

Exploring Mutual Engagement in Creative Collaborations

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ABSTRACT

Group creativity is a fundamental form of human activity. In this paper we explore what constitutes *mutually engaging* interaction between people – interaction in which creative sparks fly and we lose ourselves in the joint action. In this paper we present the results of an experiment to compare the effect representation of identity in a user interface, and task instruction, has on mutual engagement between remote participants. Surprisingly the results indicate that providing no cues to identity increased mutual engagement between participants. We also discuss the appropriateness of quantitative, qualitative, and self-report data for identifying points of mutual engagement.

Author Keywords

Collaboration, creativity, mutual engagement, design, evaluation.

ACM Classification Keywords

H.5.3 Group and Organization Interfaces; H.5.2 User Interfaces: Theory and methods.

INTRODUCTION

We are fundamentally social, creative creatures, yet our understanding of the technology we develop has conventionally focused on individual work oriented activities. Recently there has been a move away from this position with the acknowledgement of the importance of collaboration cf. [19][5] and enjoyment [1]. In order to move further along this path we need to examine the forms of interaction evident in creative collaborations and start to understand what it would mean to design for this rich behavior. We propose that a key feature of creative collaborations are the points at which participants are *mutually engaged* with each other - the points at which people *spark* together, lose themselves in their joint action, and arrive together at a point of co-action ‘where you are

when you don't know where you are’ [18]. In such situations participants are involved in activities which are focused and directed, yet sociable and enjoyable. The key question we explore is how mutual engagement can be supported when collaborators are not in the same space. In these situations we need to consider how to bring people together through technology in situations without the rich cues that normally support mutual engagement.

In the rest of this paper we outline what mutual engagement is and how it relates to other views of creative collaborations. We then discuss designing for mutual engagement and detail a study of the effect a user interface feature has on mutual engagement. We discuss the results of this experiment and consider the kinds of data we might collect to identify points of mutual engagement. Finally we conclude the paper and point to future research directions.

MUTUAL ENGAGEMENT

Engagement with technological artifacts can be characterized as a point at which participants are able to change and appreciate changes in the form being produced through the artifact [7]. We see similar phenomena in accounts of *flow* [6] - optimal experiences in which ‘attention can be freely invested to achieve a person's goals’ which results in a merging of action and awareness and consequent lack of self awareness and distortion of sense of time. Moreover, in order to achieve flow, there needs to be a balance between the skill of the person and the challenge of the activity.

In *mutual* engagement participants are engaged with both the product at hand *and* with others in the collaboration, which we could characterize as *group flow* cf. [15]. Similarly, Miell and MacDonald [12] propose that mutually engaged states are indicated by the ‘presence of reasoned dialogue, the exploration of the ideas of more than one person and the attempt to integrate these’. Their work on analyzing the interaction between pairs of children involved in creative musical composition focused on the effect friendship had on mutual engagement. They focused on examining the forms of musical interaction and the content of chat between friends and non-friends, and found that pairs of friends engaged with each other more in joint music composition tasks. In contrast, Sawyer's work focused on ethnomethodological exploration of larger groups and the group flow evident in their interaction. He studied groups in

a variety of settings including theatre and musical improvisation. In these group situations it is not only the interaction within the group that is of interest, but also their interaction with the audience and the wider sociological context that shapes their behavior. Primarily his work focused on descriptions of the interaction in order to explicate what it means to experience group flow.

Our focus is on identifying and manipulating key attributes of artifacts which have an effect on participants' ability to mutually engage with each remotely other through technology. Our position is that mutual engagement is essential to high quality collaboration which constitutes interaction beyond routine tasks or transactions. For example, collaborative design, improvisation, brainstorming, gossip and gaming all involve high levels of mutual engagement.

Identifying Mutual Engagement

Points of mutual engagement are inherently difficult to identify and measure as the act of reflecting on mutual-engagement undermines some of the characteristic qualities of the experience such as spontaneity. For current purposes, we propose that the key characteristic of mutual engagement is that it involves engagement with both the products of an activity and with the others who are contributing to those products. So, it is a form of creative activity where we are: a) involved in self-expression and yet b) we co-create the product with other people.

In order to identify points of mutual engagement in collaboration we propose examining the forms of interaction that take place between participants. This reduces the reliance on subjective, introspective assessment of participants' feeling state as is often used to identify points of flow cf. [6]. Furthermore, we follow Monk and Watt's critique of the appropriateness of task analysis [19] for collaborative work in which they argue for the objective analysis of communication rather than subjective introspective analysis of tasks and roles. Similarly, our approach allows us to objectively identify points of mutual engagement without subjective analytic modeling of the activities per se.

In terms of joint production we propose that the following features of interaction indicate points of mutual engagement:

- **Proximal interaction.** In environments with a spatial metaphor we propose that participants will work closer to each other when they are mutually engaged.
- **Mutual modification.** Increased mutual engagement is indicated by increased modification of each others' contributions to the joint production.
- **Contribution to the joint production.** Increased contribution to the joint production, as opposed to contribution to individual productions or discussion of logistical issues such as technological problems, (cf.

articulation of the task [9]) indicates increased mutual engagement.

- **Attunement to others' contributions.** As participants engage with each other they will start to repeat, or transform each others' contributions. In previous work [3] we suggested identifying points of attunement between participants as indicators of mutually engaging collaboration. These are points at which participants respond not only to major changes, or contributions, but also to smaller moment-to-moment changes in interaction. This framework has strong parallels to the alignment of words and gestures in everyday conversation which indicates a level of interaction and engagement with each other where joint meaning and understanding is being created [17]. However, by focusing on attunement of action, we do not limit ourselves to verbal or gestural interaction. Identifying these points of attunement relies on meta-level analysis of patterns of behaviour which is outside the scope of this paper. In this paper we use this idea to define three levels of mutual engagement indicated by attunement:
- **Acknowledgement** – participants show that they are aware of the contribution of another – a basic level of engagement.
- **Mirroring** – participants mirror, or reflect, others' contributions indicating a medium level of mutual engagement as they are able to (re)produce others' contributions.
- **Transformation** – participants transform others' contributions, demonstrating an understanding of the content and intent of others' contributions – a high level of mutual engagement.

DESIGN

Ijsselsteijn et al. [11] distinguish between the goal-oriented and social/ emotional oriented purpose of communication. In their view CSCW informs design of support for the former, and research on connectedness informs design for the latter. We see mutually engaging activities as residing at the boundary between goal and emotional oriented communication. There is very little work on designing for this form of interaction, yet, as discussed in the previous section, we do have some understanding of what mutually engaging collaborations might be like.

In a previous study [2] of the use of the remote group music tool WebDrum II [4], and from features of human communication in musical interaction, we identified three design features from the CSCW literature which we believed would contribute to mutually engaging collaborations. These are briefly outlined below in order to illustrate the kinds of design features we see as important:

- **Mutual awareness** of actions. In normal conversation we are aware of who is contributing what by virtue of our co-location. We proposed that awareness mechanisms cf. [10] are important to the emergence of mutual

engagement. For example, highlighting new contributions to the joint product, and representing authorship - who made contributions. Such cues give participants a sense of self and otherness in their interaction. We use the term *mutual awareness* to distinguish it from *workspace awareness* [10] as we are interested in awareness mechanisms which focus on creative interaction rather than workplace management.

- **Shared and consistent** representations. In conversation we share the same aural space, and to some extent the same visual space. This consistency needs to be retained in collaborative systems, for instance by ensuring that all views on the joint product are the same. Similarly, Robertson [14] identified the shared nature of representations as a key aspect of shared activities in a shared physical space. We would expect that collaborators would find it easier to co-locate their contributions, and mirror others' contributions, with a shared and consistent representation.
- **Mutual modifiability.** From studies of tool use it was clear to us that being able to modify each others' contributions is important for mutual engagement. Mutual modifiability implies an egalitarian approach to role assignment within the tool rather than explicitly enforcing role mechanisms – in such an approach participants co-ordinate their activity in a subtle and dynamic manner [8].

USER STUDY

In order to objectively evaluate the effect user interface features have on mutual engagement we need to examine the interaction that takes place in a creative collaboration. To this end we undertook a study of the use of the collaborative music tool – Daisyphone [2]. Music collaboration provides us with a basic and underexplored form of interaction with which to explore the features of mutual engagement. Indeed, it is the paradigmatic example of a form of human interaction in which engagement, innovation, and ensemble co-ordination are key objects of the interaction, and which involves ‘performers whose choices are continuously modifying and transforming each other’ [16]. Previous studies of the use of Daisyphone [2][3] concentrated on qualitative assessment of patterns of interaction between participants. In this study we aimed to explore the utility of different forms of data collection in assessing levels of mutual engagement. We collected quantitative measurements of interaction, qualitative assessment of patterns of interaction, and subjective participant responses to their experience of the collaboration. These are then used to compare the effect user interface features had on mutual engagement, and to understand how best to assess mutual engagement.

Daisyphone

Daisyphone is a remote collaborative music environment in which up to 10 remote participants can create and edit a short shared loop of music semi-synchronously – typically

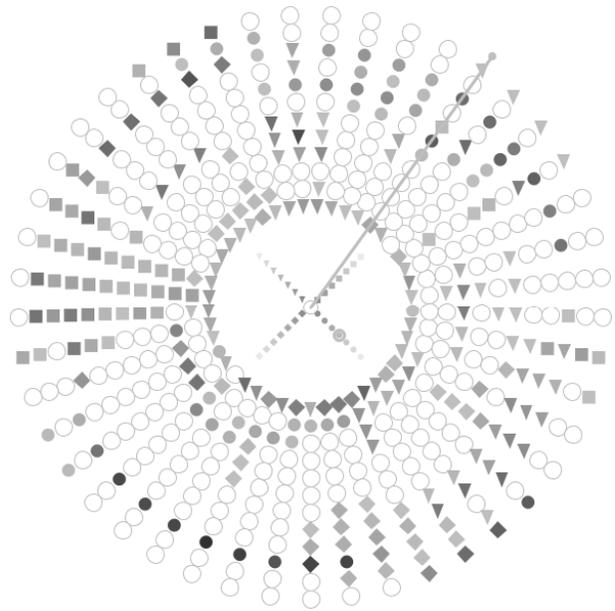


Figure 1. The Daisyphone user interface

updates take under one second to be shared. This provides support for a form of remote group music interaction whilst requiring little network bandwidth. As with other remote group improvisation tools such as WebDrum [4], Daisyphone works by remote clients sharing indications of musical contributions via a central server through the internet and providing a shared and consistent representation of musical loops being constructed.

There is no restricted ownership of contributions or instruments in Daisyphone – people can edit each others' notes and play the same instruments. Indeed, Daisyphone has no explicit notion of public or private contributions. It is worth noting that in previous studies [2] we identified examples of players using different parts of the loop as their own space, and only contributing to the ‘joint’ composition over time.

The Daisyphone user interface is illustrated in figure 1. Notes are lower in pitch towards the edge of the circle. As the grey arm rotates clockwise, the notes underneath are played, so each of the spokes represents notes played at the same time. Hues of notes indicate who contributed them (this can be systematically manipulated), and intensity of color represents the volume of the note (note that colour has been removed from all illustrations in this paper). Different shapes represent different instruments including piano (circle), and rhythm (diamond). Volume levels and instruments are selected from the four central spokes.

Experimental Design

In previous qualitative studies [2][3] identification of ownership of contribution was repeatedly identified as an important design feature. Similarly, work such as Gutwin and Greenberg [10] stress the importance of identity in collaboration with the ‘who’ category forming a key part of

their framework for understanding workspace awareness. In terms of our design features, this forms a core part of providing mutual awareness of action – participants need to be aware of both who is contributing, and what they are contributing.

We also found that the structure of activities (from undirected play to use as part of assessed coursework) with Daisyphone changed participants interaction with each other. We see this as similar to the key concept of ‘collaboration readiness’ [13] – the willingness and incentive to collaborate. Therefore, for this study we decided to focus on the effect identification of contribution had on mutual engagement as well as the effect of motivation for the collaboration. This leads to two hypotheses:

- From our design principles we hypothesized that: **H1**: mutual engagement would be greater where people have explicit cues to attribution of actions.
- Given that mutual engagement is in part a product of the motivation of participants we hypothesized that: **H2**: mutual engagement would be greater where people were encouraged to collaborate.

Two independent variables were manipulated:

- A within-subjects factor of **Instruction** (Collaboration vs. Skill). In the Collaboration condition participants were instructed to work as collaboratively as possible; in the Skill condition they were instructed to attempt to demonstrate the most skill in using the interface
- A between-subjects factor of attributed **Identity** (Cue vs. No cue). In the Cue condition participants’ contributions were distinguished by hue, whereas in the No cue condition all contributions were based on the same hue.

In order to objectively identify points of mutual engagement we measured three dependent variables derived from the indicators of points of mutual engagement outlined at the start of this paper:

- **Proximal interaction** measure: closeness of participants’ contributions to others’ contributions.
- **Mutual Modification** measure: number of deletions of participants’ own notes, and other participants’ notes.
- **Contribution to joint production** measure: number of notes contributed.

In addition we examined logs of the interaction to identify points of **attunement to others’ contributions** exemplified by repetition and transformation of others’ patterns.

We restricted communication between participants to musical contributions. This allowed us to explore how mutual engagement is sustained without recourse to verbalization. Indeed, the structure of social musical interaction is similar to that of conversation in that it is typically co-present and multimodal; the contemporaneous nature of music interaction provides a novel aspect of interaction to explore. Moreover, given Miell and

MacDonald’s [12] emphasis on the ‘presence of reasoned dialogue’ as an indicator of mutual engagement we wanted to explore what form this musical dialogue might take when no verbal communication channels were available. Moreover, ongoing public use of Daisyphone on an unmoderated website without text chat facilities for the last four years without suggests that mutual engagement was possible purely through the musical interaction.

Logs of interaction were kept for qualitative analysis of the patterns of collaboration that emerged in the experiment.

Participants

Advertisements were posted at the authors’ college campus, and 24 students were recruited to participate in the study (10 male, 14 female, average age 21). We offered £10 per participant as an incentive to take part in the study. We specifically did not recruit any Computer Science students as they may have taken courses on interface design and collaboration in the department. Moreover, they would have extensive experience of using computers which may have biased the results. All participants were novice users with no previous experience of using Daisyphone. In order to focus on the engagement between participants rather than initial social encounters participants were recruited as pairs of friends. Indeed, Miell and MacDonald [12] posit that pairs of friends would be more likely to become mutually engaged than non-friends, so selecting pairs of friends increases our chance of observing the behaviour we are interested in. All pairs had known each other for at least six months in a social or study capacity, and some had previously worked together on student projects. Whilst using pairs of participants meant that a participant would always be aware of the origin of contributions (as contributions were always either their own or the other participant’s), over time the large number of contributions in a typical Daisyphone session makes it difficult for participants to be sure who contributed what if there is no explicit representation of authorship. All but 1 participant regarded themselves as ‘beginner’ musicians, with 1 participant rating themselves as ‘intermediate’.

Procedure

The study took place in our lab which consists of two interconnected rooms. One participant sat in each room with a tablet PC running Daisyphone. They wore headphones to hear the sound produced by Daisyphone and could not directly see or hear the other participant – the only communication between participants was through Daisyphone. One facilitator moved between the rooms and had access to another PC on which they could view the progress of the participants. A video camera on a tripod recorded a view of one of the participants.

Participants were briefed that they were trialing the Daisyphone software in order to see how well it works in different situations. Additionally they were informed that the software records all actions using made using the interface, and that this data would be used for research

purposes. They were then asked to sign consent forms for subsequent use of software logs, audio and video recordings, and questionnaire responses. They were also asked to complete a demographic questionnaire. All data was held anonymously

Their tasks were to work together with a partner to jointly remotely compose two ringtones for a 12 year old boy. They worked for up to 20 minutes on each composition – from previous studies we found that 20 minutes was typically the maximum time people would spend creating one short loop (6 secs) in Daisyphone. Participants were told that they could stop the task at any point and would still be given their cash incentive. Their task motivation was manipulated between compositions; they were either instructed to work as collaboratively as possible, or to demonstrate the most skill in using the interface. Order of task instruction was randomly changed. They were also told that their interaction would be judged for collaboration/skill (depending on the instruction) and that the best examples from the study would win cash prizes.

After each joint remote composition had taken place, a post-task interview composed of open questions and ratings of the participants’ interaction and their perception of their experience was completed by the pairs of users. The ratings scale was “lots / sometimes / medium / not much / not at all”, and related to the questions in table 1. These questions were aimed at identifying whether participants understood the nature of their collaboration. We also asked participants to rate each question in relation to their partner e.g. the first question was rephrased as “Did your partner build on your

Did you build on your partner's notes, patterns or sequences by adding to them?
Did you repeat your partner's notes, patterns or sequences?
Did you repeat in a modified way your partner's notes, patterns or sequences?
Did you place your notes close to your partner's notes, patterns or sequences?
Did you modify your partner's notes, patterns, or sequences (i.e. reposition notes rather than remove them)?
Did you delete your partner's notes, patterns, or sequences, accidentally or intentionally?
Were there times when you were only removing notes?
Did you start ideas by creating new notes, patterns and sequences?
Did you respond to your partner by taking their notes, patterns, or sequences as a starting point?

Table 1. Questions asked after tasks.

notes, patterns or sequences by adding to them.” These questions were aimed at identifying whether participants had an understanding of their partner’s role in the interaction.

We also asked a range of open-ended questions about how participants interacted with their partners including:

- What effect did working with your partner have on each ringtone?
- Did the other person make edits you didn't agree with? [if so please explain]
- Did you modify your partner's notes, patterns, or sequences (i.e. reposition notes rather than remove them)?
- Were there any problems integrating both your ideas? [if so please explain]

A further interview was completed at the end of the session in which participants compared the two tasks, and fed back in an open ended way on their experience.

Results

All participants undertook the tasks for the full 20 minutes. In this section we detail the results for the three dependent variables, results from the questionnaires, and finally qualitative observations on the interaction.

Frequency of Contribution

The effects of Instruction and Identity on frequency of new notes being added was evaluated in a 2*2 Chi² test. This proved reliable: Chi²₍₁₎=330, p =0.00.

As Figure 2 shows, both Instruction and Identity affect frequency of contribution. Participant's who had explicit cues to the origin of contributions showed no effect of instruction and also produced approximately a third as many notes as those who did not. Where there were no cues to Identity, instructions that emphasized collaboration lead to more frequent addition of notes.

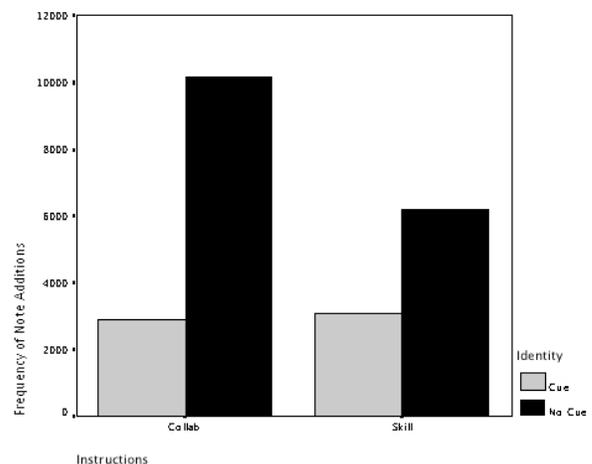


Figure 2. Frequency of contributions

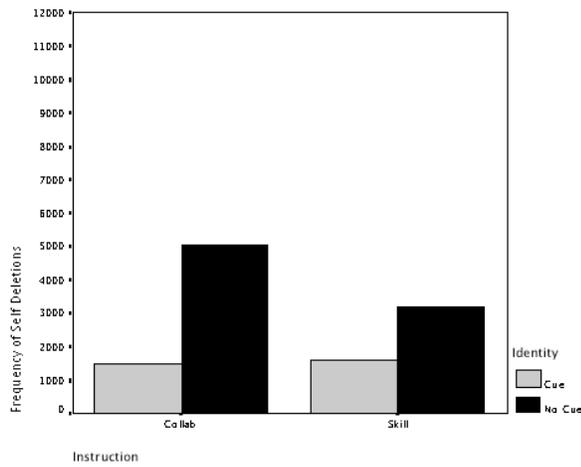


Figure 3. Frequency of self deletion

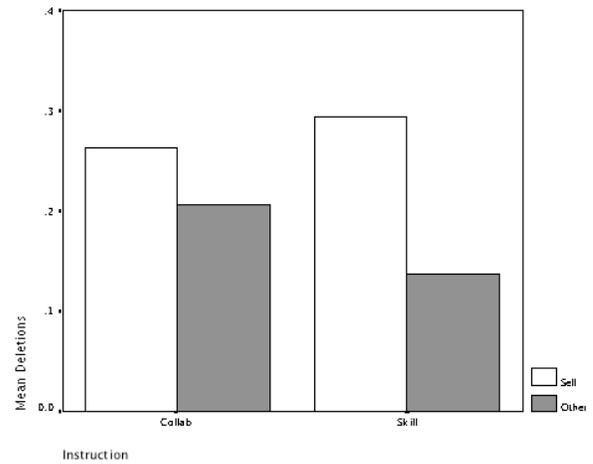


Figure 5. Mean deletions against instruction

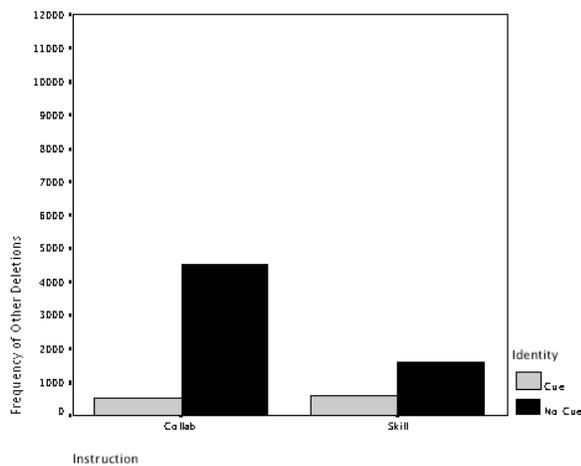


Figure 4. Frequency of other deletion

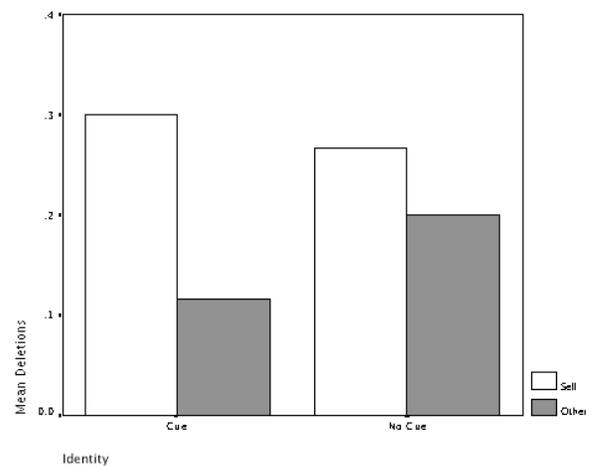


Figure 6. Mean deletions against identity

Frequency of Deletes

As Figures 2, 3 and 4 show, the overall frequency with which participant's deleted their own (self-deletion, figure 3) or others' contributions (other-deletion, figure 4) correlates with the overall frequency of contributed notes. This suggests that participants edited a similar proportion of contributions regardless of the experimental condition they were in, or the amount they produced. However, Self and other deletions were not affected in the same way by the manipulations of Instruction and Identity. As Figures 5 and 6 illustrate, if we allow for the changes in overall frequency of contribution, the proportions of self-deletions are relatively constant across conditions whereas the levels of other-deletion are more sensitive to the experimental manipulations. They are more common where the instruction was to collaborate (Matched Pairs $t_{(1,23)}=1.95, p(\text{one-tailed})=0.03$) and more common where there were no explicit cues to identity (Independent samples $t_{(1,23)}=-1.83, p(\text{one-tailed})=0.04$). Other deletions were thus most frequent when participants were instructed to collaborate and had no explicit cues to identity of contributions.

Proximity

To provide a measure of the extent to which participants were directly collaborating on their compositions we scored, for each note added by a participant, how many notes the other participant had already placed on the same spoke (i.e., notes that would be played at the same time as the added note).

The scores for each participant were averaged and entered in a mixed design analysis of variance with Instruction as a within-subjects factor and Identity as a between subjects factor. This showed a significant main effect of Instruction ($F_{(1,22)}=4.99, p=0.04$), no effect of Identity ($F_{(1,22)}= 3.36, p=0.08$) and a significant Instruction * Identity interaction ($F_{(1,22)}= 6.57, p=0.01$).

If subjects were instructed to collaborate they worked more closely than if they were instructed to be skillful. This effect of instruction was enhanced if there were no cues to identity. Overall, participants worked more on the same sub-components of tunes when the instruction was to collaborate and this was enhanced where cues to identity were not present.

Interview results

Of those who expressed a preference, fifteen participants rated their second composition as their favorite whilst five rated their first as favorite. There was no correlation between order of instruction and favored composition.

We identified a range of comments about the experience of using Daisyphone. However, there were no correlations between the comments and the conditions participants used. Generally the comments related to the confusion experienced by participants which they explained as a lack of control, and a clash of ideas as outlined below.

Lack of control – participants often commented that they felt a loss of control e.g. “yes, my input was great and then my partner took away most of it” and “yes, I had my own music, she destroyed”. This frustration was also expressed in terms of a lack of co-ordination e.g. “sometimes it was not coordinated at all”, and in response to the question about what effect their partner had on the ringtone “it would change the way I had planned in my head I would have to constantly adapt”.

Clash of ideas– participants complained that they and their partner had different visions of what the ringtone would be e.g. “yes, I wanted a melody, my partner wanted barry manilow”. This was often related to a lack of communication support e.g. “yes, we could not communicate which made it difficult to collaborate” and “yes, because I don't know the exactly idea of her”.

However, collaboration was also seen as a positive experience – participants commented that although it was difficult to collaborate, the overall effect was more than could have been achieved as an individual e.g. “I got more ideas that I would have had alone. On the other hand, it turned out quite chaotic because we were not working to the same pattern” and “it is better [in collaboration]. My partner has many good ideas I have not think about, and my ideas also different from his. So put them together sounds better”, and “interesting, more fun, more idea”. This lends support to the assertion that participants were mutually engaging even though they had no verbal communication channels.

Analysis of the interaction

We reviewed participants’ interaction using our log playback tool. This provided us with an overview of the interaction as it unfolded over time, and allowed us to replay and review previous interaction in real time.

Our first observation was that participants were much more focused on the task of creating music than in previous studies where we found that participants tended to draw geometric shapes such as lines and curves. This is probably explained by the fact that we offered participants financial incentives to take part in the study, and because they were set a very specific task. It may also have been due to the increased training time we gave participants. If so, this may indicate that Daisyphone provides an intuitive way of

collaborating through music whose learning time is in the order of tens or minutes.

We identified many points of attunement (our fourth indicator of mutual engagement) between participants illustrated below.

Acknowledgement – participants show that they are aware of the contribution of another. In the case of Daisyphone participants acknowledge each others’ contributions when they purposefully complement each others’ contributions e.g. by creating a chord. Figure 7 illustrates an example of acknowledgement of contributions. In this case one player has created a pattern of curves which the other has fitted their notes to e.g. the diamond contributions are aligned to the other participant’s circle contributions. We distinguish this from mirroring as the notes are adjacent to each other as opposed to the pattern being mirrored elsewhere in the Daisyphone.

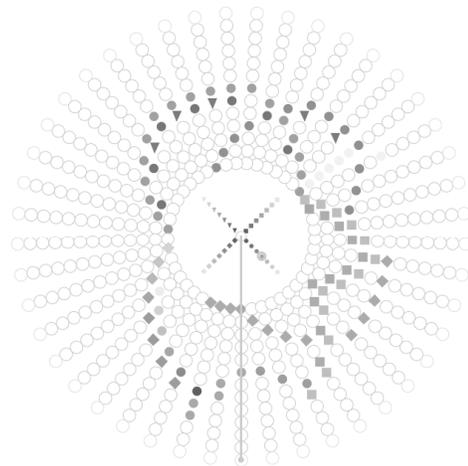


Figure 7. Acknowledgement

Mirroring – participants mirror, or reflect, others’ contributions thus demonstrating that they themselves are able to produce it. In Daisyphone we could identify this when musical patterns are repeated verbatim around the Daisyphone. Figure 8a and 8b illustrate two kinds of mirroring highlighted in black shapes. In 8a a participant has mirrored the 3 note motif of the other participant in

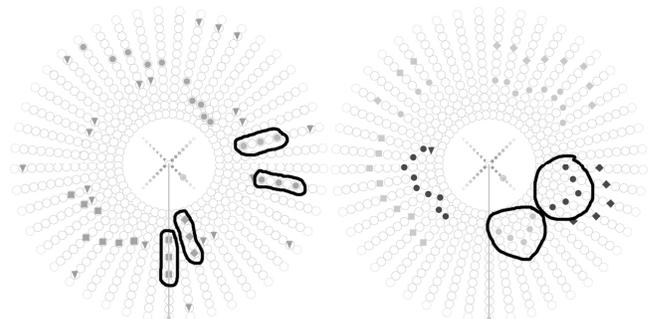


Figure 8a. Mirroring | Figure 8b: Mirroring

different places around the Daisyphone – first the top set of three circles is mirrored below it by three circles of the other participant, then the three squares at the bottom are mirrored to the right by three diamonds of the other participant. In 8b a participant (light grey) has mirrored the musical motif of the other (dark grey).

Transformation – participants transform others’ contributions, indicating a high level of mutual engagement. In Daisyphone this would be indicated by repetition of musical patterns with some modifications, or direct manipulation of others’ patterns. Figures 9a and 9b illustrate two forms of transformation of others’ contributions. In figure 9a the dark grey participant has edited and extended the light grey’s straight line contributions. In figure 9b the dark grey participant has copied and modified the musical pattern of the light grey participant around the Daisyphone.

Finally, as mentioned previously, the interaction between participants in this study appeared to be more focused on the task in hand. Indeed, unlike previous studies, we only saw one example of writing using the notes of Daisyphone even though it was the only means of communication. Figure 10 illustrates the only example of textual communication in the studies which, it is worth noting, is not related to the task itself.

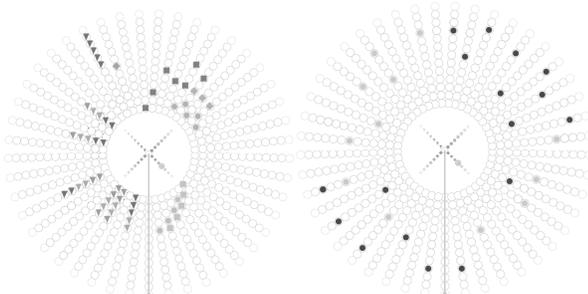


Figure 9a. Transformation | Figure 9b: Transformation

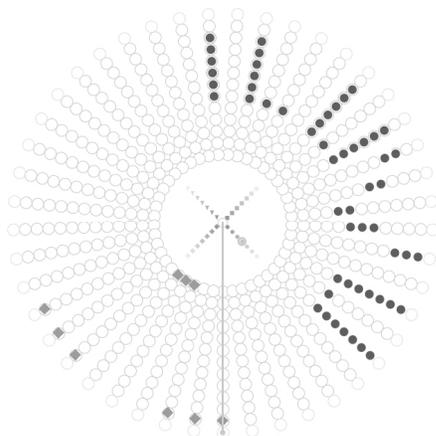


Figure 10. Written communication – “I love you”

DISCUSSION

In this section we discuss the results of our study. First we discuss the effects of user interface features on mutual engagement. Then we consider the experience of collaboration through Daisyphone, discuss the appropriateness of data capture methods, and propose future design directions.

Effects of user interface features

Overall, the results of the experiment show that participants were more willing to contribute when there were no explicit cues to the identity of contributions’ authors. This does not support our hypothesis H1. They produced almost three times as many notes when there were no cues than when there were cues to identity. This is interesting in the context of our previous findings that participants devote considerable effort to establishing their identities in collaboration. In previous versions of Daisyphone that allowed graphical annotation we found that participants would often take the effort to write their names around the edge of the screen [2]. This writing is the same color as the participant’s notes and so provides a form of identification of contributions – participants essentially make it clear which color they are. Figure 11 illustrates the name writing we have seen in previous studies of Daisyphone. Moreover, most communication tools such as on-line text chat systems prefix every contribution with the name of the contributor, or some visual representation such as an icon.

The results also suggest that mutual engagement is enhanced when people are explicitly encouraged to collaborate. This supports our hypothesis H2. However, this interacts with the availability of cues to the origin of contributions. Instructions to collaborate lead to greater overall levels of activity, including editing of each other’s contributions and direct collaboration on components of the composition. These effects were enhanced when the interface provided no explicit cues to identity. This highlights the importance of well structured experiments where participants are motivated to collaborate.

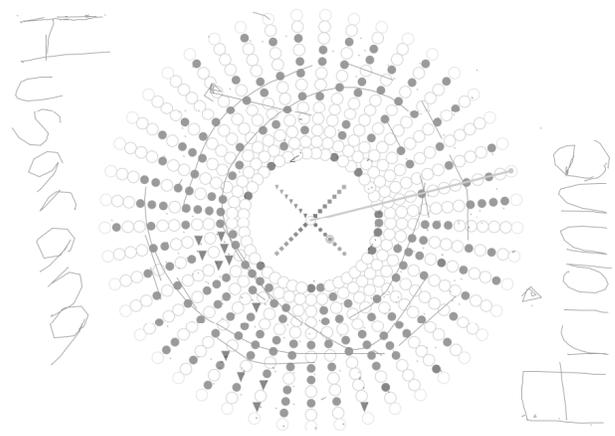


Figure 11. Name writing in previous use of Daisyphone

It seems plausible that the increased inclination to collaborate when cues to identity are removed may be due to a reduced sensitivity to ‘ownership’ of particular parts of the composition i.e. deletion of someone else’s notes is a more socially marked activity when they are labeled as belonging to the other participant. However, this explanation does not account for the previous accounts of participants’ self-motivated assertion of identity in the shared space through writing their own names. The increase in contributions when cues to identity are removed may also relate to the kind of activity participants were involved in. It may be that as cues to identity move the interface more towards a work oriented interface which does not fit with the playful nature of the interaction in the study.

An alternative explanation is that the apparent increase in mutual engagement is essentially just due to greater confusion arising from lack of cues to identity. From this point of view people delete more of the other participant’s simply because they are unclear about who has done what and contribute more overall because they effectively give up on trying to collaborate. However, this explanation doesn’t really fit the data. The effects of the manipulations are different for Self and Other deletions. Whereas Self deletions remain a more or less fixed proportion of total activity in all conditions, Other deletions are selectively affected. This sensitivity to whose contributions are deleted shows that the participants are not simply confused. Perhaps more importantly, participants’ use of space shows a selective response in terms of their propensity to work on the same elements of their composition. The fact that this is not affected by identity cues per se but that the instructions interact with identity suggests this is strategic and not the result of confusion. Moreover, reports of confusion occurred in each condition and did not correlate with any particular condition.

Through analysis of the interaction we identified a richer set of examples of attunement than in previous studies. Previously we had primarily seen participants drawing geometric lines and curves around the Daisyphone with attunement indicated by other participants mirroring and transforming these shapes. This difference may be due to the more focused structure of the activity, or may have been a product of the restricted communication channels (so all attunement occurred through the music).

Daisyphone as a collaborative experience

Whilst it was clear that participants experienced a lack of control and often felt that their ideas clashed with their partners’, they still responded positively to the collaboration itself. And, moreover, it is worth noting that no participants abandoned the tasks before the end of the allotted time even though they were explicitly told they could, though this may be because participants were offered financial incentives to take part and felt that they ought to work for the whole time allotted.

The expressed preference for the second constructed ringtone probably indicates that participants became more skilled at using Daisyphone (the instruction condition was randomized across participants). We take this as an indication of the short learning time associated with Daisyphone which indicates that it has potential to be intuitive for a range of users.

The increase in indicators of mutual engagement (proximal interaction, mutual modification, and joint contribution) when participants were instructed to collaborate suggests that these indicators do capture mutually engaging interaction as opposed to engagement with the interface or musical product itself.

Appropriateness of data collection

It is interesting to note that the interviews provided very little substantive qualitative data on participants’ experience. Only the rating of favorite ringtone provided any conclusive qualitative data. The lack of any conclusive feedback from participants illustrates the problems with using self-reporting evaluation of mutual engagement. Such approaches may be of use for understanding what mutual engagement is, and the kinds of situations in which it occurs (cf. questionnaires used to identify flow activities [6]), but they do not help us in finer grained analysis of the effect of user interface features on mutual engagement. Retrospective protocols may be appropriate, but extremely time consuming, for this level of analysis. This reinforces our position that for systematic understanding of designing for mutual engagement we need to be able to objectively compare interaction between participants rather than relying on subject self-reporting.

Future Research

In terms of future design, we could identify points of attunement in the interaction and develop interfaces which adapt to the participants. For instance, in Daisyphone we might propose that as evidence of transformation increases we increase the distinction in color of the participants’ contributions. This would reduce the sensitivity to ownership of parts of the contribution for novices, and yet as they felt more comfortable with collaboration, the explicit cues to ownership (and so, to some extent prowess) increases. Of course, it would be the case that such adaptive interfaces remove explicit control of representation of self from the participants which may be counter productive – participants may start to feel out of control if their color changes and becomes more marked as they become more experienced. This also has parallels to work on flow [6] where it is important to balance between users’ skills and the challenges of the activities they are involved in.

In order to further explore our ideas about mutual engagement we are developing a new remote collaborative music tool called Daisyfield. The underlying structure of remotely shared loops will be retained, but our new design is informed by the findings of this study. In particular, we

will provide greater flexibility of positioning of contributions so that we can examine people's placement strategies. This will be achieved by providing scope for multiple loops (Daisies) in one space which can be moved by participants. Moreover, these Daisies can be joined with other Daisies to create combined tunes e.g. by giving both loops the same rhythm or musical scale. In this way we hope to provide direct support for mirroring and transformation of each others' contributions.

Using such an approach we can examine the effect not only of identity on the interaction, but also various positioning strategies at different levels of granularity (within the loop, between loops, and the merging of loops). As with the study reported in this paper we plan to systematically manipulate a range of interface features including identity, symmetry of awareness of action, and mutual modifiability.

Studies of Daisyfield will also be carried out over longer periods of time so that we can better understand how forms of interaction change over time and how this relates to mutual engagement.

SUMMARY

In this paper we reported on the experimental study of the effect representation of identity and task instruction had on measures of mutual engagement. The result that providing no cues to identity increased mutual engagement was unexpected. We explained this in terms of a sense of 'ownership' and social awkwardness with deleting others' contributions.

Our experiment highlighted the need for objective measures of mutual engagement such as number of contributions, and amount of deletion of others' contributions. Furthermore, we showed how collaboration could be supported without recourse to verbal communication which we believe is important for the design of radical new paradigms for creative collaboration. Future work will continue to explore the role of representation of attribution of contribution in different situations. We will also explore how to design and evaluate engaging and mutually engaging interfaces.

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