway, my choice is an external GPS device that communicates with mobile phones with Bluetooth. It makes it possible to view and log your location also with older mobile devices that do not have an internal GPS module. The first experiences with it were very nice: it was very accurate, easy to pair with my mobile phone, its status was easy to understand, and, what’s most important, it made my hobby of geocaching more active because now I could use my mobile phone in geocaching instead of my old car navigator. Now I can do it anytime and without any pre-planning of the routes or trips as I can download the cache details with a mobile (with the car navigator I couldn’t). All in all, the first experiences with the device were great, and they still are, but I guess they have now become more mundane and I

**Appendix C (continued)**

Category	Description
Pragmatic, most unsatisfying experience	have got used to it” “The children were playing the new (…) game. They went out with grandma and my task was to save their game. I would have had more important things to do, but I decided to do it. There were no problems using the console, when you found how to move to avatar. But I did not know anything about the game and wondered where I would find the save option. I did not find anything about saving even in the manual, except that if it is asked it is useful to reply: save automatically. Nothing about where you could save the game or how. I wandered there for some time and after breaking some objects – which for some odd reason gave me money – I was lost somewhere, where a text ‘saving game’ was appeared on the screen. I answered ‘ok’, when it asked whether the game should be saved automatically in the future. Then I just quit the game. What is the status and should I go to that one room or does it now save the situation continuously was left hanging in the air”
Hedonic (stimulation), most satisfying experience	“One of my good user experiences is related to the music streaming service Spotify, which I started to use about half a year ago. (…) When I first used the service, I especially liked the feeling, when I thought of a song and I could find it in a minute. After the usage, I was left with a feeling that all the music in the world is within my reach and I can listen to it. The service provided me with really much, and it did not even cost me anything, because it was based on advertising money. There was also a great feeling of novelty involved, as I had not used anything like that before”
Hedonic (stimulation), most unsatisfying experience	“A while ago I installed an application for watching HD videos, and we watched a video we shot with friends. (…) The software looked really ugly, traditional gray and clumsy icons. A typical ‘cheap’ user interface, which carries out its functionality, but is little else. Whenever you played a video file, a pop-up note complained that the video cannot be shown, but still it was playing in the background normally. Ugly, but works”

(continued on next page)

**Appendix C** (continued)

Category	Description
Hedonic (identification), most satisfying Experience	“I got a new laptop to replace the work computer (IBM), which had served me for as long as 6 years. I had secretly dreamed of a MacBook. On the list of available laptops, there was also the MacBookPro, which I also chose – with mixed feelings. On one hand wanted to belong to group of the stylish, urban, and happy MacPeople. On the other hand I did not want to be regarded as a snob looking for finesses. On the scale of social pressure, the happy MacPeople weighed more. (...) WOW! MacPeople are happy”
Hedonic (identification), most unsatisfying experience	“(…) I was sitting at our clubhouse and my aim was to edit a document with my friend. I booted my computer, which takes a long time on my 2.5 years old laptop. This time the computer took an even longer time to boot than normally. It took about 20 min before the document was loaded and it could be edited. My friends and other people around me were laughing at the slowness of my computer and they were asking if I am going to buy a new computer soon. I am already used to the behavior of my computer and have almost forgotten the times when my computer booted in a reasonable time. In this case, there was a reasonable hurry, so I managed to develop a reasonably sized negative emotional stance towards my computer during those 20 min”

**References**

- Agarwal, A., Meyer, A., 2009. Beyond usability: evaluating emotional response as an integral part of the user experience. In: *Proceedings of Human Factors in Computing Systems, CHI '09*, ACM, New York, NY, pp. 2919–2930.
- Boehner, K., DePaula, R., Dourish, P., Sengers, P., 2005. Affect: from Information to Interaction. In: *Proceedings of the 4th Decennial Conference on Critical Computing, CC'05*, ACM, New York, NY, pp. 59–68.

- Crawford, J.R., Henry, J.D., 2004. The Positive and Negative Affect Schedule (PANAS): Construct validity, measurement properties and normative data in a large non-clinical sample. *British Journal of Clinical Psychology* 43, 245–265.
- Deci, E.L., Ryan, R.M., 2000. The “what” and “why” of goal pursuits: human needs and the self-determination of behavior. *Psychological Inquiry* 11 (4), 227–268.
- Finstad, K., 2010. Response interpolation and scale sensitivity: evidence against 5-point scales. *Journal of Usability Studies* 5 (3), 104–110.
- Hassenzahl, M., 2003. The thing and I: understanding the relationship between user and product. In: Blythe, M., Overbeeke, C., Monk, A.F., Wright, P.C. (Eds.), *Funology: From Usability to Enjoyment*, pp. 31–42.
- Hassenzahl, M., 2008. User experience (ux): towards an experiential perspective on product quality. In: *Proceedings of IHM'08: Proceedings of the 20th International Conference of the Association Francophone d'Interaction Homme-Machine*. ACM, New York, NY, pp. 11–15.
- Hassenzahl, M., Tractinsky, N., 2006. User experience – a research agenda. *Behavior & Information Technology* 25 (2), 91–97.
- Hassenzahl, M., Platz, A., Burmester, M., Lehner, K., 2000. Hedonic and ergonomic quality aspects determine a software's appeal. In: *Proceedings of the CHI 2000 Conference on Human Factors in Computing*. ACM Press, New York, NY, pp. 201–208.
- Hassenzahl, M., Diefenbach, S., Göritz, A., 2010. Needs, affect, and interactive products – facets of user experience. *Interacting with Computers* 22 (5), 353–362.
- Hazlett, R.L., Benedek, J., 2007. Measuring emotional valence to understand the user's experience of software. *International Journal of Human-Computer Studies* 65 (4), 306–314.
- Hornbæk, K., 2006. Current practice in measuring usability: challenges to usability studies and research. *International Journal of Human-Computer Studies* 64 (2), 79–102.
- Isen, A.M., 2006. Positive affect and decision making. In: *Handbook of Emotions*. Guilford Press, New York, NY, pp. 417–435.
- Jumisko-Pyykkö, S., Vainio, T., 2010. Framing the context of use for mobile HCI. *International Journal of Mobile Human-Computer Interaction* 2 (4), 1–28.
- Lang, P.J., 1995. The emotion probe. *Studies of motivation and attention*. The American Psychologist 50 (5), 372–385.
- Law, E.L., Roto, V., Hassenzahl, M., Vermeeren, A.P., Kort, J., 2009. Understanding, scoping and defining user experience: a survey approach. In: *Proceedings of CHI '09*. ACM, New York, NY, pp. 719–728.
- Maslow, A., 1943. A theory of human motivation. *Psychological Review* 50, 370–396.
- Nardi, B. (Ed.), 1995. *Context and Consciousness: Activity Theory and Human-Computer Interaction*. MIT Press, Cambridge, MA.
- Partala, T., Kangaskorte, R., 2009. The combined walkthrough: measuring behavioral, affective, and cognitive information in usability testing. *Journal of Usability Studies* 5 (1), 21–33.
- Partala, T., Surakka, V., 2003. Pupil size variation as an indication of affective processing. *International Journal of Human-Computer Studies* 59 (1-2), 185–198.
- Partala, T., Surakka, V., 2004. The effects of affective interventions in human-computer interaction. *Interacting with Computers* 16 (2), 295–309.
- Partala, T., Surakka, V., Vanhala, T., 2006. Real-time estimation of emotional experiences from facial expressions. *Interacting with Computers* 18 (2), 208–226.
- Picard, R.W., 1997. *Affective Computing*. MIT Press.
- Reis, H.T., Sheldon, K.M., Gable, S.L., Roscoe, R., Ryan, R., 2000. Daily well being: the role of autonomy, competence, and relatedness. *Personality and Social Psychology Bulletin* 26, 419–435.
- Ryan, R.M., Deci, E.L., 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist* 55, 68–78.
- Sheldon, K.M., Elliot, A.J., Kim, Y., Kasser, T., 2001. What is satisfying about satisfying events? Testing 10 candidate psychological needs. *Journal of Personality and Social Psychology* 80, 325–339.
- Suchman, L., 1987. *Plans and Situated Actions: The Problem of Human-Machine Communication*. Cambridge University Press, New York, NY.
- Watson, D., Tellegen, A., Clark, L., 1988. Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of Personality and Social Psychology* 54, 1063–1070.
- Wilson, T.D., Dunn, E.W., 2004. Self-knowledge: its limits, value, and potential for improvement. *Annual Review of Psychology* 55, 493–518.