Sharing places: Testing psychological effects of location cueing frequency and explicit vs. inferred closeness

Janny C. Stapel
Human-Technology Interaction group
P.O. Box 513, 5600 MB Eindhoven
The Netherlands
+31 40 247 3163
j.c.stapel@tue.nl

Yvonne A. W. de Kort
Human-Technology Interaction group
P.O. Box 513, 5600 MB Eindhoven
The Netherlands
+31 40 247 3163
y.a.w.d.kort@tue.nl

Wijnand A. IJsselsteijn
Human-Technology Interaction group
P.O. Box 513, 5600 MB Eindhoven
The Netherlands
+31 40 247 3163
w.a.ijsselsteijn@tue.nl

ABSTRACT
Recent ethnomethodological work in context and location awareness has indicated that location cues hold many socially meaningful cues for interaction. Location-aware technologies are therefore expected to bring about a shift in social life. Yet little is known about underlying psychological effects and the role of specific design decisions. The present research aims to experimentally test some of these effects. In a laboratory experiment participants' location in a virtual game world was shared. The effects of location Cueing frequency and Cueing mode (explicit or inferred closeness) on affinity, social presence, awareness, and game experience were explored. Higher cue frequencies resulted in higher perceived challenge and flow experienced in the game. The data also showed trends of heightened awareness and more behavioural engagement. A trend towards more psychological involvement was found when cues explicitly communicated that players shared a location in the game.

Categories and Subject Descriptors
K.4.2 [**Computers and Society**]: Social issues; K.9. [**Personal Computing**]: Games. J.4 Social and Behavioral Sciences - Psychology

General Terms
Measurement, Experimentation.

Keywords
social digital media, location-aware technologies, affinity, social presence, interpersonal attraction.

1. INTRODUCTION
Tracking and tracing people's physical location has become easier the last few years. GPS, WiFi, RFID, Bluetooth, and Cell-ID are just some options to discover the location of an apparatus and its owner. This information can be used individually, e.g., for navigation or targeted information retrieval. It can also be shared collectively, providing opportunities to inform or enrich social interactions. Location-awareness offers many social uses and affordances: location turns physical spaces into meaningful places, it triggers and enriches social interaction, structures and organises it, and is even part of social interaction [11]. Jones and Grandhi for instance suggest that we can use location-aware applications to coordinate meetings with friends and family, to strengthen ties with acquaintances, and to meet new people [10]. Indeed, recent ethnomethodological work in context and location awareness has indicated that from location cues individuals infer situations, actions and intentions, and that they use them as tools for coordination, as medium for expression, and as proxy for companionship [16].

Yet location aware applications also potentially introduce negative effects in terms of threats to privacy and security [6]. This makes design decisions in application development critical for their future adoption and use. For instance, is it better to share absolute locations between users, interpersonal distances (giving less information about exact location), or to merely cue proximity? The information value of each of these options is different, as are potential threats to privacy. Such decisions should be informed by a thorough understanding of underlying psychological principles. The present research aims to experimentally establish some of the psychological effects that specific information elements in location-aware applications could have. In studying these effects in isolation, we aim to attribute them to specific underlying psychological mechanisms.

Apart from the information value of the specific type of location a person is in (e.g., she's on the university campus, ergo probably working, ergo not available for a sociable chat), distance between people is also a meaningful construct. This is the focus of the present study. Below we will discuss briefly several perspectives on being close in physical space: proximity, similarity and social presence.

1.1 Perspectives on interpersonal distance
The first, most direct perspective on interpersonal distance is proximity. Being close to people in physical space has effects on how we perceive others and how we behave. For instance, studies on environmental psychology, proxemics and social group ecology have indicated that proximity of dwellings predicts friendship [17], that individuals in crowds are known to display group behaviour, and personal tendencies are suppressed in these

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situations [5], that the interpersonal distance two individuals keep tells something about their relationship (e.g., [1, 2]), and that people can generally guess who is the leader in a group, based on their relative position in space [13]. Interpersonal distance is thus meaningful on several scales and is related to familiarity, affinity, and interaction.

Physical proximity often also implies that two people have something in common: they share a common area, and are perhaps even engaged in the same activity, as location often tells something about the activity one is performing [16]. A large body of research on interpersonal attraction supports the notion that having something in common with another leads to liking each other, irrespective of what exactly is shared (e.g., attitudes, personality characteristics, and behaviour) [4]. Proximity cues may thus implicitly trigger similarity. Our hypothesis is that becoming aware that you are often at a similar location induces affinity. This could hold true in virtual reality as well as in mixed-reality situations. The current study is situated in virtual reality, but with specifically the goal in mind to apply it in real world situations later.

A third perspective on interpersonal distance is related to the constructs of awareness and social presence (i.e., 'the sense of being with another' [3]). The closer people get, the more aware they are of each other's presence. Even in mediated communication, such as a phone call or meeting each other in Second Life, one can – to some extent – have the feeling of being together with the other. However, in mediated communication, it is not physical distance that matters. Rather, it is the quality and range of the channels for communication, or, in offline communication, perhaps the number of cues and messages from the other.

In the present study, we decided to keep actual distance between people constant, and to only test the influence of application characteristics. Our hypothesis was that frequent location cueing would induce higher feelings of social presence and related constructs. In addition, we expected that making similarity of location explicit instead of implicitly inferred would result in stronger psychological effects.

2. METHOD

2.1 Experimental design

Participants were led to believe that they were playing a digital adventure game with someone who in another room. They received location cues based on this person's location in the virtual game world. Cueing Frequency and Mode were manipulated according to a 2 (frequent vs. infrequent) by 2 (implicit vs. explicit) between groups design, exploring their effects on measures of player experience, affinity, awareness and social presence.

2.2 Participants

Eighty people participated in this study; 26.3% (21) of them were female. Their mean age was 24.7 (SD = 8.5 years). Participants were distributed evenly and randomly over the four experimental conditions. Participants were recruited both face-to-face and via e-mail.

2.3 Materials

Participants played "The Legend of Zelda" on the Nintendo Wii. The setting of an adventure game was chosen for several reasons. First, a game is a controlled environment compared to the outside world, which is very useful for research purposes. Second, this game presents a virtual world players could explore freely and for which location did not imply progress in the game.

The experiment took place in the living room of the Game Experience Lab, which is furnished to give it the look and feel of a regular living room. Participants were seated on a couch. The game was played on a large screen (Philips 42PFL9632D 42 inch Full HD LCDE TV).

While playing the game, a map of the game world was displayed on the screen with a yellow arrow indicating their own location. Players also received a paper version of this map, on which the names of two equally sized zones were indicated, and an explanation of the meaning of the lamps (see below).

2.4 Manipulations

Two coloured lamps (blue and yellow), placed left and right of the screen, were directed towards the wall to create an ambient lighting effect. These were used for cueing the location of the bogus co-player. The cues were given via a Wizard-of-Oz methodology. The experimenter watched in the control room on a second screen the video images of the game the participant was playing. Based on this video information the experimenter selected and operated the coloured lights at planned intervals. In all conditions, high similarity was induced: 80% of the cues implied that the other was in the same area of the game world.

Cueing frequency: In the high frequency condition, participants received a cue (coloured light signal) every 30 seconds, whereas in the low frequency condition, the light only flashed once every 180 seconds.

Cueing mode: In the implicit cueing mode, the lamps signalled absolute location of the other, e.g., the blue lamp meant the other was in area A of the game, and the yellow light meant the other was in area B. Participants could infer from this information whether they where at a similar or different spot. In the explicit cueing mode condition, the lamps signalled the relative location of the other, e.g., the blue lamp would signal that the players were in the same area of the game, and the yellow light would signal that the players were in a different area.

2.5 Measures

Awareness: Three items were adopted from Harms and Biocca [8] to measure the awareness of the other player. Internal consistency of the awareness scale was .82.

Social presence in Gaming (SPGQ): To measure social presence, two scales from the Social Presence in Gaming module of the GEQ [12] were employed, consisting of the factors psychological involvement and behavioural engagement. Internal consistency of these scales was .77 and .71 respectively.

Game Experience Questionnaire (GEQ): The core module of the GEQ [9] was administered to probe players' experience of the game. This module consists of seven factors, being: (1) Imaginative and sensory immersion, (2) Competence, (3), Flow, (4) Frustration, (5) Positive affect, (6), Negative affect, (7)

Challenge. All internal consistencies were high (Cronbach's alpha between .77 an .87, except for the Negative affect scale which had a moderate reliability (alpha = .53).

Affinity: The affinity construct consists of three interconnected elements: interpersonal attraction, familiarity, and (perceived) similarity. The scales were largely taken from a study of Moreland and Beach [15]. The familiarity component could not be used in this study. Interpersonal attraction was measured in several ways. Three items of McCroskey and McCain [13] were used. Furthermore, two types of measures used by Moreland and Beach were included, namely trait measures and percentage estimations. For the trait measures, participants had to judge on a 5-point Likert-type scale whether they expected the other person to possess a specific trait (traits used: interesting, attractive, and kind). The percentage estimations were framed to see to what extent participants expected that the other e.g., could become a friend, or it would be enjoyable to spend time with. Internal consistency of the interpersonal attraction measure was .75. Perceived similarity was also measured by percentage estimations: it read "Imagine meeting and getting to know this person who is playing this computer game with you. Estimate on a scale of 0 to 100% that..." and then 5 items followed, e.g., "...s/he would turn out to come from the same social background as yourself." Three statements were also used by Moreland and Beach [15]. Internal consistency of the perceived similarity scale was .80.

2.6 Procedure

Participants were briefly introduced to the experiment and signed an informed consent. Instructions on how to use the Wii, what could be done in the game, and the meaning of the lights were given on a laptop. Instructions about the game were clarified with a 2 minute movie. After reading the instructions, participants would be seated on the couch and started playing Zelda for 15 minutes. During this period, the main lights in the room were dimmed to make the light signals more pronounced. When the 15 minutes were over, the experimenter stepped back into the room and turned off the game. The participants then filled out the questionnaires on the laptop in the following order: awareness, affinity, social presence, and lastly the GEQ. Participants received four euros for their participation.

3. RESULTS

Social presence and Awareness: We hypothesized that cueing frequency would lead to increases in social presence and awareness. These hypotheses were tested in three separate ANOVAs with Frequency and Cueing mode as independent variables. Indeed, awareness showed a marginally significant effect of Frequency, indicating that more frequent cueing lead to heightened levels of awareness (Figure 1a, $F(1, 76)=3.2$, $p=.075$). Similarly, Frequency had a marginally significant effect on behavioral engagement (Figure 1b, $F(1,76)=2.8$, $p=.096$). The analysis on psychological involvement did not render significant results, althought the interaction of Frequency and Cueing mode bordered on marginal significance (Figure 2a, $F(1,76)=2.7$, $p=.10$; Cueing mode: $F(1,76)=2.4$, $p=.13$; Frequency: $F(1,76)=1.4$, $p=.24$) in the expected direction: explicit cues resulted in higher Psychological involvement, but only in the Frequent cueing conditions. No other effects were found in these analyses.

Game Experience: To test the possible effects of Cueing mode and Frequency on the player experience, a multivariate ANOVA was employed with the separate components of the GEQ as dependent variables. In this analysis, a significant effect of Frequency was found both on challenge (Figure 2b, $F(1,76)=7.6$, $p=.007$), and on flow ($F(1,76)=5.2$, $p=.025$). Both effects were positive, meaning that frequently receiving information about the location of the other player made the game more challenging and gave the game a better flow.

Affinity: No main or interaction effects were found.

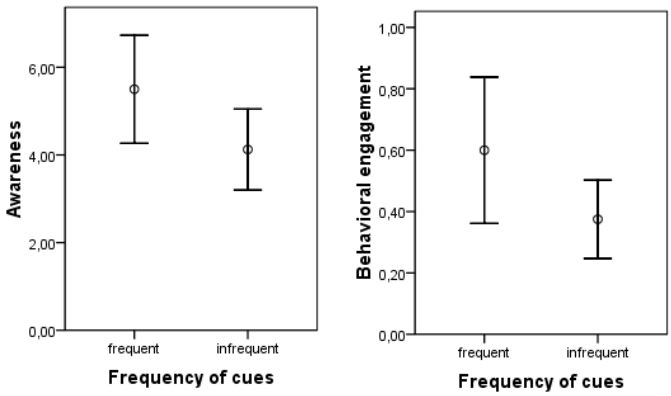

Figure 1a/b. The effects of Frequency on Awareness (left) and Behavioral engagement (right). Error bars represent 95% confidence intervals around the mean.

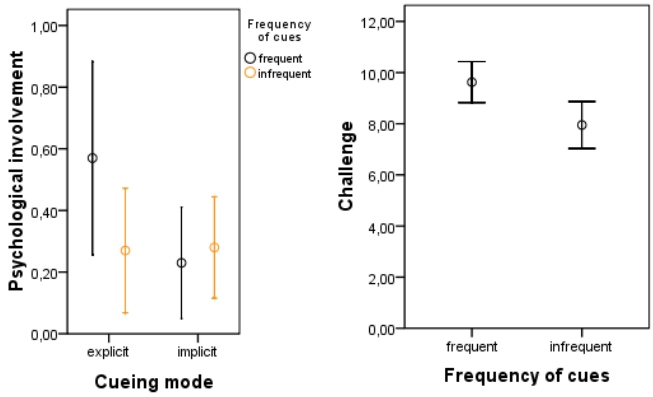

Figure 2a. Effects of Frequency and Cueing mode on psychological involvement. 2b. Effects of Frequency on Challenge. Error bars represent 95% confidence intervals around the mean.

4. Conclusion and discussion

In this study we explored two things. First we tested whether receiving more frequent location cues of a game partner resulted in higher awareness, social presence, and whether it influenced game experience. Second, we explored what type of cue would have a stronger social impact: inferred or explicit closeness.

The results of cueing frequency were all in the hypothesized direction. Significant effects appeared for perceived challenge and flow in the game. This relates to recent findings in game research, indicating that playing against a human opponent is more challenging than playing against a computer [18], and that social presence mediates these effects [7]. Marginally significant effects were found of frequency on both awareness and behavioural engagement, which is part of the social presence construct. No effects of the manipulations were found on feelings of affinity.

Furthermore, a marginally significant interaction emerged between cueing mode and frequency on psychological involvement. The trend indicated that social presence was higher for explicit cues, but only if cueing was frequent. The finding that explicit similarity/closeness cueing has stronger effects has interesting implications for application design.

All in all, the effects of cueing mode and frequency were generally modest. We can think of several reasons why the effects of the manipulation were weaker than hoped. Perhaps processing the meaning of the different colors of the lights required too much mental effort. Blue and yellow lights in themselves are meaningless and as such their interpretation is not intuitive. This notion is supported by the comments that some participants made: "I was so absorbed in the game that I sometimes forgot about the lights." Another explanation is that the location information was not specific enough to be meaningful: the whole game world was divided into two areas which made the location information not really specific. In real life, location information not only tells you were someone is, but also provides you with information about the activity one may be performing. In this case, the other player could be doing quite a lot of things in each of the areas, and consequently the location information was not really informative. Lastly, the manipulations may not have been effective because some of the participants reported afterwards that they suspected that there had been no other person playing simultaneously.

Follow-up research is needed to verify what type and form of location cues are most appealing for social interaction. For instance, similarity cueing could be based on both absolute location (e.g. GPS), or descriptive locations (i.e., meaningful locations such as home or shop). The one option would trigger physical closeness, the other perhaps psychological similarity. Insights can be used in mobile applications, for which we plan to conduct a field test in August '08. Based on the current results, it will be interesting to explore the effects of location similarity cues vs. absolute locations in the real world. It may be more meaningful to know that your friend is also in a supermarket, rather than that she is at coordinate X, Y, or in street Unknown-to-me.

5. ACKNOWLEDGMENTS

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