The Effects of Background Music on Using a Pocket Computer in a Cafeteria: Immersion, Emotional Responses, and Social Richness of Medium

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Abstract
The focus of the present paper was to examine the effects of background music on using a pocket computer (i.e., reading entertainment news and making notes) in a noisy cafeteria environment. Music listening, as compared to using PDA without listening to music, prompted higher overall user satisfaction and immersion in media use, less boredom and more pleasure, and higher perceived social richness of the medium in terms of personality, liveliness, and emotionality. It was also found that PDA user experience and personality (i.e., impulsive-sensation seeking [ImpSS]) moderated some of these responses. The results are of importance given that the modern technology make it possible (1) to use computers in various everyday environments (e.g., in cafeterias and on business trips), and (2) to adapt the information and/or interfaces to fit the individual characteristics of the user.

Categories & Subject Descriptors: H.5.1. [**Information interfaces and presentation**]: Multimedia Information Systems – *Evaluation/methodology*.

General terms: Experimentation, Human Factors, Measurement, Performance.

Keywords: Pocket Computer, PDA, Background Music, Reading, Immersion, Emotion, Social Richness of Medium.

INTRODUCTION
The number of portable devices has expanded in the past few decades (e.g., mp3 players, mobile phones and pocket computers). They have made it possible to do work and enjoy entertainment regardless of location, for example in cafeterias, public places and on business trips. In such situations, the user is typically more exposed to the background noise and other attention grabbing sounds (e.g., moving people) than when using a PC in an office. However, there is a lack of research on human interaction with computers, especially in connection with pocket computers, in ecologically valid realistic settings. There is also a scarcity of studies on subjective measures and individual differences, such as "presence", and emotional responses to pocket computer use. And yet, subjective responses are of interest given that the uses of computers have spread more and more widely from work related tasks (e.g., word processing and spreadsheet computation) to entertainment (e.g., listening to music and playing games).

There are a growing number of studies on presence in human-computer interaction. However, there appears to be a considerable controversy as to the definition of presence. From one perspective (i.e., subjective presence) presence is psychological immersion, which refers to the degree of involvement and attention. From another perspective (i.e., social presence), it includes the medium as social actor (e.g., treating computers as social entities, and the social richness of the medium (the "warmth" or "intimacy" possible via a medium, see e.g., [6]). Objects that isolate the subjects from the outside world more efficiently should increase the feeling of presence and involvement [10]. Therefore, using a pocket computer in a distracting environment while listening to music with earphones might create a greater immersion experience than using it without music listening. In regard to social richness of the medium, music may enrich it because it increases one meaningful information channel (i.e., music instead of background noise).

In addition to social purposes, one of the main reasons for using music for entertainment and commercial purposes is its emotional value. However, in general, the results of the research on background music are not well established: some studies suggest a disturbance to message processing [1], while others have found facilitating effects [7]. Nevertheless, in connection with emotions, music has been shown to increase relaxation and positive mood (see e.g., [9]). Music may also moderate the responses on stimuli it is attached to (e.g., news messages). For example, Kallinen and Ravaja [3] found, that rising background melodies prompted higher levels of pleasure and arousal for news messages than falling background melodies. Given that most of people find music as pleasurable and listen to it at least occasionally, it could be expected that background music would increase positive emotional responses (e.g., pleasure) on pocket computer use.

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In addition to music listening, there may also be important individual differences (i.e., moderator variables such as PDA user experience and personality), which affect the nature of the user experience. It has been found, for example, that extroverts and high sensation seekers show a tendency to stimulation seeking in order to raise their arousal to hedonic optimal levels [11].

AIMS

The focus of the present study was to examine the effects of background music on immersion, emotional responses, perceived social richness of medium, and overall user satisfaction when using a pocket computer in a cafeteria environment. It was expected that listening to background music as compared to no music would (hypothesis 1) increase immersion (i.e., decrease distractions to attention and increase user time), increase positive (e.g., pleasure) or decrease negative (e.g., boredom) emotional responses (hypothesis 2), increase (hypothesis 3) perceived social richness of the medium (e.g., personality, liveliness, and immediacy), and (hypothesis 4) improve overall user satisfaction. These hypotheses were based on the aforementioned discussion about subjective and social presence [6,10], and emotionality in music [9,3].

In addition it was investigated whether background factors such as PDA user experience and ImpSS personality trait moderated the responses. It was expected that PDA user experience would not moderate the effects (hypothesis 5), given that most of the subjects were familiar with computers in general (i.e., PCs). In regard to ImpSS, it was expected that especially high ImpSS scorers would prefer music-condition because of more stimulation than without music (hypothesis 6).

METHODS

Subjects

Thirty subjects with varying educational backgrounds participated in the study in return for a movie ticket. They were 15 Finnish males and 15 females ranging from 17 to 47 years of age ($\underline{M}$ = 25.2).

Materials

News stories

The reading task consisted of two news stories; the subject selected from two news story groups containing 6 stories each. Stories for the two groups were selected from an archive of Iltalehti Online from the Internet [2] on a basis of similar content (e.g., sport or health issues) and length. To minimize topic effects associated with particular news stories, the two news groups were combined both with and without music. Thus, there were 4 possible stimuli orders: A) group 1 with music and group 2 without music, B) group 1 without music and group 2 with music, C) group 2 with music and group 1 without music, and D) group 2 without music and group 1 with music. The news stories were presented as a web news service (similar to the Iltalehti on-line news sercvice) on a Casio Cassiopeia Pocket PC using Internet explorer browser.

Music

Alternatives for background music consisted of 50 music pieces differing in terms of genre (i.e., pop, rock/heavy, techno/dance, classical, jazz, blues, and traditional Finnish dance music). Because of the insufficient memory capacity in the present pocket PCs the music was recorded on and played from minidisks in Mp3 format.

Measures

Background factors, ImpSS, music volume and background noise level

Background factors such as age, gender, and PDA user experience were assessed with a questionnaire. The ImpSS scale from the Zuckerman-Kuhlman Personality Questionnaire was used to assess the participants' impulsivity and sensation seeking [12]. The ImpSS scale consists of 19 items (e.g., "I tend to begin a new job without much advance planning on how I will do it"), and can be divided into two subscales: (a) the impulsivity (Imp) dimension describes a lack of planning and a tendency to act impulsively and (b) the sensation seeking (SS) dimension describes a general need for thrills and excitement.

Subjects adjusted the music volume by a scale from 1 to 11 (equal to the steps in the Windows media players volume adjusting slide). Background noise was measured by Az 8928 digital sound level meter's record function, Fast SPL, weightening A.

Immersion

Immersion was assessed by the time the user spent with the pocket PC (given that user was informed that the experiment was not a speed or a performance test), and a self-reported measure of distractions to attention (i.e., "how often were you distracted by things happening around you during your use of the pocket computer?"). Subjects evaluated their frequency of distractions to attention using a 7-point scale (from "not at all" to "frequently").

Emotional responses

Participants rated their emotional mood instantly after both task sessions using adjectives that were chosen from the emotion-circumplex model of emotion [4]. The affect terms were: alert, energetic, happy, calm, sleepy, bored, dissatisfied, and irritated (there were one affect term for each end of each dimensions of emotion-circumplex model). The mood measure required subjects to indicate their mood while they were using the computer. Each of the items was rated on a 5-point scale, ranging from 1 (not at all) to 5 (very much).

Social richness of medium

Perceived media richness was assessed by seven bi-polar scales that were adopted from the Lombard's Television Questionnaire [5]. The scales were: impersonal-personal, unsociable-sociable, insensitive-sensitive, dead-lively, unresponsive-responsive, unemotional-emotional, and remote-immediate. Subjects were asked to evaluate the impression the pocket computer use (including "the news service") gave as a whole. Each of the items was rated on a 5-point scale, ranging from 1 (e.g., impersonal, dead) to 5 (e.g., personal, lively).

Overall user satisfaction

Participants evaluated their overall user satisfaction ("Overall how satisfied were you using the pocket computer") using a 5-point scale ranging from 1 (not at all satisfied) to 5 (very satisfied).

Procedure

An experiment with one within-subjects factor (with background music, without background music) was conducted in a cafeteria in Helsinki during the lunch hours. Subjects were randomly assigned to one of the four stimuli orders. Subjects read two stories, one without music and one with music the subject chose, and wrote a brief description of the content of both stories. Subjects were explained that the experiment was not a performance test, and they were instructed to read at their normal reading speed, as if reading a newspaper.

After each story, subjects completed the response form, regarding the emotional and other responses. After the whole experiment subject filled out the questionnaires concerning background factors and ImpSS.

The Pocket PC was held in hand and used with a stylus (pen). Music was listened to with earphones with a volume level adjusted by the subject. The experiment took about 15 to 20 minutes per subject.

Data-analysis

All data were analysed by the General Linear Model (GLM) Repeated Measures procedure in SPSS, with condition (music, no-music) as within-subject factor, continuous independent variables (e.g., age, PDA user experience), each in turn, as a covariate, and gender as a categorical independent variable.

RESULTS

Because of the number of analyses, a potential margin of error exists in obtaining statistical significant results by chance. To minimize this potential error in results, only the main effects at level $p < .05$ and two-way interactions at level $p < .01$ or higher are presented and discussed.

Immersion

The GLM Repeated Measures analysis revealed a significant main effect for condition in predicting frequency of distractions to attention, $F(1,29) = 7.90$, $p < .01$. Attention was distracted more frequently by things happening around in the no-music condition than in the music-condition (Ms = 2.20 and 1.63).

A significant main effect for condition in predicting the time users spent with the computer was also found, $F(1,29) = 4.65$, $p < .05$. The user time was longer in the music-condition than in the no-music condition (Ms = 356 and 330 seconds).

Emotional responses

GLM Repeated Measures analysis revealed a significant main effect for condition in predicting levels of pleasure, $F(1,29) = 10.55$, $p < .01$, and boredom ratings, $F(1,29) = 6.17$, $p < .05$. The music-condition elicited more pleasure and less boredom than the no-music condition (for pleasure, Ms = 2.67 and 2.13; for boredom, Ms = 1.40 and 1.77).

In addition, a significant Condition x Impulsivity interaction in predicting alertness, $F(1,28) = 8.01$, $p < .01$, and a Condition x ImpSS interaction in predicting calmness, $F(1,28) = 10.49$, $p < .01$, was found. Low impulsivity scorers were more alert in the music-condition than in the no-music condition (Ms = 3.56 and 3.06), whereas high impulsivity scorers were more alert in the no-music than in the music-condition (Ms = 3.58 and 2.50). Low ImpSS scorers were calmer in the no-music condition than in the music-condition (Ms = 3.06 and 2.61), whereas the opposite was true for high ImpSS scorers (Ms = 2.33 and 3.17).

Social richness of medium

The analysis revealed a significant main effect for condition in predicting perceived personality, $F(1,29) = 16.21$, $p < .001$, liveliness, $F(1,29) = 10.59$, $p < .01$, and emotionality, $F(1,29) = 40.64$, $p < .001$. The music-condition elicited higher ratings for personality, liveliness, and emotionality than the no-music condition (for personality, Ms = 3.77 and 3.07; for liveliness, Ms = 3.87 and 3.23; for emotionality, Ms = 3.67 and 2.53).

Overall satisfaction judgments

In predicting the overall satisfaction ratings, a significant main effect for condition was found, $F(1,29) = 4.77$, $p < .05$. Overall satisfaction was higher in the music-condition than in the no-music condition (Ms = 3.87 and 3.47).

In addition, a significant Condition x PDA user experience interaction in predicting overall satisfaction was found, $F(1,28) = 9.87$, $p < .01$. The music-condition prompted higher overall satisfaction than the no-music condition among subjects with less pocket computer user experience (Ms = 3.96 and 3.26), whereas the opposite was true for subjects with more pocket computer user experience (Ms = 3.57 and 4.14).

CONCLUSIONS

As expected (hypothesis 1), background music listening elicited a more immersed user experience (in terms of less distractions to attention and longer user time) than using PDA without listening to music. As also expected, music increased positive (i.e., pleasure) and decreased negative (i.e., boredom) emotional responses (hypothesis 2). Music also increased perceived social richness of the medium (i.e., personality, liveliness, and emotionality; hypothesis 3), and improved overall user satisfaction (hypothesis 4). Thus the results support previous research suggesting that objects that isolate the subjects from the outside world more efficiently should increase immersion, and that background music may increase positive emotional responses and perceived social richness of the stimuli or a medium to which it is attached [10,9,3]. However, given that the present study involved a reading task and plain browsing without a specific information search, the background music could have differential effects in connection with other kinds of tasks.

It was also found that the results were moderated by PDA user experience and ImpSS personality traits, whereas age, gender, music volume, and background noise level had no effects. Music elicited higher overall satisfaction among subjects with less pocket PC user experience, whereas subjects with more user experience were more satisfied with the no-music condition. Thus hypothesis 5, which stated that previous PDA user experience would not make a difference in judgments, was partially not supported. Subjects more familiar to PDAs may have been more conservative in their expectations of a typical user situation, given that at present text-based tasks (e.g., calendar scheduling and web browsing) are more common in pocket PCs than audio.

In contrast with hypothesis 6 there were no differences in positive or negative responses between high and low ImpSS scorers. However, music seems to have aroused low Imp and ImpSS scorers but relaxed high Imp and ImpSS scorers. Low Imp scorers were more alert in the music-condition than in the no-music condition, and low ImpSS scorers were calmer in the no-music condition than in the music-condition, whereas high Imp scorers were more alert in the no-music condition than in the music-condition and high ImpSS scorers were calmer in the music-condition than in the no-music condition. Given that high ImpSS (and presumable high Imp) scorers seek for more sensations and stimuli than low ImpSS scorers, they may have paid more attention to the surround in the no-music condition than in the music-condition, because in the no-music condition, many possible sound stimuli exists in the surroundings instead of only one: the music. In regard to low Imp and ImpSS scorers it may have been easier for them than high Imp and ImpSS scorers to ignore the background noise. However, these ideas need to be further examined.

As a sum, the present results are of practical importance, given the possibilities afforded by modern technology to present multimodal information effectively and adapt the information and/or interfaces to fit the individual characteristics of the user (e.g., PDA user experience or personality, see [8]) and/or the context of using a PDA (e.g., cafeteria). Thus, knowledge of the user environments and relationships between multimedia characteristics and individual differences can be used to support the listeners' information processing, learning, and enjoyment. This kind of information should be taken into account when future news services and multimedia-based interfaces are designed. However, more research should be done to investigate the different kinds of user environments (e.g., pubic transportation vehicles, offices), and tasks (e.g., information search), as well as individual differences in responses to media use.

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