

# Social Presence in a Home Tele-Application

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## ABSTRACT

The current paper presents a study on the subjective evaluation of an advanced telecommunication platform aimed at informal home use, called the *PhotoShare* tele-application. This platform enables users to view photos (e.g., family or holiday snapshots) together, while the presenter and the viewer are at different, remote locations. The platform includes a common viewing space where the photos are displayed and selected, as well as an audio connection and a large-screen video connection for communication between the remote sites. The study investigated the effects of videocommunication on social presence. In addition, the ability to point at a picture with an electronic pointer was evaluated. In the context of presence research, the current study also provided information regarding the validity of the IPO Social Presence Questionnaire (IPO-SPQ), which was specifically designed to investigate social presence with telecommunication applications. The results indicated that adding broadband, life-size video communication significantly increased social presence. In addition, we found a significant effect of sex on social presence: women gave substantially higher social presence ratings than men. The absence of a significant effect of the pointing function indicated that extensive workspace functionality may be of minor importance to the user's feeling of social presence.

## INTRODUCTION

**B**OTH AUDIO- AND VIDEOCONFERENCING systems have received considerable attention in the literature, mainly in the context of professional, work-related meetings and computer-supported collaborative work (CSCW). Participants typically appear in video-windows on a desktop system, or on adjoining monitors, and may work on shared applications that are shown simultaneously on each participant's screen. Examples include the work of Bly et al.,<sup>1</sup> Fish et al.,<sup>2</sup> Gaver et al.,<sup>3</sup> and Hindus et al.<sup>4</sup>

In this paper, we present the PhotoShare sys-

tem, a tele-application supporting informal communication in a home environment. The PhotoShare application supports both audio- and videocommunication and enables participants to view photos (e.g., family or holiday snapshots) together while the presenter and the viewer are at different, remote locations. Whereas in work-related settings usability criteria such as effectiveness and efficiency are of high importance, these concepts have only limited use in informal, domestic settings where no clear *task* needs to be accomplished, and thus task-related measures (e.g., number of errors during task execution or time needed to complete a task) make little sense in evaluating

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the user's experiences. In this context, it is more appropriate to evaluate the user's affective judgements with respect to the system and its ability to support pleasurable, informal communication. Inasmuch as the PhotoShare telecommunication environment is able to provide a sense of being together for the participants, evaluating social presence appears to be of particular importance.

After presenting the PhotoShare system in more detail, we describe the background and development of the social presence questionnaire and present an experiment that was performed, using this questionnaire, to investigate the user experience related to the PhotoShare tele-application.

### THE PHOTOSHARE SYSTEM

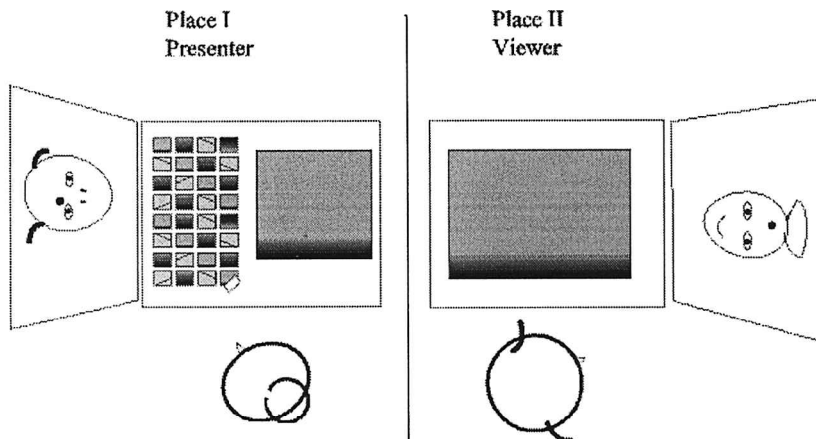
The implementation platform of PhotoShare (see Fig. 1) is a distributed version of the Visual Interaction Platform (or VIP), which is based on computer-vision input, while the computer output is projected onto a normal table surface.<sup>5</sup> Instead of a mouse, the users can use simple wooden bricks to select thumbnail pictures for viewing larger images. This follows the design philosophy of graspable user interfaces,<sup>6,7</sup> and has the advantage of enhancing the usability and learnability of the interface by providing unencumbered, natural interaction

and a unified action-perception space (i.e., "what you see is where you act."<sup>8</sup>)

The current version of the distributed platform is asymmetrical. Only one side can select photos for viewing large images. We call this the presenter's area. At this side a brick may also be used as a pointer in the large viewing area. This was done to facilitate communication about specific details within each photo. Inside the viewing area it creates a red dot that is also visible in the viewer's viewing area. In addition to the common viewing space where the photos are displayed and selected, PhotoShare's distributed platform also provides videocommunication using a large (life-size) projection screen and a high-quality audio connection. Miniature cameras positioned at eye level within each screen convey a sense of eye contact between the participants. This is likely to be of considerable importance to social presence since (mutual) gaze is known to serve several communicative functions, such as regulating the flow of conversation, communicating emotions, and communicating the nature of the interpersonal relationship.<sup>9</sup>

### SOCIAL PRESENCE, INTIMACY, AND IMMEDIACY

It is important to note at this point that social presence, or the "sense of being together,"



**FIG. 1.** The PhotoShare tele-application. On the left ("Place I"), the presenter can select one or more thumbnail pictures using one or more small wooden bricks. The picture(s) is (are) then shown in the large view on both the presenter's and the viewer's shared space (projected onto a table surface). Presenter and viewer can communicate with each other via an audio and large screen video connection.

is quite distinct from physical presence, or the sense of 'being there' in a mediated environment. Although a number of medium manipulations will have a similar effect on both social and physical presence, and a unifying definition has been proposed,<sup>10</sup> the two types of presence can be meaningfully distinguished. For instance, a medium can provide a high degree of physical presence without having the capacity for transmitting reciprocal communicative signals at all.<sup>11</sup> In some instances, an application may be specifically aimed at providing a sense of being together in a shared space (see, e.g., the TELEPORT system<sup>12</sup>). This experience is usually referred to as "co-presence" and combines elements of both physical and social presence.

When using the concept of social presence to distinguish between different communication media, we need to have a basic understanding of the communication processes that contribute to a sense of social presence. For supporting *informal*, mediated communications, as is the focus in our study, nonverbal communication and intimacy behavior seem to be of particular importance.

In face-to-face communication, the nonverbal channels are continuously attended to and communicate information that is primarily affective in quality and connected with personal relationships. In this respect, the nonverbal channels seem to be less controllable than the verbal channels (i.e., they are more likely to "leak" information about feelings).

Argyle and Dean<sup>13</sup> argue that interpersonal *intimacy* is kept at an optimal, equilibrium level through factors as physical distance, smiling, eye-contact, and personal topics of conversation. Other scholars have added to this list of intimacy behaviors to include factors such as gestures, touching, vocal cues (e.g., tone of voice), turn-taking behavior in dialogues (e.g., frequency of interruptions), the use of space (e.g., moving toward someone), and verbal expressions directly acknowledging the communicative partner (e.g., "How did you do that?" or "I see what you mean"). Wiener and Mehrabian<sup>14</sup> have applied the concept of *immediacy* (i.e., the psychological distance a speaker puts between him or herself and the hearer, to an understanding of speech). They showed that

the choice of "We . . ." as opposed to "I . . ." or "You . . ." connote a feeling of closeness and association. Thus, intimacy and immediacy behaviors seem to be particularly relevant for social presence.

Media capacity theories, such as social presence theory and media richness theory, are based on the premise that media have different capacities to carry such interpersonal communicative cues. Theorists place the array of audiovisual communication media available to us today along a continuum ranging from face-to-face interaction at the richer, more social end and written communication at the less rich, less social end. As Fish et al.<sup>2</sup> state:

To the extent that audio/video communication mimics the features of face-to-face communication in being expressive, interactive, and focussing attention on personal attributes, it should function like face-to-face communication. Thus, the media richness and social presence perspectives suggest that video teleconferencing should be well suited for informal communication, and especially good for aiding the more social, the more uncertain, and the more equivocal aspects of communication. (p. 38)

The broadband video communication channel that is part of the PhotoShare system supports a visually oriented, socially rich, and informal mode of communication. We thereby hypothesize that adding video communication will have a positive effect on the users' sense of social presence.

## MEASUREMENT OF SOCIAL PRESENCE

There are two general approaches to measuring presence—subjective and objective.<sup>11</sup> Since presence is primarily a subjective experience, subjective assessment methodologies, such as questionnaires or interviews, have most commonly been used in presence studies to date. However, given the potential instability of subjective measures,<sup>15</sup> there has been a growing interest in objective measures that focus on behavioral or physiological responses to media (i.e., responses that are produced automatically and without much conscious delib-

eration). As has been argued in IJsselsteijn et al.,<sup>11</sup> the most fruitful approach to measuring presence is likely to combine both subjective measures and objective corroborative measures, thus yielding different but complementary types of insight into the determinants and structure of the participant's media experience.

In this paper, we limit ourselves to reporting on the development and responses to our subjective measure, the IPO Social Presence Questionnaire (IPO-SPQ). However, to enable the investigation of behavioral responses (e.g., smiling, eye-contact, gestures, body posture, etc.) that may constitute an objective corroborative measure of social presence, we also made video registrations of all experimental sessions, filming both communication partners, as well as their shared workspace. The results of the analysis of these behavioral responses will be reported elsewhere.

In developing the IPO-SPQ, two different approaches to measuring social presence were combined. One is based on the semantic differential, essentially an evaluative or emotional response, the other on agreeing or disagreeing with statements about attitude toward the media experience. The questionnaire will be discussed in more detail in the remainder of this section.

#### *Semantic differential questionnaires*

According to Short et al.<sup>16</sup> (p. 66), the chief subjective method for measuring social presence is Ogood's semantic differential technique.<sup>17</sup> Subjects are asked to rate the communication media on a series of bipolar scales such as:

impersonal 1---2---3---4---5---6---7 personal

Other examples of bipolarities are:

insensitive--sensitive  
cold--warm  
impersonal--personal  
passive--active

Media that support a high degree of social presence are typically judged as warm, personal, sensitive and sociable. Short et al.<sup>16</sup> claimed that this measurement was also influ-

enced by aesthetic appeal (ibid., p. 66) but their factor-analytical approach on small sets of data that are not independently measured, is not convincing from a modern statistical point of view. They reported an experiment in which 72 managerial civil servants each evaluated three different media (face-to-face, closed-circuit television, or an audio system) on 24 bipolar rating scales. Of these, only four distinguished between the video medium and face-to-face:

unsociable--sociable  
meaningful--meaningless  
public--private  
true--false

From the same data set they concluded that the following four scales seem to measure

aesthetic appeal:  
small--large  
closed--open  
colorless--colorful  
ugly--beautiful

#### *Statements about system qualities*

Users' comments on new media frequently relate to social presence<sup>16,18</sup>:

- One does not get a good enough idea of how people at the other end are reacting.
- One gets no real impression of personal contact with the people at the other end of the link.
- One can easily assess the other people's reactions to what has been said.
- It provides a great sense of realism.
- One gets a good feel of the people at the other end.
- It isn't at all like a face-to-face meeting.
- It was just as though we were all in the same room.
- People at the other end do not seem real.
- I would be happy to use the system for a meeting in which I intended to persuade other people.
- I could not get to know people very well if I would meet them over this system.

Such statements can be used in attitude test items in which subjects can agree or disagree on a Likert-type 7-point scale.

*Construction of the IPO Social Presence Questionnaire (IPO-SPQ)*

With the above we have two different approaches to measuring social presence—one based on measuring the more affective qualities of the medium using the semantic differential technique, the other based on subjective attitude statements with a 7-point agree–disagree scale. Both approaches were combined in the construction of the IPO-SPQ. The questionnaire was drafted in Dutch, and included, besides items on social presence, a number of items about usability, communication in general, and about the audio communication in particular. At the end of the questionnaire three general questions were added to assess the potential customer acceptance of the PhotoShare system:

- How much may the system cost?
- What grade do you give the system as a whole, on a scale of 1–10?
- Would you use or utilize the system?

In the context of evaluating the PhotoShare system, the experiment described next investigates the effects of video communication, role (viewer vs. presenter), and pointing on social presence. In the context of presence research, the PhotoShare study also provides information regarding the validity of the IPO-SPQ to investigate social presence with home telecommunication applications.

## METHOD

### *Design*

Using the IPO-SPQ, we investigated the effects of video, role, and pointing on social presence in a mixed design, comparative experiment. The major independent variables were video (audio-only vs. audio + video), participant role (presenter or viewer), and pointing (pointing functionality available or not).

For the experiment, a repeated measurements design was used with two trials, with video as within-subjects factor. Each pair of subjects took part in two trials, one with video communication (i.e., with the life-size projec-

tion of the communication partner available) and one without. These trials were counterbalanced to avoid any potential sequence effects. Thus, half the subjects were given the sequence audio-only (AO) / audio + video (AV), and the other half the reverse sequence. The shared space where the photos were selected and viewed was available across all conditions. Sex was included as a control variable since it is known that men and women differ in dialog behavior.

### *Subjects*

Thirty-four subjects (15 males, 19 females, age range: 15–59) took part in the experiment, in 17 presenter-viewer pairs. Members of a pair always knew each other beforehand and could be regarded as friends. The pairs consisted of six male/male, eight female/female, and three male/female combinations. All subjects were naïve to the hypothesis under test.

### *Procedure*

On arrival, the subject that was going to act as the presenter handed over 20 photos from his or her private collection to the experimenter, which were subsequently scanned to enable display on the PhotoShare system. Presenter and viewer were then led to separate rooms where the PhotoShare system was set up. All subjects were first made comfortable with the basic functionality of the system. Given its easy-to-use interface, this took in general no longer than 1 minute. The presenter was then asked to start by selecting a photo and talking about it. For both trials (audio-only or audio + video), 10 photos were discussed. After each trial, both viewer and presenter were asked to fill in the IPO-SPQ. As stated earlier, all experimental sessions were videotaped for later analysis.

## RESULTS

### *IPO-SPQ measurement scales*

The coding of the item value in the raw data was the number chosen by the subject. With some items, a high score reflects a low judgement and these items were recoded. After this,

reliability analysis of the items of each response variable was performed. For this analysis, all 68 questionnaires of the 34 subjects and 2 trials were used. Only a few items were deleted that had a low item-total correlation. Cronbach's alphas for social presence items are good, meaning that the items in each scale are consistently measuring the same quality (see Table 1). Intercorrelations among the response variables show a substantial correlation between the two social presence scales (0.58) and much lower correlations with the other scales. The largest of these are between communication quality and the social presence scales (0.34 with the semantic differential and 0.26 with the agree-disagree questions).

#### *Effects on social presence*

Analysis of the data using the General Linear Model for repeated measures in SPSS 7.5 showed the following effects to be significant:

#### *Agree-disagree*

Effect of video	$F(1,18) = 9.9, p = 0.006$
Interaction effect of video and age	$F(1,18) = 4.4, p = 0.049$
Interaction effect of video, sex and trial	$F(1,18) = 5.8 p = 0.027$

#### *Semantic differential*

Effect of video	$F(1,18) = 9.9 p = 0.007$
Effect of sex	$F(1,17) = 5.2 p = 0.036$

On both measures the effect of video is substantial and in the expected direction. The effect of sex is also substantial. The pattern of the

effects for each measure is rather similar and there is a substantial correlation between the two measures. The two measures can thus be added to form an overall measure of social presence. The profile diagram of the effects of sex\*trial\*video on this compound measure is shown in Fig. 2.

At the first trial, to the left in the diagram, there is hardly any difference between the social presence mean scores for video and no video in the male group and in the female group. Between males and females, the difference is small. At the first trial, subjects seem to select a baseline level on the presence scales, regardless of whether they have video or not. Only in the second trial, to the right in Fig. 2, do substantial differences in means appear. Those who are in the AO-AV sequence show on the second trial a higher social presence judgement while those in the AV-AO sequence show a drop in their social presence scores. It appears as if subjects make a comparison between the systems experienced in Trials 1 and 2, rather than separate absolute judgements of each.

The outcome suggests that difference scores may be used to characterize subjects; that is,  $Y(\text{video}) - Y(\text{no video})$ . Using these difference scores, we get rid of the two trials, and thus of the repeated measurements situation. The control variable sequence can be used to check for the effect of sequence on the difference score.

For the factors role (presenter vs. viewer) and pointing (yes or no) we do not have within-subject comparisons but only between-subjects comparisons. The factor role has no effect and the factor pointer has a small negative effect, at a conventional 5% significance level.

TABLE 1. RELIABILITY ANALYSIS OF ITEMS IN THE IPO-SPQ

<i>Response variables</i>	<i>Items in questionnaire</i>	<i>Items removed after reliability analysis</i>	<i>Alpha</i>
Communication quality	4-7		0.89
Audio quality	8-10		0.45
Social presence (agree-disagree)	12-17	12	0.72
Social presence (sem. dif.)	18-31	27, 31	0.90
Ease of use	32-44		0.70
System in general	45, 46, 48		

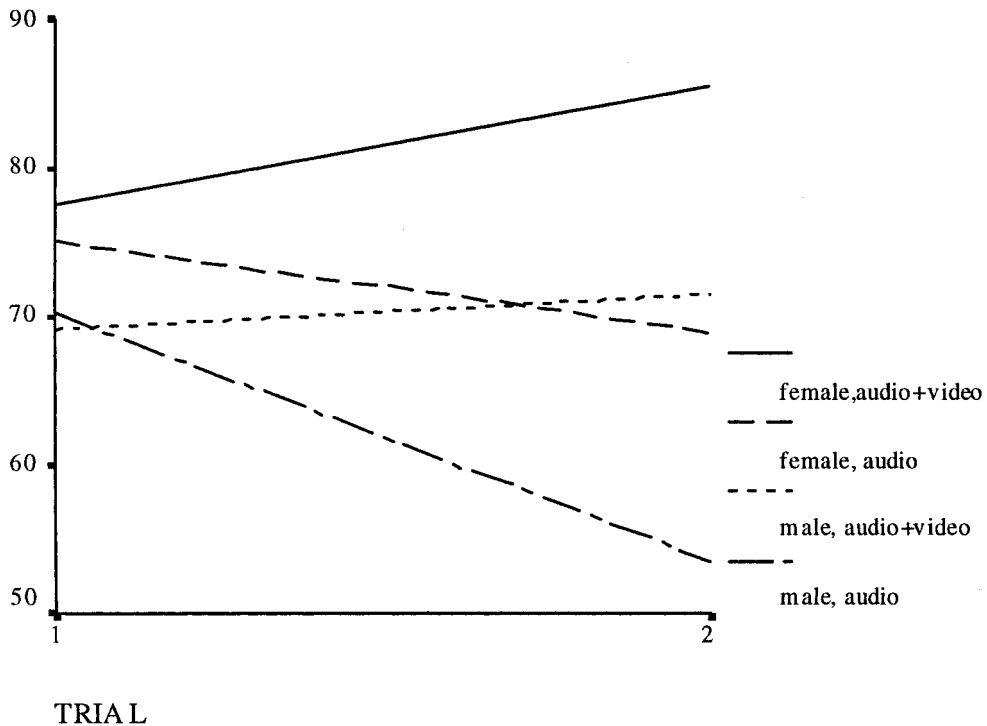


FIG. 2. Mean social presence scores for audio only vs. audio + video conditions for Trials 1 and 2. Results of male and female participants are plotted separately.

## DISCUSSION

### *Measurement and experimental procedure*

The construction of the IPO-SPQ, based on various sources in the literature, appears to be successful. Importantly, the difference we found between the results over the two trials strongly suggests that subjects are able to make a comparison judgement between the two media over trials (i.e., a within-subjects comparison), but cannot reliably give an absolute judgement of each medium individually (i.e., a between-subjects comparison). Thus, without some kind of anchor point or calibration of the subjective scale (as is provided through a previous trial or a training session), subjects tend not to differentiate between the different media conditions in terms of social presence. They are however quite capable of providing a comparative judgement of a difference or shift in levels, and it seems fair to say that the within-subjects comparison is thus more sensitive to differences in perceived social presence.

In IJsselsteijn et al.,<sup>19</sup> subjects performed a continuous judgement of presence level, and

for this they used a slider button whereby they could continuously adjust their subjective presence level. This method also appears to provide valid results and it relies, as in our case, only on the ability of subjects to detect differences in perceived presence.

We need to be cautious in generalizing the methodological implications of our study to questionnaire-based studies of *physical* presence, since the two types of presence are distinct. It is quite possible, for instance, that the sense of physical presence relies more on "explicit" elements of media form (e.g., screen size), whereas social presence is more likely to rely heavily on picking up "implicit" social cues from the communication partner, which are to a large extent less consciously perceptible (i.e., automatically processed) and less cognitively accessible when filling out a posttest questionnaire. We hypothesize, however, that the analysis of the various verbal and nonverbal communication patterns will reveal a number of indicators that are sensitive to the media manipulations under study, for both within- and between-subjects comparisons, thus providing us with a more absolute, objective measure of social presence.

### Effects on social presence

With video, social presence is substantially (and significantly) higher than with audio-only. This result is in line with much of the published research evaluating videocommunications in work-related settings. There is also a substantial effect of sex: women have higher scores on social presence. The effect size of video and sex are about equally large. It is quite possible that women experience a higher level of social presence, considering the large differences in communication behavior between men and women. However, another possibility is that there is a response bias in that women tend to give higher ratings than men for the same thing. This issue is clearly of interest, and will be investigated in future experiments.

The factor role (presenter vs. viewer) did not yield a significant difference. This result could have occurred because it was measured in a between-subjects comparison, which may lack sensitivity as was discussed earlier. Another possibility, however, is that increased control over the application does not increase social presence judgements, since increased application control may distract the user from the social interaction aspects, as do the addition of extra workspace functions, discussed below. This hypothesis thus diverges from the effect one would expect increased control to have on physical presence judgements, as has been shown by Welch et al.,<sup>20</sup> thereby underlining the importance of distinguishing between the two types of presence.

### Workspace functions

The effect of pointing on social presence is small and negative. We must be cautious and cannot draw a firm conclusion. Video is a within-subjects factor and pointing and role are between-subjects factors. We have not offered our test subjects an opportunity to make a comparison between different roles or pointing versus no pointing like we did for video and no video. This might be the reason for the small or negligible effects found. However, another possible explanation is that there is less communication with the pointing function present.

To summarize, the main conclusions are that the availability of a video communication chan-

nel has a large positive effect on social presence, as was hypothesized. Furthermore, for measuring social presence subjectively, a within-subjects comparison seems to be more valid, since subjects are not well able to provide social presence ratings that differentiate between media manipulations. Extensive workspace functionality seems less important and may even diminish social presence; however, from this study, we cannot draw a firm conclusion about this issue.

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