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Social enjoyment with electronic photo displays: Awareness and control

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Abstract

Two experiments are reported in which groups of three friends socialised around their own photos. The photos were of two types, depicting events where all three had been present, permitting reminiscing, and events where only the photographer had been present, permitting storytelling. In Experiment 1 the seating arrangement was manipulated so that the two audience members sat either *behind* or *around* the photographer. It was hypothesised that the former would lower levels of peripheral awareness within the groups, resulting in a more formal conversation and a poorer recreational experience. In Experiment 2, control over the photos was manipulated so that either only the photographer had access to a remote control (*single control*) or all three group members did (*distributed control*). It was hypothesised that distributed control would result in less formal conversations and a better recreational experience. In both experiments the hypotheses were supported: patterns of social interaction were significantly affected by the manipulation of awareness during storytelling, and by the manipulation of control during reminiscing. Additionally, the two manipulations were found to affect ratings of enjoyment and fun, respectively. The results are interpreted in terms of a causative model of unfolding and recounted behaviour.

Keywords: affordance, conversation, experiment.

1 Introduction

This paper is concerned with the design of technologies to support recreational activities that typically take place in a domestic environment. Many of these recreational activities are social, indeed the home has been identified as an environment with particular potential to cater for shared experiences (Hughes et al., 2000). However, new technologies often fail to align with the social aspects of the domestic environment. For example, Frohlich et al. (2001) have recorded some of the difficulties that families have when using their PCs to collaborate over projects and to jointly browse the Internet, and Plaisant et al. (2002) have observed how the home PC can isolate users from other family members, even when those people are in the same room.

If shared experiences are to be supported in the home more effectively, it seems that appropriate sharable displays are needed. The idea of *affordances for social interaction*, proposed by Gaver (1996), is particularly relevant to the design of sharable displays. This

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concept is an extension of the notion of *affordances for action* (Gibson, 1979), which are purported to be properties of artefacts in the environment that offer particular opportunities to an individual regarding the actions they may take. Gaver (1996) argues that similar to action, social behaviour can be understood in the context of the material world in which it occurs. Hence the physical attributes of objects, and of technology, are relevant when considering how groups might behave towards one another while using these. One of the purposes of this paper is to explore how affordances that are offered by technology affect group behaviour and social interaction in a recreational context.

A review of the existing work on sharable interfaces for collocated groups reveals that much of it is focused on the workplace. Researchers in the field of Computer-Supported Cooperative Work (CSCW) have examined the development of interactive whiteboards (Guimbretière et al., 2001; Pedersen et al., 1993), interactive tables (Shen et al., 2004) and even whole rooms (Stefik et al., 1987; Streitz et al., 1999). Most of these findings are difficult to generalise to the area of domestic technologies because activities in the home are rather different to those at work. In the workplace there is generally some goal; a state of the world to be achieved. Activity is then oriented to that goal with supporting technology that has the general aim of making the task as efficient as possible. For this reason, technology in the workplace has to be easy-to-use and easy-to-learn. However, what is the goal when sharing photos? For many recreational activities, the process of carrying out an activity is just as important as the end result. Domestic technologies must support sociability and enjoyment throughout the activity, whereas workplace technologies must support efficiency and high levels of performance.

This difference has important implications for research in the area of Human-Computer Interaction (HCI). First, the notions of usability and learnability have to be rethought. Second, and critically for this paper, the typical performance measures used in experiments (e.g. time to completion and the number of errors made) are no longer relevant. Producing a game that is usable in the sense that it can be completed in a minimum amount of time would be ridiculous. Consequently, identifying criteria to evaluate the 'success' of a sharable interface in a recreational context is a nontrivial task. To do so we have to define what might constitute a positive experience, and also identify a reliable way of measuring this. The aim of this paper is to experimentally examine two concepts, interpersonal awareness and control, that appear to be important when designing sharable interfaces to support collocated groups within the home.

The remainder of this introduction justifies and clarifies the experimental approach taken. The motivation for the manipulations (independent variables) used in each experiment will be described and some quantitative measures proposed to measure social enjoyment explained. These measures have not been employed for this purpose before and so a causative model will also be developed to make explicit our assumptions in using them. The paper will then describe two experiments that use these quantitative measures. A review of the background literature relevant to each study will be provided at the start of the section describing it.

1.1 Experiment or field study?

Researchers in the areas of HCI and CSCW have turned their focus to recreational activities in recent years. Many of these can be performed by collocated users, such as joint explorations of music collections (Stavness et al., 2005), television watching (Lee and Lee, 1995), game playing (Mandryk et al., 2005, Lindley et al., to appear) and photo sharing (Crabtree et al., 2004; Frohlich et al., 2002). All depend on enjoyment and sociability to be successful, although some, such as game playing, may require more attention to be dedicated to the activity in hand than to collocated players.

The above studies have variously used field studies and experiments. Crabtree et al. (2004) observed people while they were sharing photos in order to understand the meaning that they gave to different parts of this activity. In contrast, Mandryk et al. (2005) used psychophysiological measures to give an indication of how experience differed for game players who competed with a friend or a computer. These different approaches can be seen as complementary; while ethnographies have the very open-ended aim of understanding some activity from the point of view of those participating in it, an experiment focuses very closely on some single question. The experimental approach requires the investigator to operationalise concepts as experimental manipulations and then to devise quantitative measures that characterise user behaviour. This process forces the researcher to precisely define the concepts and criteria to be operationalised. However, very often the motivation for choosing the concepts of interest comes from a field study of some kind. Experimental results can then provide complementary evidence to elucidate the ethnographic findings that inspired them (for examples of this approach see Daly-Jones et al., 1997; Monk and Reed, 2007).

In the research described here, an experimental approach is taken so as to allow a close examination of two variables suggested to be of interest in previous fieldwork. In a study by Lindley and Monk (2006), interviewees were asked about their experiences of photo sharing in the home, and how this was affected by the use of different media. The results were interpreted in terms of the affordances for social interaction that these various media offered, and highlighted two factors as worthy of further exploration: interpersonal awareness and equality of control. Photo sharing is the focus for this research project because it is a prime example of a social recreational activity (Crabtree et al., 2004; Frohlich et al., 2002) as well as being an area where technology is developing rapidly. Recent research in HCI has seen the development of various new devices for collocated photo sharing, including handheld photograph viewers (e.g., Balabanović et al., 2000), DiamondTouch applications (e.g., Shen et al., 2002; Apted et al., 2005) and tabletops with tangible elements (e.g., Hilliges et al., 2007). However, experimental explorations of photo sharing remain limited. The present paper offers an example of how such an approach might be undertaken.

1.2 Overview of the experiments: Independent variables

As indicated above, previous work by Lindley and Monk (2006) served to motivate the experimental manipulations reported here. Their findings suggest that the sharing of printed photos affords a degree of physical closeness that is lost when using a PC. This was reported to be because prints encourage the formation of group “huddles” around photos, while the PC affords “hovering”, in which group members peer over the shoulders of the person who is using the computer. It seems clear that different arrangements might be linked to different levels of interpersonal awareness, and that this could have a subsequent effect on social behaviour and experience. Therefore, Experiment 1 involves a manipulation of interpersonal awareness through constraints on seating, making it easier or harder for participants to see one another’s faces during photo sharing. It is predicted that reduced awareness will result in a less enjoyable social experience, and significant differences would demonstrate that social awareness has some importance in the design of displays and their deployment in the home.

The second affordance of interest relates to control of images during photo sharing. Findings from the field study indicated that when photos were displayed on a screen, the person who owned them was often reluctant to hand over control of them. This contrasted with photos shared as loose prints or albums, where control was often either shared with or handed over completely to the audience. It is not clear why this occurred, but it may be the case that being in command of a piece of technology makes the role of control more explicit. It may therefore be beneficial to make the role of control more open to being shared between members of a group. Gaver et al. (2003) have suggested that ambiguity is a useful resource in the design of artefacts for individuals, and these findings suggest that it could also be relevant when

designing for groups. Therefore, Experiment 2 involves a manipulation of control. It is predicted that equal access to control will result in more social enjoyment than unequal access. Again the manipulation is somewhat unusual but a significant effect would indicate that this is also a concept worthy of consideration in the design of displays for social activities.

In both studies there was a second independent variable, photo content. This had two levels, reminiscing and storytelling, a distinction based on previous research into photo sharing (Frohlich et al., 2002). Reminiscing conversations occur when everyone in the group was present when the photos were taken, whereas storytelling conversations occur when the person who took the photos is sharing them with an audience who were not at the event shown. Reminiscing and storytelling are very different kinds of conversations and this manipulation was originally added to ensure an equal number of each type of photograph. However, it was found that the strength of the effects of the primary manipulations depended on whether the participants were reminiscing or storytelling, as will be reported.

The danger of the experimental approach is that the controls introduced make the questions asked practically irrelevant. For this reason, some care was taken in the present research to make the situation as natural as possible. The experiments described involve groups of three friends socialising around their own photos. They were paid to do this and some aspects of the photo sharing context were controlled; however, we would claim that the context was semi-natural. The experiments took place in the York Responsive Home, which is set up to appear as a normal household, and every effort was made so that the participants could behave genuinely. Furthermore, by retaining some control over the setting, behavioural measures, i.e. measures of group process, could be taken. These will now be described.

1.3 Measuring social enjoyment: Dependent variables

The emphasis on social experience outlined in the predictions described above, and the importance of this in recreational activities, has led us to consider carefully how we might measure social enjoyment during photo sharing. In order to frame our experimental measures we have adopted a causative model, which is based on an earlier distinction between unfolding experience and the recounting of that experience, made by McCarthy and Wright (2004). Unfolding experience is defined as the process of sense-making that goes on concurrently with the activity, while recounted experience involves revisiting it, either through describing it to others or retelling it to oneself. McCarthy and Wright are mainly concerned with the experience of the individual (e.g., while playing a computer game or watching a film), but their dialogical approach would seem to be equally applicable to social activities.

Our model posits that some manipulation of social affordance can affect group behaviour and, through doing so, unfolding experience. This, in turn, affects how that experience is recounted. Unfolding experience is conditioned by previous experiences of the individuals in the group, as well as by the group's ongoing behaviour. The recounting of experience is conditioned by the social context in which it occurs, as well as by the memory of how the original experience unfolded. Perhaps more contentiously, it is suggested that because group behavioural measures that tap into aspects of conversation (e.g., conversational equality) are intrinsically linked to the group's experience, they reflect the nature of that experience as it unfolds. In contrast rated experience, as derived from questionnaire scales, is in fact a type of recounting. Although experience is fundamentally tied to the individual and not the group, we suggest that the two are closely related and form a tight feedback loop. Therefore, aspects of group behaviour, such as conversation, are seen as affecting individual experience, this in turn affects individual behaviour within the group, and so on (see Figure 1).

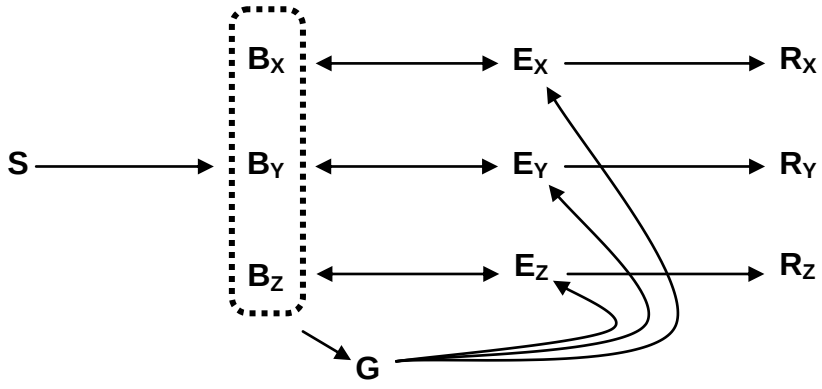

Figure 1. Causative model showing links between environment, behaviour and experience. S = social affordances of technology and physical context; B_i = behaviour of individual i (e.g., % $gaze_i$, % $speech_i$); G = group behaviour (e.g., conversational equality); E_i = unfolding experience of individual i; R_i = recounted experience of individual i (e.g., rating of felt fun).

Having decided to tap into unfolding experience through behavioural measures, the next question regards which aspects of behaviour to measure. For the purposes of recreational tasks, it is necessary to choose measures that are reflective of informal and jovial social interaction. Characteristics of talk that may be related to these aspects of conversation have been identified in previous work, for example by Edelsky (1981). Using Conversation Analysis to examine interaction during a series of meetings, she identified two key styles of conversation, which have since been termed *exclusive floors* and *cooperative floors* (Morgenthaler, 1990). Exclusive floors can be characterised by their orderliness, with only one person owning the floor at a time and turns rarely overlapping. In contrast, cooperative floors are typified by a feeling of participants being "on the same wavelength" in a conversation that is a "free-for-all" (Edelsky, 1981, p. 384). They are characterised by overlapping turns and give the sense that no one owns the floor; participation is fairly equal and it is perfectly acceptable for everyone to talk at once. The idea of informal social interaction having these characteristics has also been reported by a number of other researchers (Coates, 1988; Dunne and Ng, 1994; Tannen, 1984). For example, overlap and latching of utterances can be used to convey solidarity, enthusiasm, and interest in someone else's talk (Tannen, 1984).

This idea of the cooperative floor captures the sense of cohesiveness and engagement that is associated with positive experiences in recreational situations, and could be tapped into through a number of process measures. The idea of the floor being jointly owned and the conversation being a free-for-all implies a fluent and unpredictable pattern of conversation that involves all parties fairly equally. Measures that tap into these, for example that assess the extent to which conversations are equal and consist of unpredictable turn-taking patterns, have previously been used by Carletta et al. (1998) to examine social interaction in chaired meetings. In addition to this, studies of Computer-Mediated Communication (CMC) have suggested ways of measuring conversational fluency, through the occurrence of short, frequent turns (Daly-Jones et al., 1998) and the degree of overlap (Watts et al., 1996), and have suggested this to be an indicator of informality (O'Malley et al., 1996). Overlapping turns are specifically mentioned by Edelsky (1981) as being a characteristic of cooperative floors, and the fact that these may also be suggestive of informal talk adds further weight to their usefulness as a measure here. Based on this work, the concepts of conversational equality, freedom and fluency will underlie the measures to be used.

If these arguments are accepted, then the methods used here can be recommended as one solution to the pressing practical problem of assessing unfolding experience (Mandryk et al.,

2006). At present this is generally done by experience sampling (Csikszentmihalyi and Rathunde, 1993), that is, interrupting the activity under study to obtain ratings or other reports of what the people involved were feeling just before they were interrupted. However, interruptions inevitably disrupt the activity, and in the case of social activities, disastrously so. If a positive unfolding experience can be inferred from observable characteristics of group behaviour, then we can assess unfolding social experience without destroying the very thing we are trying to observe. A further advantage of using process measures is that they are often more sensitive than measures of outcome. A recurring finding in CMC is that while performance may not be affected by some experimental manipulation, group processes often do change (see Daly-Jones et al., 1998; Sellen, 1995). In perhaps the closest previously published experiment to those reported here, groups collaborating around an interactive table and an interactive whiteboard showed no measurable difference in performance during the task of planning a day trip for tourists (Rogers and Lindley, 2004). However, they were able to position themselves so that they could see each other more easily when using the table, and this in turn had measurable consequences for both nonverbal and verbal behaviours. Results such as these emphasise that, as well as being a cornerstone of experience and sociability, process measures are worth measuring because they may be the most effective way of detecting differences.

Rating scales completed after a social activity do not suffer from the same methodological problems as those used for experience sampling, and are widely employed in HCI. As already suggested, in the causative model these ratings are considered to be a form of recounted experience, which, according to McCarthy and Wright (2004), can be understood as a component of the whole experience. For the present experiments, rating scales will be used as another way of assessing enjoyment and satisfaction, as well being a means of exploring the experience of being in a group. Because recounted experience is based at least in part on the experience that has unfolded, we expect these variables to lead to similar conclusions about the effects of the manipulations on user experience.

2 Experiment 1: Effects of Peripheral Awareness

As explained in section 1.2, the aim of this experiment was to examine the distinction between huddling around a display and hovering behind someone who is using it. Seating was manipulated so that the person who was presenting the photos could easily see the other group members (because they were seated around him/her) or less easily see them (because they were seated slightly behind him/her). This was predicted to have an impact not only on how easily the photographer could see the audience, but also on how well the audience could see the photographer.

There are two previous areas of research that are particularly relevant to this experiment. The first is the literature on gaze, and the role of gaze in conversation. The second is the literature on seating arrangements, and how this has an impact on social interaction. Gaze is thought to have a number of purposes in conversation, in addition to gathering visual information. Early work by Goffman (1963) reflected on the social role of gaze in initiating and maintaining social interaction, and more thorough analysis by Kendon noted a number of different functions of gaze in social behaviour (Kendon, 1967). These include monitoring the conversational partner (e.g., to gain feedback), regulating the flow of conversation (e.g., by signalling the intention to speak), and expressing feelings or attitudes (e.g., by seeking or avoiding mutual gaze). Gaze has also been shown to be a means of signalling the current focus of visual attention (Monk and Gale, 2002). Of particular relevance to the current experiment is work by Kalma (1992), which showed that gaze is an important turn-taking cue within triads. In conversations between groups of three, the speaker was found to use a *prolonged gaze* as an invitation for someone else to take the floor. Additionally, analysis

showed that the receiver of that gaze was the more likely of the two listeners to take it. Therefore gaze in triads is used not only as a way of coordinating speech, but also as a way of controlling who can speak next. This ability to use gaze in conversation is often referred to as *peripheral awareness*.

When considering the role of gaze in conversation, it should also be noted that gaze behaviours vary according to task. This is particularly relevant to the present experiment, as photo sharing obviously involves looking at photos. Levine and Sutton-Smith (1973) found that there was more gaze towards another person during a conversational task than during a construction task, and Argyle and Graham (1976) found that the amount of gaze towards a relevant object varied with the complexity of that object. They measured gaze at another person, at a map of central Europe, and at the background while participants were either asked to get to know each other or to discuss where in central Europe they would like to go on holiday. The results showed that when the map was irrelevant to the conversation it attracted little gaze. However, when the map was relevant, even if it was an extremely simple representation that contained only familiar information, it attracted a great deal of gaze. It seems that during photo sharing a similar effect may be found, with much of the group's gaze being directed towards the images displayed (see also Watts and Monk, 1996). For this reason this experiment includes an analysis of the gaze direction of all three participants to confirm that the manipulation did have the intended effect on gaze awareness; effects could be negligible if gaze is largely directed towards the image in both conditions.

There have been a number of studies on seating arrangement and how this relates to social behaviour, although nearly all of this research has focused on dyads. The studies that have been performed using groups have found the visibility of others to be an important factor. In early observational work, Steinzor (1950) noted that in circular discussion groups of ten, people were more likely to speak following those opposite them than those next to them. Steinzor suggested that this was because people in view are a stronger expressive stimulus, although following Kalma's (1992) findings, it seems that the ease of passing the floor to someone in clear view may also have played a role. While few studies have manipulated group seating arrangements experimentally, one example does come from Patterson et al. (1979). They studied groups of four and predicted that a circular arrangement would produce greater involvement and less discomfort than an L-shaped layout. Despite a number of dependent variables being utilised, the only significant finding was that the frequency of self-manipulations, an indicator of discomfort, was lower in the circular arrangement. It may be that Patterson *et al*. failed to find stronger differences regarding group involvement because they did not look at patterns of interaction, as will be the case here, instead focusing on overall measures such as the number of speaker turns.

It should be noted then that the current experiment expands on the literature describing experimental manipulations of seating arrangements as follows: (i) it analyses conversational patterns; (ii) the experiment requires the participants to spend much of their time looking at a display (a factor potentially important in HCI), and (iii) the activity used is relatively natural, that is, an existing friendship group chatting about their own photos.

Following the causative model set out above, hypotheses can be made regarding the groups' behaviours across the two seating conditions. If the manipulation of seating has the expected effect on peripheral awareness, group members should look at one another less in the condition where the other participants are sat behind the photographer as compared to the condition where they sit around them. This in turn is predicted to have an effect on the conversation that surrounds the photos and the unfolding experience that is associated with it. Conversations in the behind condition should be less enjoyable and more formal, and this should be reflected in lower conversational fluency, as indicated by fewer turns and lower

overlap, and reduced conversational equality and freedom. This effect on unfolding experience should then have a further effect on recounted experience in the form of questionnaire ratings made after the experiment. Ratings should be higher when photos are shared in the around condition and, in particular, enjoyment should be rated more highly when this experience is recalled.

2.1 Method

2.1.1 Design

The experiment had a within-groups design with two independent variables. The first independent variable was seating condition, with two levels; seating *around* the photographer or *behind* the photographer. The second independent variable was photo content, with two levels; *reminiscing* and *storytelling*. Each participant brought in a set of photos to show the rest of the group, therefore the roles of *photographer*, or the person who provided the photos, and *audience* changed across participants from one condition to the next. The order of the four possible combinations of seating condition and photo content was counterbalanced across the groups.

2.1.2 Participants

There were 8 groups of 3 participants, who were all undergraduate students at the University of York. The sample consisted of five groups of females, one group of two females and one male, one group of two males and one female, and one group of males. Two of the groups had known each other for just under six months prior to the experiment. Of the remaining 18 participants, 16 had known their fellow group members for at least a year, and the other 2 had known each other for at least 6 months. The mean age of the participants was 19.93 years, with a standard deviation of 0.82 years. All participants were paid £10 or participated for course credit.

2.1.3 Materials

The experiment was run in the dining room of the York Responsive Home. For both seating arrangements the participants were sat on separate chairs with their movement partially constrained by carefully positioned tables. A Hewlett Packard tablet PC (TC1100) with a stylus was placed on top of the table(s). The computer was running Microsoft Windows XP (Tablet PC edition 2005). The photos were displayed using a slideshow from the Windows Picture and Fax viewer. The slideshow was paused, allowing participants to proceed through the set at their own rate by tapping the screen with the stylus or pressing a Next button to go forwards and a Back button to go backwards.

The photographer always sat in the middle of the group in front of the PC, with the two audience members on either side. Plans of the two setups are shown in Figure 2 and photos of them are given in Figure 3.

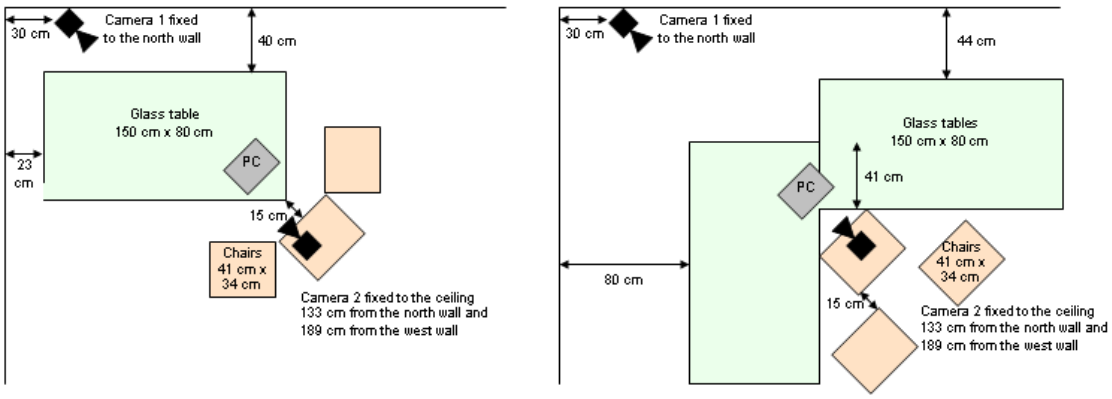

Figure 2. Plans of the experimental setup in the around (left) and behind (right) awareness conditions in Experiment 1.

Figure 3. Photos of the experimental setup in the around (left) and behind (right) awareness conditions in Experiment 1.

The participants provided their own photos for the experiment. Two participants per group brought in 24 photos each. 12 of these allowed for reminiscing and 12 allowed for storytelling. In addition, the other participant brought in 16 photos, 8 for reminiscing and 8 for storytelling. These photos were used before each experimental set as a practice set. Examples of photo content included university balls, field trips and nights out for reminiscing, and family holidays, friend's birthdays and photos from secondary school for storytelling.

A Panasonic (NV-GX7) video camera was placed on the wall in front of the PC, to record the groups' behaviour from the front. A second camera was fixed to the ceiling to record what was shown on the PC screen.

Three questionnaires were used. The first was to gather background information about the participants. The second assessed what the participants thought of sharing photos in the two conditions by asking them to rate their level of agreement with 20 statements. This questionnaire had an equal number of positive and negative statements, one for each of 10 topics (see Table 2). Agreement was rated on a Likert scale from 1 to 5. The third questionnaire asked three open-ended questions comparing the two setups for photo sharing. A semi-structured questionnaire was also used to gather the opinions of the participants.

2.1.4 Procedure

During the first session the participants brought in their photos and were taken to the Responsive Home where they were given a practice session with the tablet PC.

In the second session the participants were reminded how to use the PC and software before taking turns to show each other their photos. The person who had provided the practice set of 16 photos presented 8 from the set, which were randomly selected and ordered. At the end of this set the experimenter entered the room and asked the participants to swap seats so that one of the group members who had provided an experimental set of 24 photos was sat in front of the tablet PC. These photos were presented in the order that they had been given to the experimenter, with the order of reminiscing and storytelling photos fixed in accordance with the counterbalanced experimental design. After the experimental set, the experimenter again entered the room and asked the participants to sit in the living room and complete questionnaires about the first condition. During this time the seating arrangement was changed. Following this, the procedure was repeated with the remaining practice photos followed by the experimental set belonging to the third participant. The group then completed the second set of questionnaires, and were interviewed together.

Participants were told that if they talked for longer than 20 minutes, the experimenter would come in and end the discussion. In practice, groups that went over 20 minutes were always allowed to finish discussing the photo that they were currently looking at, and if they were approaching the end of the set they were allowed to complete it, time permitting. This was to make the experience as natural as possible. The only other instructions to the participants were that they should stay seated and should not move their seats, although they could move about in their chairs. They were also instructed that only the photographer could use the stylus.

2.2 Data Analysis

2.2.1 Analysis of verbal behaviour

16 minutes of conversation were coded for each group, that is the final 240 s of the group's behaviour in each of the four conditions, around-reminiscing, behind-reminiscing, around-storytelling, behind-storytelling. The Observer®, a software package that supports the coding of behaviour was used to do this. Verbalisations were coded as *turns* or *other utterances* (data for other utterances are not reported here). Turns are defined as a period of meaningful talk that contributed to the group's conversation, and can be contrasted with other utterances, which encompass backchannels (c.f. Yngve, 1970), defined as verbalisations that signal continuing attention (e.g., saying "mmm" or "yeah"), and laughter. Turn onset and offsets were recorded, with the turn offset being defined as the point when a speaker stops talking in such a way as to allow somebody else to take the floor, even if nobody else does.

The following calculations were used to derive process measures from the data on turns. In the notation that is used, G represents a score for a group and the letters X, Y and Z represent the three participants within that group.

Conversational equality (Carletta et al., 1998) is calculated by first computing e for each participant. This is done for participant X as follows:

$$e_X = -((d_X/D_G)\log_2(d_X/D_G))$$

where d_X is the total duration that participant X spends talking (in a turn), and D_G is the sum of these durations for all three participants in the group.

e_Y and e_Z are calculated in the same way. These three values are summed and divided by 1.58 (for a three person group) to give E_G. This results in a score between 0 and 1, where $E_G = 0$ indicates that only one person spoke and $E_G = 1$ indicates that all three group members spoke equally.

Conversational freedom (Carletta et al., 1998) is a similar calculation to characterise whether one participant is equally likely to talk following a turn from each of the other participants. In these terms a conversation where one participant only tends to talk after one other is less free.

Conversational freedom is calculated by computing f for each participant. This is done for participant X as follows:

$$f_{XY} = -((n_{XY}/n_Y) \log_2 (n_{XY}/n_Y))$$

where n_{XY} is the number of turns by participant X that are followed by turns by participant Y, and n_Y is the total number of turns by participant Y after any member of the group.

F_G is obtained by summing f for all 6 of the possible pairwise orders and dividing by 3.00 (for a three person group). This gives a score between 0 and 1, where $F_G = 1$ is the most free, or interactive, conversation possible.

Equality and freedom in turn taking are theoretically independent measures; for example the speaker sequence {X, Y, Z, X, Y, Z} has the potential for $E_G = 1$, if all participants speak for equal durations, but $F_G = 0$, as Y always speaks after X, Z after Y and X after Z.

Conversational fluency was assessed in two ways: (i) by counting the number of turns and (ii) by measuring the extent to which those turns overlapped during the 240 s that were analysed for each condition. Instances during which all three group members spoke simultaneously were exceedingly rare, therefore the mean overlap of the three pairwise overlaps (for participants X and Y, Y and Z, X and Z) was used instead.

2.2.2 Analysis of gaze

Gaze for each participant was coded as belonging to one of four states: *socially directed*; *image directed*; *other*; or *ambiguous*. Socially directed gaze was defined as gaze towards the head of any other member of the group, with the participant that was the focus of this gaze also being recorded. Image directed gaze was defined as gaze at the photograph. Gaze was recorded as other when the participant was looking at something unrelated to the task, such as looking at their watch or out of the window, or when looking at nothing in particular while talking. Gaze was coded as ambiguous when it was not clear what the participant was looking at (i.e. their eyes were concealed from the viewpoint of the camera). Only the data for socially directed gaze are reported here.

2.2.3 Inter-rater reliability

An additional rater analysed a sample of 16 video clips, 8 from Experiment 1 and 8 from Experiment 2, from the set of 64 that were recorded for both experiments. Inter-rater reliability for the measures presented here was assessed by correlating scores taken from the second rater's video analysis with those of the first author. In all cases the correlations exceeded .80 and were highly significant ($p < .01$), indicating that the analysis was more than adequately reliable for the purposes of comparing means.

2.3 Results

The analysis of gaze will be presented first, followed by an analysis of verbal behaviour and then the questionnaire results. All of the analyses, including those of the rating data, treat the group rather than participant as the sampling unit. Details of the results of statistical tests are only cited where results reach significance.

Interview data will also be presented in order to illustrate the participants' interpretations of their behaviour. These are intended simply to flesh out the statistical data. It is not surprising

that we can find quotes in line with our hypotheses in these qualitative data, and the existence of such is not taken as supporting evidence for our predictions. However, we suggest that while these qualitative data are not interpretable within a hypothesis testing framework, they do provide additional insights.

2.3.1 Peripheral Awareness and Gaze

A test of the first hypothesis serves as a manipulation check. It is possible that the manipulation of seating had no effect on gaze behaviour in this photo sharing activity. If this were the case, there would be no reason to expect parallel effects on verbal behaviour or ratings of experience. In the event clear effects of seating condition on gaze behaviour were found.

Table 1 gives the total amount of time participants spent looking at each other (socially directed gaze) averaged over the three members of the group (to give a value out of 240 s). The around seating condition results in approximately twice as much socially directed gaze as the behind condition and this is true for both reminiscing and storytelling photos. A two-way within-subjects analysis of variance showed a significant main effect of seating condition ($F(1, 7) = 7.757$, $MS_e = 570.5$, $p < .05$) but no significant main effect of photo content and no significant interaction. It is concluded that the seating manipulation had the desired effect on interpersonal awareness, even though socially directed gaze accounts for a relatively small proportion of the session.

Interview findings. Interviews were conducted after the groups had experienced both seating conditions so that participants were able to compare their experiences. The importance of what was termed “face contact” by one participant was made clear in the interviews. Participants felt that it was important to be able to monitor each other’s reactions to see “whether they’re interested and they want to know more about the subject matter, or whether it’s gone to its natural end”. The advantages of being able to see people out of “the corner” of one’s eye were also noted, with one participant saying “You can see people moving […] so you know if someone wants to say something”. Many of the participants commented on the difficulties of having to turn their head to see their fellow group members, and of having “to pick which side” to turn to.

Table 1. Means (and standard deviations) for measures of gaze and verbal behaviour in Experiment 1.

	Reminiscing		Storytelling	
	Around	Behind	Around	Behind
Mean total time group members spend in socially directed gaze (out of 240 s)	44.1 (28.8)	19.8 (7.0)	45.8 (28.6)	23.0 (17.2)
Mean total number of turns for the group	125.5 (27.74)	121.13 (30.73)	97.88 (22.89)	85.75 (12.89)
Mean mean pairwise turn overlap (s)	11.15 (6.26)	10.68 (7.11)	5.84 (2.72)	4.97 (3.68)
Mean E_G (equality)	0.97 (0.03)	0.93 (0.06)	0.77 (0.12)	0.53 (0.15)
Mean F_G (freedom)	0.95 (0.02)	0.89 (0.10)	0.83 (0.07)	0.66 (0.21)

2.3.2 Verbal behaviour

The next hypothesis to be tested was that in the around seating condition the greater amount of socially directed gaze would result in conversations with features that are indicative of enjoyment and informality, such as fluency, equality and conversational freedom. Conversational fluency was assessed by measuring the number of turns in the conversation and the extent to which turns overlapped. The results, also given in Table 1, are consistent with these predictions but the differences are small. Larger effects were found when comparing across the two types of photo content, with more turns and more turn overlap occurring in the reminiscing condition, as one might expect. This characterisation of the results is confirmed in a two-way within-subjects analysis of variance, where only the main effect of photo content was significant (number of turns: $F(1, 7) = 28.3930$, $MS_e = 279.63$, $p < .01$; mean turn overlap: $F(1, 7) = 16.727$, $MS_e = 14.537$, $p < .01$).

It was similarly predicted that the equality and freedom of the conversation would be higher in the around seating condition than the behind condition. A two-way within-subjects analysis of variance was not considered to be appropriate for these data because of the large differences in the standard deviation for the reminiscing versus the storytelling conditions. Wilcoxon matched-pairs signed-ranks tests show that equality and freedom were significantly higher for the around seating condition than the behind condition during storytelling (E_G: $z = 2.380$, $p < .05$; F_G: $z = 2.100$, $p < .05$). While the same trends are apparent in the reminiscing photo condition these do not reach statistical significance. Comparable pairwise comparisons of the photo conditions show that reminiscing leads to higher equality and freedom than storytelling in both seating conditions (around E_G: $z = 2.521$, $p < .05$; around F_G: $z = 2.380$, $p < .05$; behind E_G: $z = 2.521$, $p < .05$; behind F_G: $z = 2.521$, $p < .05$).

Interview findings. Participants felt that the around seating condition offered more opportunities for “flowing conversation”, whereas the behind condition was “a lot more forced”. The general feeling was that in the latter case, the interaction “was more like a presentation” as opposed to “a group conversation”. One participant noted that “you kind of bounce off other people when you’re having a laugh”, and felt that this was difficult in the behind condition. Most groups also felt that there were differences in conversational equality across the two levels of awareness, with the around condition bringing “a lot more equal input […] from everyone”. In particular, some of the photographers in the behind conditions were conscious of the danger of leaving people out, with one noticing his own bias in turning his head to one group member more than the other, and saying, “I felt I was doing it, I don’t know why […] but I was conscious that it was like S and I were talking”. Similarly, members of the audience found that “you couldn’t kind of butt in, cos you couldn’t make eye contact”. Participants tended not to perceive any divisions in the conversation in terms of the people at the back splitting off and talking between themselves, instead most groups felt that the conversation was “going forwards”, with the audience trying to involve themselves in the conversation by “leaning forwards” towards the photographer.

2.3.3 Rated Experience

Ratings on the positive and negative version of each question were used to derive a composite score on a scale of 1 to 5 and then averaged over the three participants in each group. Questionnaires were completed only after each seating condition was completed, therefore it was not possible to compare ratings across photo content as was the case with the process measures.

The mean ratings of ease, satisfaction, enjoyment, fun, and engagement given in Table 2 assess the personal experience of the participants. In all cases, these are higher in the around condition than the behind condition. Two-tailed within-subjects t-tests showed this difference to be significant in the cases of ease of sharing and enjoyment. The remaining five

scales were intended to examine subjective experience of the group process. Again, these are all higher in the around condition than the behind condition. Two-tailed within-subjects t-tests showed this difference to be significant in the case of group involvement, flowing conversation and photo sharing as feeling unconstrained.

Table 2. Means (and standard deviations) for questionnaire scores in Experiment 1. Scores are on a scale of 1 to 5.

	Around	Behind	*t*(7)	*p*
Easy to share photos	4.40 (0.44)	2.60 (0.81)	6.179	<.001
Satisfying experience	3.79 (0.71)	3.60 (0.62)	< 1	n.s.
Enjoyable	4.19 (0.38)	3.01 (0.60)	4.112	< .01
Fun	3.79 (0.64)	3.42 (0.80)	< 1	n.s.
Absorbing	3.46 (0.97)	3.19 (0.56)	< 1	n.s.
Involved the whole group	4.29 (0.55)	2.96 (0.46)	4.793	< .01
Flexible roles	3.17 (0.80)	2.60 (0.70)	1.185	n.s.
Flowing conversation	4.17 (0.50)	2.82 (0.90)	3.494	< .05
Felt unconstrained	3.83 (0.57)	2.58 (0.49)	4.279	< .01
Felt natural	3.25 (0.96)	2.77 (0.71)	< 1	n.s.

Interview findings. Participants found it easier to interact with each other when sat around the photographer. They felt that photo sharing was “much more natural”, “less formal”, “more relaxed” and “comfier […] because you could sit back”. In contrast, participants found it “quite hard to actually engage in a conversation” in the behind condition, and did not “feel quite as close as a group” because it was more difficult to “group round”. The conversation in this condition was perceived to be more like a “presentation” than “chatting”.

Participants also felt that roles were more “defined” in the behind condition. One group viewed this positively, saying, “It was nice to have somebody who knew what the photos were about [… as] sort of separate”. Although the participants recognised that there were no actual differences in control across the two conditions, because “it was always just one person changing the photos”, there was a perceived difference, with it seeming as though “someone was in charge” in the behind condition. In particular, it was felt that the photographer “couldn’t really tell when the other two had finished looking at the photograph”, making the decision to move on feel less like a “consensus”.

2.4 Discussion

The aim of this experiment was to understand how seating arrangements during photo sharing might influence social behaviour and subjective experience. Firstly, it seems that the manipulation of seating arrangement was successful in affecting levels of peripheral awareness within the groups. It was expected that when the audience were sat behind the photographer, participants would find it more difficult to monitor one another visually. An analysis of the groups’ gaze behaviours showed that groups were unable to compensate for the difficulties of this seating arrangement and instead spent significantly less time looking at one another.

The next prediction was that this reduction in gaze awareness would in turn affect the verbal behaviour of the groups, and that this would be inherently linked with their unfolding

experience. Measures of verbal fluency (number of turns and mean turn overlap) did not yield significant main effects of seating condition; however, there was a significant effect of seating condition on the equality and freedom of the conversation for storytelling photos. In terms of the previous literature, these measures of group process were designed to tap into the occurrence of cooperative floors as an indication of cohesiveness and engagement. The differences that were found indicate that the groups' experiences were affected by the experimental manipulation. Why this should result in significant differences only with the storytelling photos will be returned to in the general discussion.

The final prediction was that recounted experience, as reflected in ratings made immediately after each seating condition, would be influenced by unfolding experience so that the behind seating position would get generally less favourable ratings. This was true for five of the ten rating scales used. Comments made by participants in discussion at the end of the experiment supported these interpretations. Participants reported that difficulties in making eye contact contributed to the lack of conversational equality when awareness was low, and those that took the role of photographer felt that by turning their head to one member of the audience, they were excluding the other.

Taken together these results support the causative model of how social affordance may affect unfolding and recounted experience as set out in the introduction. They also support the idea that the arrangement of group members is an important factor during photo sharing, and one that should be considered when designing affordances for domestic technologies.

3 Experiment 2: Effects of equality of control

Alongside the distinction between huddling and hovering, it is of interest to look at the role of equality of control in photo sharing. Lindley and Monk (2006) suggest that the feeling of formality often associated with digital photo sharing may be related to the explicit nature of the photographer's control. In this experiment, control will be manipulated by providing groups of participants with either one remote control between them, or with one each, while they are viewing their photos on a television screen. The remote controls allow participants to move through the set of photos and to zoom in on specific areas. There are two potential ways this could affect the dynamics of the group: (i) by changing the adoption of roles within the group, and (ii) by providing an additional channel of communication through the shared display. It is therefore of interest to explore whether making control less explicit or easier to share will make photo sharing seem more informal and that this will in turn lead to more positive unfolding and recounted experiences for the participants.

Biddle (1979) has noted that role differentiation within a group leads to the formation of role expectations, that is, behaviours that become associated with particular roles. Roles are already apparent during photo-talk, with reminiscing and storytelling involving different expectations of the photographer and audience members (Frohlich et al., 2002). It is possible that the ownership of artefacts such as the remote control will emphasise these roles further and introduce new expectations. For example, when only one person has access to a remote control, the role expectations for that person may become more akin to those of a leader within the group. When everyone has a remote control, there is more potential for different roles to develop, for example, one person may take the role of moving within the set of photos, and another may take the role of zooming in. Alternatively the roles adopted may be more flexible, passing from one group member to another over time. Shaw (1976) argues that the social environment of a group includes status, roles and norms, as well as the way that members interact with one another. If roles, status or norms are altered, social interaction should also be affected. In particular, it seems likely that if a leadership role is less obvious,

social behaviour will be less likely to revolve around one person, a common difficulty associated with presenting photos on a PC (Lindley and Monk, 2006).

The remote controls are not designed to be used in parallel, and do not have any functionality built in to support multiple users. Consequently the potential exists for clashes to occur. One person may press 'forward' to move to the next slide when another is pressing 'back'. The HCI literature suggests that that this may not be a problem in practice, as one can often rely on social conventions to coordinate simultaneous access to an interface (Rogers et al., 2004; Tang et al., 2006). Indeed, this approach may be preferable to restricting the users' behaviour with formal access controls, as it allows interactions with the technology to remain fluid, but it will only work if collaborators are fully aware of the actions of others (Gutwin and Greenberg, 1996). Awareness can be maintained by monitoring artefacts within the environment and through verbal communication. Research has demonstrated how group members subtly communicate by monitoring shared displays and modifying their behaviour to enhance actions that they believe to be important to others, for example through the use of verbal 'outlouds' (Heath et al., 2002). Furthermore, it has been observed that interaction with a workspace can be used to mediate turn taking and to direct the focus of a group's attention (Tang, 1991). This can be seen as a form of consequential communication (Segal, 1994), or communication through the artefact. If more than one person can change an artefact and the other group members are aware of those changes, then they contribute to communication within the group. In Experiment 2, the remotes in the distributed control condition can thus be thought of as an additional channel of communication, as each person can make changes to the display, which serves as their joint focus of attention most of the time.

Most of the above research is concerned with collaboration at work. The present experiment continues to focus on recreation, using the same photo sharing task as in Experiment 1. It is hypothesised that when control is distributed within the group, the remotes will provide an additional channel for group interaction, breaking the formality of the single control condition. There may also be effects on role adoption, with control of the presentation becoming more flexible as it is distributed within the group. As with the manipulation of seating arrangement in Experiment 1, these changes in social affordance are predicted to lead to a more positive unfolding experience. The groups' interactions should be more enjoyable and sociable, as evidenced by higher conversational equality, higher conversational freedom, more turns and more overlap. It is also hypothesised that this difference in unfolding experience will promote positive recounted experience through the rating scales.

3.1 Method

3.1.1 Design

The experiment had a within-groups design with two independent variables. The first independent variable was control, with two conditions: single (one remote control) and distributed (three remote controls). The second independent variable was photo content, with two conditions: reminiscing and storytelling, manipulated as in Experiment 1. The order of the four possible combinations of control and photo content condition was counterbalanced across the groups.

3.1.2 Participants

There were 11 groups of 3 participants, who were all undergraduate students at the University of York. Three of the groups were excluded from the analysis because they did not talk for four minutes in all of the conditions, giving a final sample of 8 groups. The sample consisted of six groups of females and two groups of two females and one male. Four of the groups had known each other for just under six months prior to the experiment, three of the groups had known each other for between six months and one year, and one group had known each other for between two and three years. The mean age of the participants was

19.37 years, with a standard deviation of 1.08 years. All participants were paid £8 or received course credit for taking part.

3.1.3 Materials

The experiment was run in the dining room of the Responsive Home. For both conditions the participants were sat in a row on three separate chairs, facing a Sony Triniton television with a 21" screen. The photos were shown in the order that they were provided by saving them to a 256 MB flashcard and viewing them using a SanDisk flashcard reader. The slideshow was paused, allowing participants to proceed through the set at their own rate. The participants were provided with either one or three remote controls, with functions to allow them to move forwards and backwards through the set, to zoom in, rotate, and to move a zoomed-in area of a photo up, down, left and right.

The photographer always sat in the middle of the group, with the two audience members on either side. A plan of the setup is shown in Figure 4, and a photo of it is given in Figure 5.

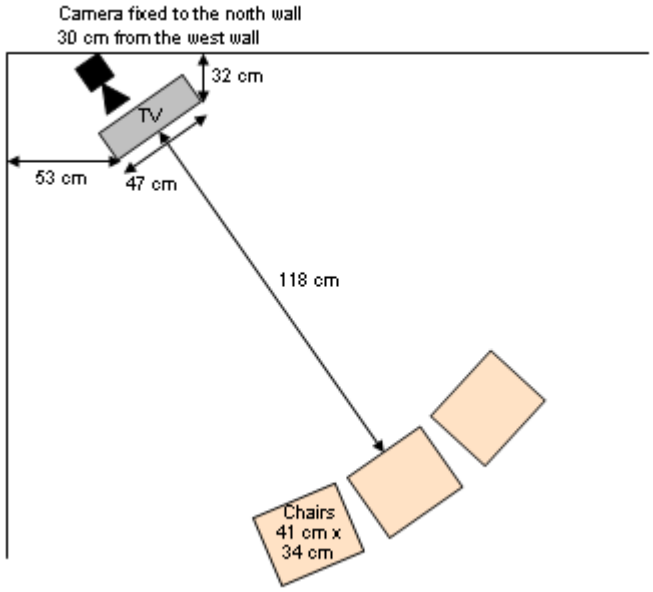

Figure 4. Plan of the experimental setup for Experiment 2.

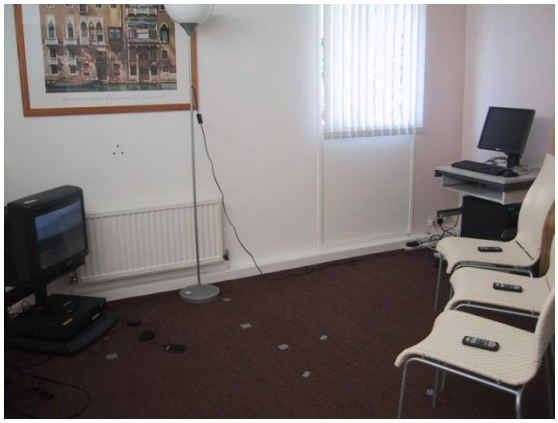

Figure 5. Photo of the experimental setup for Experiment 2.

The participants provided 16 of their own photos each for the experiment. Eight of these allowed for reminiscing conversations and eight allowed for storytelling. One participant's set of photos was used as a practice set, with the other two sets being used in the two experimental conditions. Examples of photo content include Halloween parties, Christmas balls and nights out for reminiscing, and family birthdays, holidays and weddings for storytelling.

The groups' behaviour was recorded using a video camera that was placed on the wall over the television. A view of what they saw on the television was recorded to VHS.

The questionnaires used were the same as those in Experiment 1, with slight rewording to reflect the use of a television and remote controls instead of a tablet PC.

3.1.4 Procedure

The procedure was a slightly modified version of that used in Experiment 1. Participants had a practice phase of 8 photos for the single control condition and 8 photos for the distributed control condition (the order of which was counterbalanced across groups), followed by the two experimental sets of 16 photos. They were told that if they spoke for longer than 15 minutes the experimenter would enter the room and end the discussion.

3.2 Results

Behaviour over the final 240 s of conversation in each of the four conditions was coded using the same approach as for Experiment 1. Additionally, use of the remote controls was coded, with actions such as pressing the Next, Back, Zoom and Rotate buttons being scored as events (with a single timestamp) and moving the zoomed-in area being coded as a state (with onset and offset timestamps). Three groups that did not talk for at least four minutes in each condition were excluded from the analysis.

3.2.1 Equality of Control

It is important to ascertain whether or not the manipulation of equality of control was successful. Although participants had access to remote controls in the distributed control condition, they may have chosen not to use them.

Table 3. Means (and standard deviations) for scores of the equality of overall remote control usage, equality of use of the next and back functions, and equality of use of zoom, move and rotate functions. Equality is scored from 0 to 1.

	Reminiscing	Storytelling
Mean equality of overall remote control usage	.69 (.33)	.67 (.20)
Mean equality of next and back functions	.40 (.35)	.30 (.32)
Mean equality of zoom, move and rotate functions	.69 (.31)	.57 (.35)

Table 3 gives descriptive statistics for the groups' usage of their remote controls in the distributed control condition. All instances of using the remote control to interact with the television were summed for each participant. Equality of remote control usage was then calculated using the same statistic that was used to calculate equality of turn taking in Experiment 1 (using frequency rather than duration). This would result in a score of 0 if only one person used the remote control, and a score of 1 if the three participants used the remote controls completely equally. Equality was of course always zero in the single control condition. In all cases the equality scores in Table 3 are considerably greater than zero indicating that members of the group did share control of the display. The next and back functions that control which photo is visible show less equality than the zoom functions, as the former tended to be used by the photographer.

Interview findings. In general, participants reported that they did use the remote controls when they had access to them. However, some groups perceived that roles had developed regarding who used which features. In particular, they noted a distinction between moving on to the next photo and zooming in and out of the images. One participant said, "I think maybe the person whose photos [they were] was making it move on more, but we were all zooming in and out". One commented that he was less likely to interact with the photos in the storytelling sets because "it's someone else's little bit of life isn't it, so you don't think… it's not a lot to do with you". However, not all participants felt this way, with one commenting, "I got bored with the ones I didn't know […] sometimes I'd skip, like press the next button, probably after less time [than during reminiscing]". These different approaches to using the remote controls may explain why the variance in the data is so high.

3.2.2 Verbal behaviour

It was hypothesised that the conversation would be less formal in the distributed control condition than the single control condition and that this would be reflected in patterns of social interaction that are indicative of a positive unfolding experience. This was assessed by measuring the number of turns, mean turn overlap and the equality and freedom of the conversation, as in Experiment 1. The results are given in Table 4, which confirms the prediction that the mean number of turns per group is greater and the mean turn overlap is larger in the distributed control condition. Equality and freedom of turn taking are also both higher when control is distributed than when it is single, for both types of photo content. Additionally, equality and freedom of turn taking are higher during reminiscing than during storytelling.

Table 4. Means (and standard deviations) for various measures of gaze and verbal behaviour in Experiment 2.

	Reminiscing		Storytelling	
	Distributed	Single	Distributed	Single
Mean total number of turns for the group	128.5 (18.57)	114.88 (15.07)	113.13 (31.17)	91.75 (24.33)
Mean mean pairwise turn overlap (s)	11.57 (9.27)	8.35 (5.11)	6.54 (5.55)	5.56 (4.62)
Mean E_G (equality)	.97 (.02)	.90 (.08)	.71 (.21)	.63 (.22)
Mean F_G (freedom)	.97 (.03)	.86 (.10)	.72 (.25)	.68 (.23)

An analysis of variance of the number of turns revealed statistically significant main effects of control ($F(1, 7) = 9.178$, $MS_e = 266.93$, $p < .05$) and photo content ($F(1, 7) = 11.199$, $MS_e = 264.71$, $p < .05$). Analysis of the mean turn overlap revealed a significant main effect of photo content ($F(1, 7) = 20.505$, $MS_e = 5.970$, $p < .01$). No other main effects or interactions reached significance. As the variance for the scores of equality and freedom is much larger for storytelling than for reminiscing, a non-parametric analysis using Wilcoxon matched-pairs signed-ranks tests was used for these data. This revealed significant differences between distributed and single control for reminiscing (E_G*: z* = 2.100, $p < .05$; F_G: z = 2.521, $p < .05$) but not for storytelling conversations. Differences between reminiscing and storytelling photos were significant in the distributed (E_G*: z* = 2.240, $p < .05$; F_G: z = 2.100, $p < .05$) and single (E_G*: z* = 2.240, $p < .05$; F_G: z = 2.380, $p < .05$) control conditions.

Interview findings. The participants did report differences in their behaviour across the four conditions, with one saying that when she was the only person to have a remote control, “I felt like I was doing all the talking”, and another saying, “I felt a bit like I was doing a cheesy slideshow”. Members of the audience also described the situation as feeling “like a presentation, so if it was just one person with it you felt like you had to be kind of quiet”. In contrast, the condition with three remote controls was described as “sharing rather than one person showing”, and as a “discussion” rather than a “question and answer” session.

3.2.3 Rated Experience

The questionnaire results were calculated using the same method as in Experiment 1, using composite scores from 1 to 5 for each group. Descriptive statistics for the participants’ ratings are given in Table 5 along with the results of a two-tailed within-subjects t-test. All the mean ratings are more positive in the distributed control condition. Considering the ratings of personal experience first, only fun provides a significant difference. This can be contrasted with the ratings in Experiment 1 where there were significant differences of seating condition in ease of sharing and enjoyment. The lack of an effect on ratings of ease of sharing in Experiment 2 is understandable. Why enjoyment should show a significant effect in Experiment 1 and fun in Experiment 2 is less clear. In this experiment the big differences were in ratings of the group process, all of which show significant positive differences in favour of the distributed control condition, in line with the predictions made in the introduction.

Table 5. Means (and standard deviations) for questionnaire scores in Experiment 2. Scores are on a scale of 1 to 5.

	Distributed	Single	*t*(7)	*p*
Easy to share photos	3.88 (0.41)	3.48 (0.84)	1.048	.330
Satisfying experience	4.08 (0.31)	3.79 (0.62)	1.643	.144
Enjoyable	3.96 (0.49)	3.5 (0.85)	1.883	.102
Fun	3.98 (0.48)	3.42 (0.65)	3.264	< .05
Absorbing	3.77 (0.44)	3.33 (0.63)	1.649	.143
Involved the whole group	4.21 (0.39)	3.17 (0.82)	3.434	< .05
Flexible roles	3.75 (0.49)	2.38 (0.75)	6.011	<.01
Flowing conversation	4.02 (0.55)	3.23 (0.85)	3.890	< .01
Felt unconstrained	3.50 (0.77)	2.67 (0.54)	2.837	< .05
Felt natural	3.50 (0.53)	2.94 (0.88)	2.409	< .05

Interview findings. Participants reported a stronger element of fun when they had access to three remote controls. One said, “It was quite funny when everyone clashed with the remotes”. However, the downside of this was that “it could get a bit annoying when everyone messed it up” and that it could be “confusing”. Another positive element of having equal control was that “there was more chance of something funny coming out of it” because everyone can zoom in, thus highlighting things that others “didn’t actually spot”.

Participants also noted a difference in the level of formality of the experience. They felt that when there were three remote controls, it gave a greater sense of “freedom, if you do want to swap [control]” and had the potential to be more “engaging”. They also found it “easier”, with one participant saying, “You can just do it without having to say like ‘ooh zoom in’, you can just do it instead of having to get permission or whatever from the remote holder”. The general feeling was that in the distributed control condition, the experience involved everyone more. One participant said, “It was nice that everyone had to listen to each other, to say ‘hang on a minute let’s go to the next picture’ or ‘let’s look there’ cos then it really involved everyone”.

In addition to the interview findings, the open questionnaire responses also included some interesting points. One participant noted that having only one remote control encouraged people to work “more as a group”, and she also noticed that having three remote controls allowed people to be included without “having to ask or involve yourself in the conversation”. Another participant described how the distributed control condition meant that “you felt included even if you didn’t use [the remote controls]”. From the photographer’s point of view, having three remote controls was more enjoyable because it “took the pressure off” while she was describing the photos.

3.3 Discussion

The aim of this experiment was to understand how changing the social affordances of photo sharing by giving every member of a group a remote control could affect behaviour and experience. The first question addressed by the data concerns the degree to which participants engaged with the remotes in the distributed control condition, which was summarised in terms of the equality of remote control actions across the group. This was higher for use of the zoom, move and rotate functions than for the next (photo) and back

functions, but in both cases the remotes are clearly being used by all the members of the group. Interestingly, there was little difference between equality of use of these functions across the two photo content conditions, despite some participants noting that they chose not to use their control, especially during storytelling conversations.

The positioning of the TV display and the nature of the task meant that interaction could be facilitated between group members by their using the remotes in the distributed control condition. Thus having established that participants in this condition were indeed using their remotes it was hypothesised that this would lead to more enjoyable and informal conversation, as indicated by more turns and more turn overlap, and higher conversational equality and freedom. The results show significantly more turns and higher equality and freedom of turn taking for reminiscing conversations. The lack of a significant difference for storytelling may be related to the higher variance in the data for the measures of equality and freedom. The interview findings suggest that groups might have reacted differently to the distributed control condition with the storytelling photos, some staying with the more formal approach of giving control to the photo owner in this context and some opting for the more anarchic social dynamic observed with the reminiscing photos. However, this is not reflected in the standard deviations for the equality of remote control usage statistics (Table 3). A more likely explanation is that the social conventions associated with reminiscing make it easier for equality of control to have an effect. Comparisons of reminiscing and storytelling conversations are consistent with Experiment 1, with reminiscing being more equal, more interactive, and more fluent.

The majority of the questionnaire results are also in the predicted direction. Participants found photo sharing to be more fun, less constrained and more natural when equality of control was high. Additionally, they felt that roles were more flexible, that everyone was involved more and that the conversation flowed better. The results are similar to those from Experiment 1 in that the condition that was rated more positively was the one that afforded a more equal and interactive conversation, and also in this case, higher conversational fluency. This lends further support to the idea that these process measures are related to important aspects of the overall experience of photo sharing.

One difference between these two studies is that ratings of fun differed significantly when equality of control was manipulated, but not when seating arrangements were changed. Participants noted that the “jostling” involved when everyone had a remote control was fun. Additionally, the functionality offered by the remote controls makes it possible to zoom in on funny sections of the photos or to rotate them for comic effect. In contrast, perhaps the enjoyment afforded by a closer seating arrangement and higher peripheral awareness relates to the quality of the conversation itself.

In conclusion, Experiment 2 has provided a further example of how social affordances can affect both unfolding and recounted experience in the recreational task of photo sharing. Giving everyone an additional communication channel via a remote and the display affected verbal behaviour and rated experience very much in the way that changing seating arrangements did in Experiment 1. It thus lends further support to the model of how social affordance may affect unfolding and recounted experience that was set out in the introduction. This suggests that facilities for control of a photo presentation are important and should be considered when designing affordances for domestic technologies.

4 General discussion

This paper set out to address the topic of how technology can be better designed to support usage by collocated groups in the home. It is distinctive in two main respects: (i) a

recreational activity, photo sharing, was adopted requiring an emphasis on experience as opposed to efficiency or classical usability; (ii) the data presented are mostly quantitative and compare controlled manipulations in two experiments. These aspects of the work will be considered in turn.

Most previous research into the development of sharable technologies has been carried out in the context of the workplace, with the aim of increasing productivity and supporting the attainment of clear goals. However, HCI research in general has become more attuned to the significance of user experience, and this concept is particularly relevant in the home, where enjoyable and sociable experiences need to be supported. A causative model was set out in the introduction as a framework for thinking about how user experience might be measured. This draws on the distinction between unfolding and recounted experience (McCarthy and Wright, 2004); the concept of affordances for social interaction (Gaver, 1996), and Edelsky's (1981) characterisation of informal social interaction as evidenced by group behaviour and the concept of the cooperative floor. The causative model posits that social affordance can affect group behaviour and thus unfolding experience, which, in turn, affects recounted experience. Group behaviour and individual unfolding experience form a tight feedback loop, allowing group behaviour to be used as a proxy for the assessment of unfolding experience (see Figure 1). The parallel effects of our experimental manipulations on conversational equality and freedom on the one hand, and rated experience on the other, support this model.

Finding an alternative to experience sampling to assess unfolding experience with social activities is a challenging problem (Mandryk *et al*., 2006). Those authors criticise the use of video analysis of behaviour for this purpose on the basis of its time-consuming nature. While this is a problem, these experiments have demonstrated the possibility of getting significant results with relatively small sections of video record (4 m). Mandryk *et al*. propose a physiological approach as an alternative to both experience sampling and video analysis. They claim to be able to distinguish between five different emotions including fun, frustration and excitement when data from electrodes that sense activity in the muscle groups associated with smiling and frowning are combined with a measure of arousal inferred from skin conductance and heart rate. However, physiological approaches such as this may not be feasible for activities like photo sharing because of movement artefacts in the EMG record where participants are talking.

The use of video analysis in the present study permitted a very thorough examination of group behaviour for the four minute time periods that were analysed for each condition. Because the analysis was focused on small sections of the session, efforts were taken to ensure that the behaviour sampled was not unduly influenced by the novelty of the situation. For both experiments groups experienced an initial practice session lasting approximately 10 minutes, followed by a period of photo sharing lasting for about five minutes before the first four-minute analysis period began. Therefore groups had been using the configuration for an average of at least 15 minutes before the first analysis period, and often for up to an hour before the final section of video to be analysed was reached. The fact that statistically significant results were obtained indicates that a sufficient amount of video was analysed and that this was representative enough of each condition to show how the experimental manipulations affected behaviour. It would, of course, be very interesting to see whether the effects observed were stronger or weaker after extended use more typical of existing photo sharing displays.

An additional distinctive feature of this research is the use of an experimental method as opposed to a more open-ended ethnographic field study approach. There has been little previous work on the use of experiments when examining recreational experiences, and research that has been undertaken in this area has struggled to find statistically significant

effects (e.g., Monk and Reed, 2007). In designing these experiments it was necessary to devise a new experimental task, new experimental manipulations and to select appropriate quantitative measures. The task was made as natural as possible by using groups of friends that knew each other well, asking them to bring their own photos to talk about, and setting the experiment in a domestic environment. The comments of participants and the ratings obtained after the activity indicate that they saw this as an enjoyable and natural activity. Conversation flowed and the interventions of the experimenter or the presence of cameras did not appear to overly distract them.

While the measures adopted provide results that are consistent with the predictions made, the pattern of statistical significance is slightly complex. The manipulation of seating in Experiment 1 was found to significantly affect conversational equality and freedom during storytelling conversations. In contrast, the manipulation of control in Experiment 2 was found to significantly affect conversational equality and freedom during reminiscing conversations. It is probably unwise to read too much into this pattern of significant results. A repeated measures design with eight groups is close to the minimum needed to detect even a large effect; furthermore, there were clear ceiling effects on equality and freedom in the reminiscing conditions. While the latter could explain the results for equality and freedom in Experiment 1, it cannot do so for Experiment 2, where reminiscing is the condition to show a significant effect. We cannot say from these results that there was no effect, or even a significantly smaller effect, in one photo condition as opposed to another (see Lindley and Monk (in preparation) for a discussion of the sensitivity of measures of group behaviour). It is, however, possible to speculate about why the effects of our manipulations might have been stronger in some cases than others.

Manipulating the seating condition may have had larger effects on equality and freedom during storytelling in Experiment 1 because peripheral awareness may be less important during reminiscing conversations. When reminiscing, the large amount of common ground relating to the topic under discussion makes it relatively easy for group members to contribute to it. Even when peripheral awareness is low, and it is difficult for the speaker to 'invite' someone else to take the floor, group members should feel quite comfortable chipping in. Furthermore, the lack of formality in reminiscing conversations and the prevalence of overlapping speech associated with this type of photo-talk (Frohlich *et al*., 2002) should make it more acceptable to interrupt others or to speak simultaneously with them. For these reasons a lack of awareness may not affect reminiscing conversations as much as it will affect storytelling, which involves little common ground and is more formal in its nature.

The ease of contributing to the conversation during reminiscing makes it all the more surprising that significant differences were found in this type of conversation when equality of control was manipulated. It is possible that the use of a single input device during reminiscing conversations introduces a role in which the owner of that input device takes the lead. As this role is already quite evident in storytelling conversations (only the photographer can tell the 'story' of the photos) the introduction of multiple remote controls has a reduced effect for this type of photo content.

Across the two experiments, the manipulations were found to affect conversational equality and freedom, whereas the number of turns was only influenced by the manipulation of control, and turn overlap showed no significant effects for either of the primary manipulations. However, both were significantly affected by the two manipulations of photo content. It may be that these measures were not sufficiently sensitive to pick up the differences in unfolding experience caused by the other experimental manipulations; while reminiscing and storytelling conversations have fundamentally different properties, alterations of seating and control had more subtle effects on conversation. Lindley and Monk (in preparation) present an

analysis of the reliability and sensitivity of several measures of group behaviour, including those that showed weak effects here and some others that are not presented in this paper.

4.1 Further Work

Two possible interpretations of the effects of providing multiple remote controls were suggested in the discussion of Experiment 2. One is that the distributed control condition has its effects because it permits communication through the display. The other is that multiple remotes change the roles adopted by group members, with a single remote forcing the person holding it into a position of control. Both are probably important in this experiment but it would be interesting to examine some manipulations that favour one or the other. For example, one could devise an input device that only permitted one user to have control at a time thus minimising the possibility for communication through the display. The same device could facilitate, or force, changes of ownership of control thus permitting effects on role flexibility.

There is also room for detailed qualitative work to examine how control is negotiated within a group with distributed control. In Experiment 2, the technology placed no restrictions on who could use the remote controls or when they could do so. The flashcard reader simply responded to the first signal that it received. Despite this, clashes were rare and participants tended to govern their usage of the controls to fit the conversation. When the discussion revolved around a person on the left of the photo being displayed, it was common for more than one group member to try to zoom to the left. This was not disruptive as the group members concerned were aiming to perform the same action. It seems that a range of cues implicit within the conversation, and possibly also derived by glancing at one another's remote controls, were used to coordinate behaviour.

As suggested above there is a need for further experiments. The approach that has been devised here could also be applied in different contexts and to improve understanding of the effects of different social affordances. For example, one could manipulate the tangibility of an interface or the proximity of participants. It would also be interesting to manipulate the composition of the groups to include families and younger or older groups of friends, and to look at groups of different sizes. There is also potential to expand further the process measures presented here as proxies for unfolding user experience. Lindley and Monk (in preparation) offer a first step towards this.

4.2 Implications for design

Experiment 1 demonstrates the potential importance of ensuring that the design of displays, and the spaces in which they are used, afford good interpersonal awareness. While the experiment manipulated seating it seems reasonable to speculate that any design decision that affects social awareness could have similar effects on social enjoyment. A display with a wide viewing angle will allow group members to arrange themselves so that they remain in one another's peripheral vision and can easily glance across at one other. For the home PC, wireless input devices coupled with a large monitor may support peripheral awareness by removing the constraint of one person having to sit directly in front of the monitor. When using very large vertical displays, which cannot easily be viewed at close range, one should encourage all group members to sit together through the use of remote input devices, as opposed to touch- or stylus-based interfaces that require one group member to locate themselves, and possibly isolate themselves, at the screen.

Experiment 2 similarly demonstrated the potential positive effects of distributing control when supporting recreational activities for collocated groups. Distributing control can allow group members an additional channel of communication through the display. Alternatively, input devices might be chosen that differ to the extent with which control can be handed from one

group member to another. For example, a remote control may be more likely to change hands than a mouse. However, technologies in which there is no input device, such as touch screens, may afford the most equal type of control, and would be appropriate with a smaller screen that groups can huddle around. Avoiding a single input device means that there is no artefact that could encourage the development of a central role. Of course, in some circumstances there may be advantages to encouraging a central controlling role, and the influence of interface design on behaviour and experience will be mediated by task. Similarly, peripheral awareness may be less important in a context where facilitating equal and interactive conversations is not important.

As indicated above, these implications for design need to be replicated and fleshed out with further research. Perhaps the major contribution of this paper is to demonstrate that an experimental approach can be successfully adopted when considering interface design in a recreational and social context. This was made possible by adopting a causative model of user experience where unfolding experience is seen to be observable from group behaviour and recounted experience accessible through ratings.

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