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Peripheral participation in video-mediated communication

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The importance of overhearing, and other ways of monitoring communicative behaviour not explicitly directed at oneself, has been illustrated in numerous ethnographic studies of computer-supported cooperative work. This paper is concerned with a particular form of monitoring. A "peripheral participant" is defined as someone who has a legitimate interest in monitoring a joint task (being carried out by some "primary participants") but who is not actively involved in carrying out the task themselves. The concept is illustrated through field studies of telemedical consultation and related to other analyses of overhearing. Two experiments are reported where participatory status was manipulated using a role-play task. Ratings of interpersonal awareness, measures of gaze direction and recall of the conversation all indicate that the task successfully operationalized the distinction between primary and peripheral participation. In addition, the experiment manipulated the visibility of the peripheral participant to a remote primary participant. This was shown to have an effect on the remote primary participant's interpersonal awareness of the peripheral participant. Potential mechanisms for this effect are considered. It is concluded that peripheral participation is a potentially important form of involvement that needs to be considered when designing and configuring equipment for video-mediated cooperative work.

1. Introduction

The role of overhearing, and more generally the monitoring of other people's behaviour in order to coordinate work, has been a recurrent theme in ethnographic studies of computer-supported cooperative work (CSCW). Heath and Luff (1996) for example, describe how the operators responsible for line control and passenger information in a London Underground control room coordinate their work by monitoring each other's communicative behaviour with other people. Thus, the announcer was observed to make a passenger announcement about a delay inferred from overhearing the controller's conversation with a driver without any explicit communication between the two of them. Other examples they cite show how the coordination of these "convergent activities" can depend on monitoring activities such as looking at some information source or picking up a phone, as well as overhearing conversations. A similar point is made by Hutchins (1994) with his concept of distributed cognition. Hutchins, observing work contexts such

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as aircraft cockpits, sees information sources available to all the individuals in a team as cognitive resources. These resources include not only instruments and displays but also the utterances and behaviour of team members.

The stimulus for much of the work described above was the possibility of technological intervention in the work contexts concerned. Quite small changes in the layout of a control room, or the way an information resource is displayed, can severely disrupt this subtle monitoring of behaviour. Changes to a work context involving the physical separation of co-workers present even more severe design challenges as the monitoring functions then have to be performed using electronically mediated sound, images and data. Consider the work context described by Watts and Monk (1997, 1999). Three sites were studied where the treatment room in a primary-care practice was connected to a hospital with a video telephone. Using this equipment a GP or nurse practitioner, in the presence of a patient, could consult with a medical specialist in the hospital. Consulting involved the remote specialist gathering information about the patient's condition by discussion with the copresent primary-care practitioner and patient. The specialist could also perform a limited form of observation, with the primary-care practitioner as intermediary. This "telemedical consultation" is further facilitated by the ability to send X-rays or images of a wound or skin rash, for example.

The telemedical workspace can be characterized as a hybrid virtual and real workspace (Harrison & Dourish, 1996) as it contains real and virtual objects (e.g. a wound or an image of a wound) and real and virtual presences (i.e. a person or an image of a person). Interviews with the users of this technology showed how the precise configuration of video and audio equipment, and its relationship with other equipment and furniture, has the potential to affect the work by making some object or presence more or less salient or more or less easy to utilize during some part of the work. These effects can be very subtle even when there is no virtual presence to cope with. For example, Greatbatch, Heath, Luff and Campion (1995) have shown how patients adapt their behaviour to allow for the fact that a GP is operating a computerized patient records system while consulting with them. How much larger will these effects be when the participants have to communicate through the technology?

Following this work, Watts and Monk (Monk & Watts, 1997; Watts & Monk, 1998) have suggested a task analysis notation for reasoning about the effects of communication equipment on collaborative work. The Comms usage diagram (CUD) is a tabular notation that associates the positive and negative reported effects of the communications facilities with a particular part of the work and the particular personnel involved. An important distinction made in this analysis is between the personnel actively involved in the current task (the primary participants) and others who have a legitimate interest in what is going on but who are not actively involved at that moment. When a patient talks to a remote consultant, for example, it may be in the presence of her GP, a relative and a nurse. At any point in time some of these participants are actively engaged in a particular work task and some are not. However, the latter can legitimately and usefully monitor what the others are doing. For example, the patient may be a child who is accompanied by her mother. At some point, the GP the patient and the consultant may be discussing the patient's history over the video link. They may be thought of as the "primary participants" as they are actively engaged in this shared task of understanding the patient's history. At this point, the mother is not a part of this shared task but she is

listening to the conversation. This is legitimate and potentially useful. If at some later point, she needs to be brought into the conversation she will be in a better position to do so because she knows what has been said. From the point of view of the work of diagnosing and treating the patient it is potentially useful because she may be in a better position to explain the treatment to the child at a later date. Monk and Watts (1997) describe the mother as being a "peripheral participant" at this point. This distinction between two levels of participatory status, primary and peripheral, has proved useful when analysing the task requirements of communication facilities (Watts & Monk, 1998). The communications requirements of the primary participants must be met in order for the work to be done. Where possible secondary participants should at least be able to hear what is being said.

Of course, participatory status changes throughout the work. At some later point the mother may be a primary participant in this or another work task. The facility with which participants can make these changes in status is described here as mobility of participatory status. An interesting hypothesis to be tested in the two experiments described in this paper is precisely how the hybrid virtual and real workspace could affect this mobility. For example, if because of the camera angle the remote consultant cannot see the patient's mother then it may be difficult for the latter to break into the conversation and change her participatory status from peripheral to primary. Similarly, if the primary participants are using telephone handsets rather than a speaker phone, she will only be able to hear one side of the conversation with similar effects on the mobility of participatory status. Before describing these experiments other treatments of overhearing will be reviewed and our notion of participatory status related to Clark's theory of language use.

1.1. OVERHEARING

Goffman has distinguished three kinds of overhearer (Goffman, 1976). A *side participant* is a "ratified participant", i.e. a participant recognized by speaker and addressee as a full member of the conversation. A *bystander* is not a ratified participant but the speaker is aware they can overhear. Finally, an *eavesdropper* is an overhearer that the speaker is not aware of. Clark (1996) relates these terms to his theory of language use. In Clark's analysis the speaker is engaging in different joint actions with each of these listeners. A speaker addresses an utterance to an *addressee*. The utterance is designed for the addressee and the speaker has a strong obligation to monitor understanding and repair any evidence of trouble that may arise. The addressee has similar obligations to try to understand the speaker and to signal when this is and this is not possible. The mutual obligations are carried out in a process of "grounding".

The mutual obligations between speaker and overhearer depend on the kind of overhearer. Those between speaker and side participant are similar to those between speaker and addressee as the latter is a part of the conversation. However, many of the mechanisms for grounding described by Clark (Clark & Brennan, 1991) depend on the addressee responding in the next turn at talk and this may make it harder for a side participant to complete the grounding process. The mutual obligations between speaker and bystander are much weaker. The speaker may modify his or her language in the knowledge of the presence of a bystander and the bystander may signal whether he is

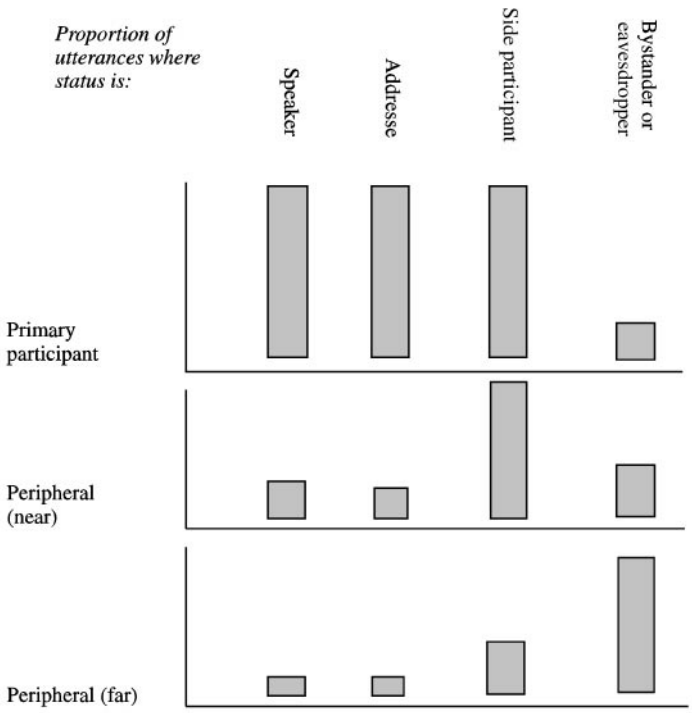

FIGURE 1. The relationship between participatory status and Clark's categories of overhearer (conversational status).

attending or not but these are not strong obligations. There are no mutual obligations between speaker and eavesdropper as the speaker is by definition unaware of the eavesdropper.

This analysis is at a level different from that of participatory status. Clark is concerned with individual utterances that a specific speaker designs for a specific addressee. Participatory status has a much broader grain of analysis, that is, the work task. An utterance may be over in a few seconds, a work task may take minutes or hours. The two analyses can be related by considering the proportion of time, or proportion of utterances for which a participant is addressee, side participant, bystander or eavesdropper during a work task. Figure 1 illustrates this point. Goffman's categories of overhearer can be thought of as categories of "conversational status" to contrast it with our participatory status. Consider a three-party conversation. If for some part of the work someone is a primary participant then one would expect him to be speaker, addressee and side participant for equivalent proportions during that period. Also, they should only rarely, if at all, be bystanders or eavesdroppers. This is depicted in the first row of columns in Figure 1. If on the other hand someone is a peripheral participant he should most often be a side participant, bystander or eavesdropper. The lower two rows of columns in Figure 1 depict the different ways in which this may arise. The middle row depicts a situation where someone is most often a side participant. This can be contrasted

with the bottom row where he is most often a bystander or eavesdropper. The former can be considered to be more peripheral than the latter. Thus this analysis leads to the concept of *degrees of peripherality*. A peripheral participant is more likely to be a side participant, bystander or eavesdropper than an addressee or speaker. A near peripheral participant is more likely to be a side participant than a bystander or eavesdropper and a far participant is less likely to be a side participant than a bystander or eavesdropper. The experiments described below are attempts to manipulate degree of peripherality through the communication facilities provided. Clark's analysis, in terms of obligations of speakers to addresses and overhearers, is also influential in certain manipulations and the dependent variables used.

In summary, our concept of participatory status adds to previous work demonstrating the importance of overhearing in CSCW. We distinguish between primary participants, for whom resources for coordination are of prime importance, and peripheral participants whose work is less directly intertwined with that of the primary participants but who nevertheless can benefit from monitoring the talk and behaviour of these primary participants. By locating this concept within an analysis of the components of the work to be completed, this can be seen as a link between the group-oriented perspective of CSCW research and the more individual perspective of conventional task analysis (Watts & Monk, 1998). In addition, the analysis represented in Figure 1 shows how the concept relates to Clark's (1996) approach which similarly bridges sociological and cognitive accounts of interaction.

1.2. RATIONALE FOR THE EXPERIMENTS

While there have been numerous observational studies stressing the importance of overhearing in cooperative work, there has been relatively little experimental work on this topic. In fact, there have been relatively few experiments carried out on electronically mediated communication with multi-party groups (but see O'Conaill, Whittaker & Wilbur, 1993; Sellen, 1995). Schober and Clark (1989) performed an experiment in which people were put in the position of overhearers by playing a tape of two other people solving a communication task. A "director" had a set of cards containing difficult to describe abstract shapes. The task was to direct the "matcher" in ordering the same set of cards. Overhearers were 78% correct, compared with the matcher's 95%. Video analysis of the overhearers' and matchers' behaviour suggests that this advantage was mainly due to the matchers being able to control the pace at which the instructions were given. In another experiment, overhearers were played tapes from late on in the session after the directors and matchers had negotiated their own vocabulary for describing the shapes. These late overhearers were at a considerable disadvantage compared to both the matchers, and the overhearers who had listened in from the start, demonstrating the importance of common ground in this task.

In the Schober and Clark experiment the overhearer and matcher do the experimental task at different times and the overhearer is necessarily an eavesdropper as the primary participants are not aware that they will be overheard. To make it possible for the presence of an overhearer to influence the behaviour of the other participants an experimental task is required that allows the overhearer to be legitimately present. A role play was developed that mimics certain characteristics of the telemedical consultation

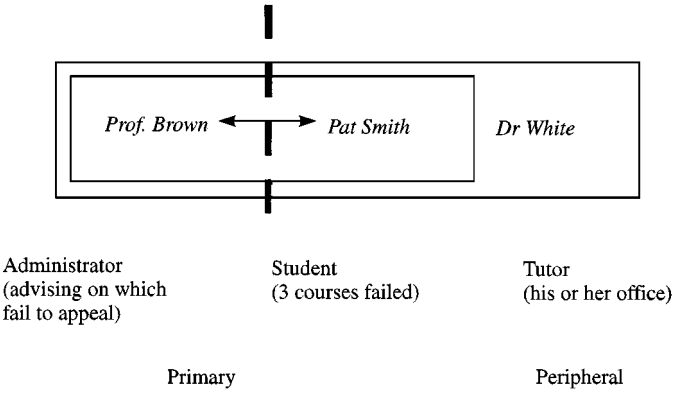

FIGURE 2. Roles used in both experiments. The vertical dashed line indicates that the administrator role was in a different room from the other two roles.

scenario described in the introduction. This is depicted in Figure 2. In the main part of the experiment a student role player is meeting with an administrator role player in an advisory capacity. They discuss various reasons for failing certain courses that might be used in a later appeal hearing. The student role player is situated in the room of his or her tutor and the role play is designed to make the administrator and the student primary participants and the tutor a peripheral participant, who is an interested party but not actively involved in the task on hand.

The first aim of the experiments described below is to demonstrate that this role play successfully operationalizes the concept of participatory status. The criterion for success in this aim is that the two primary participants (the administrator and the student) should be highly aware of each other and much less aware of, though still sensitive to, a peripheral participant (the tutor). However, this peripheral participant should be highly aware of the two primary participants and the discussion they are having. If this can be demonstrated then we can go on to look at whether it is possible to affect the degree of peripherality of a peripheral participant by making small changes to the configuration of an audio video link. In these experiments, the manipulation consists of changing the visibility of the peripheral participant (the tutor) to the remote primary participant (administrator). The peripheral participants were made peripheral through the task characteristics and by restricting their access to the audio equipment.

2. Experiment 1

Groups of three were required to collaborate in the role-playing discussion task described above. Communication between the locations was achieved through an audio–video link. Half of the groups were in a high visibility condition and half in a low visibility condition (see Table 1 for a summary of who could see and hear whom). This manipulation was achieved by altering the seating position of the tutor (the peripheral participant) so that they could either both see and be seen by the administrator (the remote participant), or neither see or be seen by the administrator.

TABLE 1
Who could see and hear who in the high visibility condition in Experiment 1

Role	Status	Can see	Can hear
Admin.	Primary	Student, *Tutor*†	Student
Student	Primary	Admin., Tutor	Admin., Tutor
Tutor	Peripheral	*Admin.*†, Student	Admin., Student

†(and italics) In the low visibility condition the tutor was not visible to the administrator nor the administrator to the tutor.

The video configuration used two cameras at each end of the link and was intended as an optimal configuration for contexts involving peripheral participation. A quarter of the screen was given to an inset view of the other primary participant to support primary participation (see Figure 4). The other three-quarters of the screen surrounding this inset was a context view to support peripheral participation.

In this initial experiment only two kinds of dependent variable were employed, ratings of interpersonal awareness and recall of what was said in the conversation. Interpersonal awareness was assessed by four analogue scales. Two (a positive form and a negative form) assessing the degree of "presence" and two assessing the extent to which the rater could assess the reactions of the person being rated. The first two are taken from a set of items describing the Short, Williams and Christie (1976) social presence construct. The second two were adapted from the Daly-Jones, Monk and Watts (1998) interpersonal awareness questionnaire to take account of asymmetries in the communication equipment used in our task. The latter two scales can also be seen as directly relevant to the ability of a speaker to carry out the obligations of speakers to hearers set out by Clark (1996). The expectation is that the two primary participants will be highly aware of each other but much less so of the peripheral participant. If the high visibility condition reduces the degree of peripherality then this difference should be smaller for groups in that condition. One would expect such an effect on the primary participants to communicate itself, through the gaze behaviour, speech style and content, to the peripheral participant. So whilst the peripheral participant should always be highly aware of the primary participants, reflecting our definition of peripheral participation, this should be particularly so in the high visibility condition as they benefit from this social recognition. In analysing the recall scores one is mainly interested in the recall of the peripheral participants. Their recall should be high and comparable with that of the primary participants, reflecting their interest in the task, and should also be higher in the high visibility condition where they are less peripheral.

2.1. METHOD FOR EXPERIMENT 1

2.1.1. Participants

Forty-eight members of York University were recruited as groups of three that already knew each other, through poster and electronic bulletin board advertisements. They were each paid £3 to attend a 1-h experimental session.

2.1.2 Equipment

Figure 3 shows the layout of the two rooms used in this experiment. Domestic analogue video equipment was used throughout. High-quality sound was provided through boom microphones worn by the administrator and student channelled to speakers in the 26″ TVs labelled "monitor". Thus, the peripheral participant (tutor) was discouraged from trying to speak to the administrator in the main part of the experiment as this would have meant the student passing the headset across (see Table 1 for summary of who could hear and see whom).

Three cameras in the tutor's meeting room sent images to the administrative office. The images from two of these were mixed to form the picture shown in Figure 4. Camera 1 [see Figure 3(a)] provided a view of the top half of the student's body as an inset (see Figure 4, top left). Camera 2 provided the wide-angle view of the whole office that can be seen to surround this inset. Finally, a document camera (not depicted in Figure 3) provided an image to a horizontally mounted 13″ TV that acted as a document display. Visibility of the tutor (peripheral participant) to the administrator was manipulated by having the tutor sit at T1 in Figure 3(a) in the high visibility condition and station T2 in the low visibility condition. Note that in the latter case neither the administrator nor the tutor can see the other and that in the former case both can see the other.

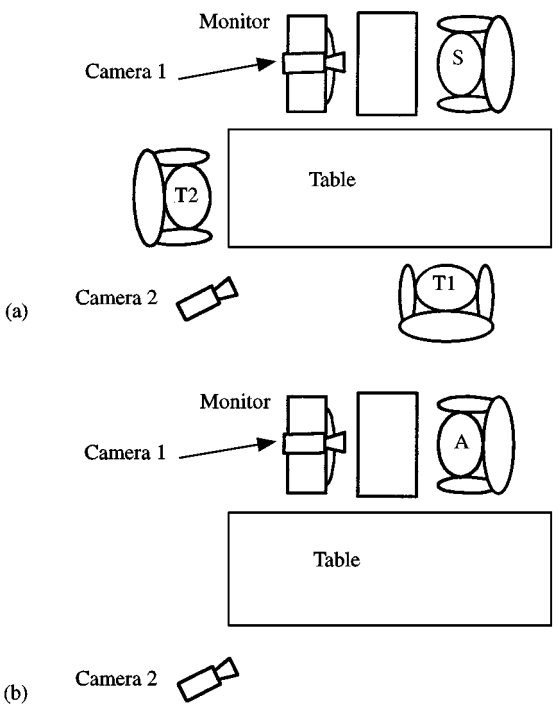

FIGURE 3. Schematic diagram of (a) the tutor's room and (b) the administrator's office in Experiment 1. S is where the student sat. The tutor sat at T1 in the high visibility condition and T2 in the low visibility condition. A is where the administrator sat.

FIGURE 4. View of the student and tutor presented to the remote administrator in the high visibility condition of Experiment 1. In the low visibility condition the tutor (right) is at the other end of the table so that he is no longer visible to the administrator and vice versa. To maintain confidentiality, the people in this picture and Figure 6 were actors and not actual participants in the experiment.

2.1.3. The experimental task

The experimental task had the objective of making the peripheral participants legitimate and interested parties to the task of the primary participants but of preventing them from becoming actively involved. As all the dependent variables relate to the three participants' experience of the discussion between the primary participants it was also designed to standardize the information exchanged in the discussion as much as possible, within the constraints of a natural role play. The procedure consisted of four parts.

Phase 1—*briefing.* Participants were informed that the experiment was to investigate remote communication and would involve a role-playing exercise, discussing a fictitious student's academic difficulties, during which they would be videotaped. They completed a consent form and were randomly allocated to one of three roles for the session. They were then led to the rooms in which they would carry out the experimental task and were given a demonstration of the equipment. The student and the administrator sat at their respective stations and were asked to confirm whether they could hear and speak to each other clearly over the link.

Participants were then separated and given a set of written instructions, describing the background for a meeting between a student, his personal tutor and an official at a fictitious university together with a mock Academic Transcript, recording the marks obtained by the student. Each set included a statement about the purpose of meeting, namely, to prepare a case in support of a student threatened with expulsion from the university for failing in three courses in a year, and the respective role to be taken by each participant. The student and administrator's materials included grounds for reversing

each of the three failures. The tutor's materials contained only procedural information, that his role was mainly to reassure the student prior to the video-mediated meeting, explain what was going to happen and to review what had been said afterwards (this review did not actually take place). They were all asked to read through the material carefully, writing notes where required. The student and tutor roles were allocated 10 min to complete this task, whereas the administrator role had 15 min. They were not informed that there was to be a recall test following the experimental discussion.

Phase 2—*introductions*. After the 10 min allowed for part (i) had passed, all the briefing materials were taken from the student and tutor, with the exception of a single sheet summarizing the fictitious student's academic performance. The student was instructed to knock at the door of the room in which the tutor was situated. The tutor's instructions were to formally greet the student, to explain what was about to happen and to set out the agenda for the meeting.

Phase 3—*discussion*. After the tutor's introduction to the student had been completed (phase 2) the experimenters entered both rooms to switch on the audio and video equipment. The administrator then initiated the videophone call, greeting the tutor before talking to the student. Up to 30 min was allowed for this remote interaction, depending on how quickly agreement was reached on the ranking of most likely grounds for appeal. After this period, the experimenters terminated the meeting.

Phase 4—*post-session ratings and recall test*. Participants were again separated and presented with ratings and recall tests. They were allowed as much time as required to complete these tasks. The rating scales consisted of pairs of analogue scales relating to each of the other participants. The recall test asked them to write down the points made in discussing each of the three courses in turn. They were asked to recall both the excuse made for failing the course and arguments made accepting or rejecting these excuses.

2.2. RESULT, EXPERIMENT 1

To recapitulate, there are two questions asked of the interpersonal awareness ratings and recall data: (1) was the experimental task successful in meeting our definition of peripheral participation, and (2) did visibility condition affect degree of peripherality?

Consider first the first question with regard to the interpersonal awareness ratings. Four rating scales assessed interpersonal awareness. The two positively phrased items were: "I was very aware of the presence of … " and "I could easily assess … 's reactions to what was said". The two negatively phrased items were "It felt as though … wasn't really present and "I did not get a good enough idea of how … was reacting". The ratings for the negative scales were subtracted from 100 and combined with that for the positive form to give a mean rating for "presence of" and a mean rating for "can assess reactions of". Means of these scores for the different raters are presented in Table 2. The scores for each rater were submitted to a separate three-way split-plot analysis of variance. The sampling unit in this analysis of variance, and all subsequent analyses, is the group of three participants. Thus, visibility condition is a between groups variable, while role rated and scale are within groups variables.

The ratings made by primary participants (student and administrator) of one another are high, whereas their ratings of the peripheral participant (tutor) are low. There is

TABLE 2
Mean interpersonal awareness ratings (and standard deviations) for high and low visibility conditions in Experiment 1

Rater	Rated	Relationship	"Presence of"		"Can assess reactions of"	
			High vis.	Low vis.	High vis.	Low vis.
Tutor	Admin.	Periph. p. rates remote primary p.	71 (25)	63 (19)	46 (26)	40 (15)
	Student	Periph. p. rates co-present primary p.	90 (5)	90 (8)	67 (18)	83 (14)
Admin	Student	Primary p. rates remote primary p.	95 (3)	91 (7)	75 (18)	80 (17)
	Tutor	Primary p. rates remote periph. p.	18 (24)	7 (10)	11 (13)	6 (7)
Student	Admin	Primary p. rates remote primary p.	79†(26)	84 (23)	69 (24)	58 (28)
	Tutor	Primary p. rates co-present periph. p.	57 (38)	30 (30)	55 (26)	30 (26)

†Note that $N = 8$ except for this mean where one participant omitted to provide a rating.

a significant effect of role rated [Administrator as rater: $F(1,14) = 245.72$, $p < 0.001$; Student as rater: $F(1,13) = 7.63$, $p = 0.016$], a significant main effect of scale [Administrator as rater: $F(1,14) = 10.09$, $p = 0.007$; Student as rater: $F(1,13) = 11.33$, $p = 0.005$] and a significant scale by role rated interaction [Administrator as rater: $F(1,14) = 6.98$, $p = 0.019$; Student as rater: $F(1,13) = 5.41$, $p = 0.037$]. The last two effects are due to the generally higher ratings given and a larger effect of role rated for the "presence of" scales.

In contrast to the ratings that the primary participants make of the peripheral participant, the ratings made by the peripheral participant of the primary participants are quite high, and comparable with the ratings primary participants make of one another. These ratings were analysed with the same three-way analysis of variance. Only the role rated [$F(1,14) = 28.21$, $p < 0.001$] and scale [$F(1,14 = 22.53$, $p < 0.001$] main effects were significant. Again the "presence of" ratings were higher than the "can assess reactions of" ratings. The co-present primary participant was rated more highly than the remote primary participant.

It would seem then that the experimental task succeeded in creating a context that satisfies our definition of peripheral participation. These rating data show that the peripheral participant was highly aware of the two primary participants but that the latter were mainly aware of each other. To obtain further evidence that the peripheral participant is fully involved in the task the recall of excuses and justification of excuses were scored. Twenty-one core points were identified from the materials given to the administrator and the student to be learnt in phase 1 of the experiment and a "blind" rater scored how many were mentioned (inter-rater reliability, $r = 0.85$). Mean scores for

TABLE 3
Mean recall scores (and standard deviations) out of 21 for high and low visibility conditions in Experiment 1

	High vis.	Low vis.
Tutor	9.25 (1.58)	7.75 (2.71)
Admin	10.50 (1.77)	9.75 (2.31)
Student	10.88 (1.13)	8.75 (1.58)

the high and low visibility conditions are presented in Table 3. Averaging over the high and low visibility conditions, it can be seen that the student and the administrator mentioned 9.8 and 10.1 of these 21 points, respectively, and the tutor, who only listened to the discussion, 8.5.

The first question asked with this experiment is "is it possible to operationalize the concept of participatory status in an experiment?" The above results indicate that the answer to this question would seem to be "yes". The second question asked was, "having created this context of peripheral participation, can we demonstrate effects on the degree of peripherality of a peripheral participant by making small changes to the configuration of an audio–video link?" Here the answer is less clear cut. There is no large effect of visibility condition in the rating data. The only significant effect involving visibility condition was a scale by condition interaction in the ratings made by the student ($F(1,13) = 5.47$, $p = 0.036$]. They rated it to be harder to judge the reactions of both of the other roles in the low visibility condition. This is unexpected as the student has exactly the same view of the administrator in both visibility conditions. The expected effects on the ratings of the other primary participant and the peripheral participant did not materialize.

Visibility also had an unexpected effect on recall. It had been predicted that tutors in the high visibility groups would have recalled more of the discussion than those in the low visibility groups because they were more peripheral giving rise to a role by visibility condition interaction. In fact, the effect, a gain of about 7% in the high visibility condition, was spread across all three participants (see Table 3). A two-way split-plot analysis of variance with visibility condition as a between-groups variable and role as a within-groups variable demonstrates significant main effects of visibility condition [$F(1,14) = 5.78$, $p = 0.031$] and role [$F(1,14) = 3.58$, $p = 0.041$] but not a significant interaction.

2.3. DISCUSSION, EXPERIMENT 1

The effects of the visibility manipulation then are puzzling. The manipulation was to move the seating position of the tutor thus changing the visibility of the tutor (peripheral participant) to the administrator and vice versa. The interpersonal awareness ratings of the two participants directly affected by this manipulation, the tutor and the administrator, were unaffected. Instead there was an effect on the ratings made by the student role who reported being less aware of the reactions of both other participants in the low

TABLE 4
Who could see and hear who in the high visibility condition in the experiment

Role	Status	Can see	Can hear
Admin.	Primary	Student, *Tutor*†	Student
Student	Primary	Admin., (Tutor)	Admin., (Tutor)
Tutor	Peripheral	Admin., Student	Admin., Student

†(and italics) In the low visibility condition the tutor was not visible to the administrator. Parentheses indicate that in practice the availability was minimal (see Section 3.1.3).

visibility condition. There was an across the board effect of visibility on recall. This was again contrary to expectations as degree of peripherality was not expected to affect the recall of the primary participants.

The video configuration used in this experiment involved two cameras at each end of the link and was intended as an optimal configuration for contexts involving peripheral participation. The configuration was not changed to manipulate visibility, but only the seating position of the peripheral participant. This makes the manipulation plausible as representing the sort of design decision that has to be made in real computer-supported cooperative work contexts. Unfortunately, it also makes the unexpected effects on the ratings made by the student role and the recall of all participants difficult to interpret. While the tutor was visible to the student, and vice versa, in both visibility conditions their relative positions in the room changed. Experiment 2 uses the same experimental task with a simpler video configuration and a simpler manipulation of visibility.

3. Experiment 2

The most important result from Experiment 1 is the demonstration that it is possible to create an experimental task that operationalizes the concept of participatory status. Experiment 2 uses the same role-play task but with a simpler visibility manipulation and more dependent variables. The video configuration used one camera at each end of the link giving a view of a table at which the participants sat. As in Experiment 1, the administrator sat alone at one end. At the other end the student and the tutor sat shoulder to shoulder (see Figures 5 and 6). In the low visibility condition the half of the screen containing the tutor was blanked off. Thus, the administrator could no longer see the tutor but the tutor could still see the administrator (see Table 4 for summary of who could see and hear whom in this experiment).

An extra set of points was introduced to the materials learned by the administrator and student roles in the form of a letter, purportedly from the student to the administrator, both of whom had a copy. This was intended as a manipulation of common ground (Clark, 1996). Both the administrator and the student know that the other has read this letter and that the tutor has not. If the tutor is less peripheral in the high visibility condition then the tutor and administrator should be more likely to take account of this difference in common ground in the conversation. Specifically, it is

predicted that groups in the high visibility condition should mention the letter more than groups in the low visibility condition.

The dependent variables measured included the same ratings of interpersonal awareness used in Experiment 2 supplemented with two extra scales measuring how well, during the conversation, the rater could judge whether the others could understand what was being said, and whether the others were attending to what was being said, respectively. With the negative forms this makes eight questions and should result in more sensitive measures of interpersonal awareness. In order to assess the possible mechanisms by which manipulations of the visibility of tutor to administrator could affect the ratings of the student we also analysed the gaze focus of the participants during the discussion and the topics discussed.

3.1. METHOD FOR EXPERIMENT 2

3.1.1. Participants

Sixty individuals were recruited in groups of three, as in Experiment 1. They were paid £4 to attend a 1-h experimental session.

3.1.2. Equipment

Figure 5 shows the layout of the two rooms used in this experiment. Sound and video were again provided by 26″ domestic TVs and only the student wore a boom microphone. This meant that although the tutor role could hear the administrator role clearly, anything the tutor said was virtually inaudible to the administrator. The cameras used were SVHS-C camcorders mounted above the monitors, the image presented to the administrator role being passed through a Panasonic Digital AV mixer used to blank a vertical half of the image to a black colour in the low visibility condition [see Figure 6(b)]. Table 4 summarizes who could see and hear whom. Note that although the tutor and student were sitting next to each other they were shoulder-to-shoulder. Data in Section 3.2.2 show that they seldom look at each other. Thus in practice the student and tutor did not have visual access to one another.

3.1.3. The experimental task

The procedure followed was as described in Section 2.1.4. In phase 1 some additional material, in the form of a letter, supposedly written by the student to the administrator, was introduced (see Section 3.2.3 for a full description of the contents of these materials). The letter was not removed after phase 1 so that in phases 2 and 3 the student and administrator both had access to the letter and their single sheet of notes.

3.2. RESULTS OF EXPERIMENT 2

3.2.1. Ratings of interpersonal awareness

Eight rating scales assessed interpersonal awareness. In addition to those used in Experiment 1 there were: "I could readily tell when … was concentrating on what was said"; "I found it difficult to tell when … was paying attention to what was said"; "I knew when … understood what was being said"; "It was hard to tell when … had taken in

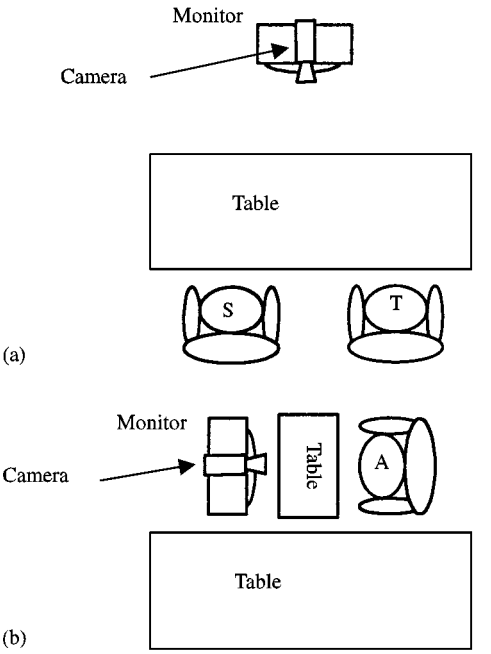

FIGURE 5. Schematic diagram of (a) the tutor's room and (b) the administrator's office. S, T and A are where the student, tutor and administrator sat, respectively.

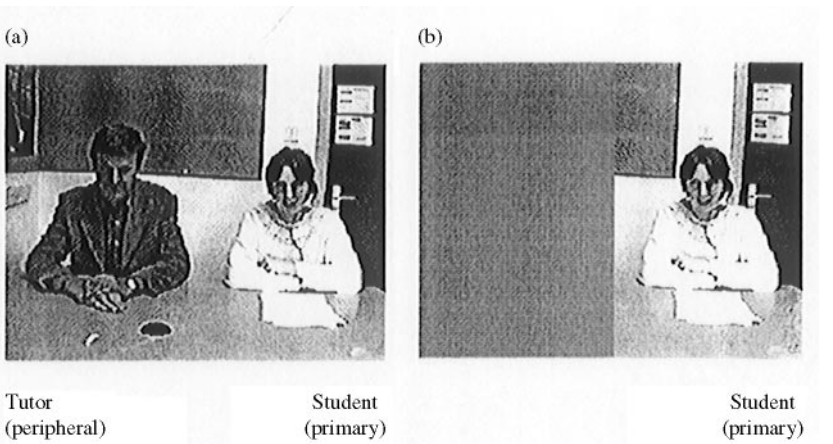

FIGURE 6. View of the student and tutor presented to the remote administrator in Experiment 2: (a) in the high visibility condition, (b) in the low visibility condition. In the latter case the left-hand side of the picture was blanked out using a video mixer making the tutor no longer visible to the administrator.

TABLE 5

Mean interpersonal awareness ratings (and standard deviations) for high and low visibility conditions in Experiment 2. The last two columns (in bold) are the mean of the four other scales

Rater	Rated	Relationship	"Presence of"		"Can assess reactions"		"Can assess if attending"		"Can assess if understanding"		Mean interpersonal awareness	
			High vis.	Low vis.	High vis.	Low vis.	High vis.	Low vis.	High vis.	Low vis.	High vis.	Low vis.
Tutor	Admin.	Periph. p. rates remote primary p.	80 (15)	82 (20)	65 (27)	75 (12)	76 (26)	82 (14)	73 (19)	73 (15)	**73 (16)**	**78 (9)**
	Student	Periph. p. rates co-present primary p.	88 (7)	89 (18)	62 (18)	83 (13)	70 (21)	78 (24)	72 (20)	77 (14)	**73 (13)**	**82 (9)**
Admin.	Student	Primary p. rates remote primary p.	91 (8)	92 (7)	69 (21)	82 (19)	87 (9)	85 (12)	77 (15)	84 (11)	**81 (10)**	**86 (10)**
	Tutor	Primary p. rates remote periph. p.	22 (14)	14 (22)	17 (9)	14 (17)	34 (28)	32 (30)	27 (25)	21 (26)	**25 (16)**	**20 (20)**
Student	Admin.	Primary p. rates remote primary p.	86 (14)	86 (14)	63 (32)	71 (16)	81 (19)	87 (10)	83 (15)	74 (14)	**78 (18)**	**80 (9)**
	Tutor	Primary p. rates co-present periph. p.	70 (30)	26 (16)	49 (32)	24 (24)	62 (37)	31 (28)	63 (29)	32 (23)	**61 (26)**	**28 (20)**

what was said". The ratings for the negative scales were subtracted from 100 and combined with the positive form to give mean rating for each of the scales listed in Table 5. The scores for each rater were submitted to a three-way split-plot analysis of variance as for Experiment 1, except that the scales variable now has four levels. Scale did not interact significantly with any of the other variables in two of the three analyses and so it is reasonable to compute an overall interpersonal awareness score by averaging the four scales. The means and standard deviations of these are given in Table 5.

As in Experiment 1, the primary participants (administrator and student) are much more aware of one another than the peripheral participant. This is demonstrated by a significant main effect of role rated [Administrator as rater: $F(1,18) = 118.09$, $p < 0.001$; Student as rater: $F(1,18) = 30.35$, $p < 0.001$]. The peripheral participant (tutor) is equally aware of the other two and the only significant effect in the analysis of the tutor's ratings is a scale main effect [$F(3,54) = 3.81$, $p = 0.015$]. The analysis of the administrator's ratings show a role rated by scale interaction [$F(3,54) = 6.50$, $p = 0.001$] reflecting differences in the size of the effect of role rated for different scales (largest for "presence of", smallest for "can assess understanding").

Again, as in Experiment 1, the only significant effect of visibility condition was in the analysis of the ratings made by the student role. There is a significant main effect of visibility condition [$F(1,18) = 7.07$, $p = 0.016$] and a significant role rated by visibility condition interaction [$F(1,18) = 7.61$, $p = 0.013$]. There was no significant three-way interaction in this or any of the other two analyses of variance. The effects of visibility condition can be described as follows. The student role is highly aware of the other primary participant (administrator) providing ratings comparable to those the administrator makes of them. Whereas the student roles in the low visibility condition make low ratings for their awareness of the peripheral participant (tutor) comparable to those produced by the administrator role, in the high visibility condition they do not. In the high visibility condition they give ratings nearer to those made for the other primary participant. So, as in Experiment 1, there is no effect of changing the visibility of the peripheral participant to a remote primary participant on the ratings provided by the remote primary participant. Instead, the effects are on the other primary participant, who in this experiment is sitting next to the peripheral participant in both cases and whose auditory and visual accessibility to both parties is wholly unchanged by the manipulation.

Care was taken to conceal the nature of the visibility manipulation to the tutor and student roles in case some complex demand characteristic could explain these results. As a check that this was successful they were asked to rate how well they thought the administrator could see each of them on a scale from "not at all." to "very clearly". A rating of 25 or less on this 100 point analogue scale was taken as a conservative criterion for indicating that the rater believed that the administrator could not see the tutor. Of the 10 students in the low visibility groups, where this was indeed the case, only two believed it to be so. Two of the ten students in the high visibility groups, where the administrator could actually see the tutor, also believed that the administrator could not see the tutor.

The effect of visibility condition on the interpersonal awareness ratings of the primary participant not directly affected by the manipulation is surprising and interesting. It replicates a similar effect noted in Experiment 1 and so probably is not a chance result. It

TABLE 6

Mean time per minute (and standard deviation) each participant looked in the direction of another participant for high and low visibility conditions in Experiment 2

Gazer	Gazed at	Relationship	Seconds per minute	
			High vis.	Low vis.
Tutor	Admin.	Periph. p. looks at remote primary p.	31.78 (6.92)	26.04 (10.27)
	Student	Periph. p. looks at co-present primary p.	12.19 (8.05)	9.58 (6.19)
Admin	Student	Primary p. looks at remote primary p.	30.29 (9.28)	32.96 (9.16)
	Tutor	Primary p. looks at remote periph. p.	3.54 (2.57)	0.62 (1.00)
Student	Admin	Primary p. looks at remote primary p.	38.46 (5.71)	37.28 (4.96)
	Tutor	Primary p. looks at co-present periph. p.	1.77 (2.07)	0.54 (0.56)

Note: $N = 10$ for the high visibility condition and $N = 9$ for the low visibility condition as the video recording of one group was lost due to equipment failure

cannot be explained as a demand characteristic due to knowing what the administrator could or could not see, neither can it be due to differences in the seating position of the peripheral participant as in Experiment 1. It must be then, that the visibility manipulation affects the behaviour of the remote primary participant (administrator) and that this change in behaviour then somehow affects the ratings of the other primary participant. The next two sections examine this possibility, first by looking at where the participants direct their gaze and second the content of the conversation between the two primary participants.

3.2.2. Analysis of gaze direction

Videotaped recordings of the experimental discussions were subjected to an activity set analysis (Watts, Monk, & Daly-Jones, 1996; Watts, 1998) using Action Recorder. Action Recorder allows near real-time analysis of behaviour. Keystrokes are pre-defined to represent the start of certain behavioural states. These states are grouped as exhaustive mutually exclusive sets known as activity sets. Activity sets were defined to describe the gaze behaviour of each of the three roles.

- Student looking towards: Tutor, Administrator, Papers, Elsewhere.
- Tutor looking towards: Administrator, Student, Papers, Elsewhere.
- Administrator looking towards: Tutor, Student, Papers, Elsewhere.

The Elsewhere activities are simply to make the states exhaustive. Action Recorder provided analyses in terms of overall amount of time in activity state and frequency of activity state engagement for each activity. For simplicity, only the proportion of time (in

seconds per minute) is presented for gaze towards another participant. Inter-rater reliabilities were calculated with Pearson's r for 55 samples each 100 s long. For the proportion of time a participant spent looking at one of the other participants these range from 0.88 to 0.98 and can be taken to be highly reliable (see also Watts *et al.*, 1996).

The primary participants spend more than 30 s of each minute looking towards each other and very little time looking towards the peripheral participant, regardless of the visibility condition. The interesting question, in connection with detecting behaviour that could mediate the effect of visibility on the ratings of the student role, is how visibility affects the gaze behaviour of the administrator towards the tutor. Even though the administrator spends only a mean of 3.54 s per minute looking towards the tutor when they are visible (high visibility condition) they spend even less time when they are not visible (low visibility condition). The low values in these data suggest a non-parametric analysis. A Mann–Whitney U-test shows that this difference is significant ($U = 11$, $p = 0.004$). The proportion of time that the student role spends looking towards the tutor is even smaller than that for the administrator and this time the difference between the two visibility conditions cannot be shown to be significant ($U = 35$, n.s.)

The analysis of gaze direction of the tutor shows effects of role looked at but not visibility condition. These data were evaluated in a two-way split-plot analysis of variance with visibility condition as a between groups variable and role looked at as a within groups variable. The main effect of role looked at was significant [$F(1,17) = 43.41$, $p < 0.001$]. Neither the visibility condition main effect [$F(1,17) = 2.93$, n.s.] nor the visibility condition by role looked at interaction [$F(1,17) < 1$, n.s.] were significant.

3.2.3. Topic mention

This analysis was carried out on transcripts of the discussion between the administrator and student roles. The expectation was that they would each be more likely to mention the points they had memorized in phase 1 of the experiment. The letter was used in this experiment to introduce points that the primary participants could assume were known to each other, i.e. were common ground, but which they knew were not available to the peripheral participant. The rating data indicate that the students were more aware of the presence of the peripheral participant in the high visibility condition and so, if the primary participants were allowing for the presence of the peripheral participant, one might expect the student in particular to be more likely to mention them.

Sessions were recorded with the microphones from each location recorded onto separate audio channels. A trained audio typist transcribed all speech from the audio tapes, blind to condition and controlling for condition order. Transcripts comprised all vocalization from each role in the experimental discussion, in sequence as successive paragraphs. Transcripts were then blind scored by a trained rater for inclusion of each of the case points included in the briefing materials (see the Appendix). Inter-rater reliability was assessed by comparing two raters' coding of two transcripts (approximately 300 utterances) with Cohen's κ for nominal data ($\kappa = 0.951$).

Table 7 gives the mean proportion of points mentioned by source of information and by visibility condition. To explain, there were seven points mentioned only in the student's briefing materials. Table 7 shows that the student roles mentioned 0.74 of these points at least once in the transcript, on average, in the high visibility condition and 0.79

TABLE 7
Mean (and standard deviation) proportion of possible points mentioned by Student and Administrator by information source, and experimental condition

	Student mentions			Administrator mentions		
	Own	Other	Letter	Own	Other	Letter
High vis.	0.74 (0.17)	0.33 (0.21)	0.72 (0.15)	0.61 (0.14)	0.34 (0.22)	0.26 (0.13)
Low vis.	0.79 (0.24)	0.34 (0.26)	0.72 (0.20)	0.69 (0.13)	0.26 (0.19)	0.36 (0.19)

in the low visibility condition. There were eight points mentioned only in the administrator's briefing materials and nine points mentioned only in the letter giving the other proportions listed in Table 7. These proportions were subjected to a three-way split-plot analysis of variance with visibility condition as a between-groups variable and with role and source of information as within-groups variables.

There was a highly significant source of information main effect [$F(2,36) = 16.09$, $p < 0.001$] and role by source of information interaction [$F(2,36) = 28.69$, $p < 0.001$]. Each role mentions the topics in their own briefing materials more than those in the other role's materials, as one would expect. The interaction arises because this difference is more marked in the case of the student than the administrator and because the student mentions more of the points in the letter than the administrator. However, there was no significant main effect of or interaction with visibility condition reflecting the very similar proportions observed in the high and low visibility groups.

The lack of a visibility effect on topic mention, is disappointing but unsurprising in hindsight. It was predicted that there would be more mention of the points in the letter in the high visibility condition. Given the effect of visibility condition on interpersonal awareness, one would expect this to be most noticeable in the student's data but there is no such result.

3.2.4. Topic recall

The original hypothesis was that there would be an interaction between visibility condition and role such that the peripheral participant would recall more in the high visibility condition but not the other two roles. In Experiment 1 there was a main effect of visibility condition on recall but no interaction.

Recall of the arguments and evidence brought up in the discussion was scored in the same way as topic mention from the written response sheets. Inter-rater reliability was computed on a random sample of half the response forms, including all three roles from both conditions. Reliability was again high, $r = 0.90$.

Table 8 gives the mean number of the possible 27 points recalled by role and condition. The recall scores are very comparable with Experiment 1 but this time there is no apparent effect of visibility condition. A two-way split-plot analysis of variance with visibility condition as a between-groups variable and role as a within-groups variable gives a significant effect of role [$F(2,36) = 5.87$, $p = 0.006$] but no significant main effect of visibility condition [$F(1,18) < 1$, n.s.] and no significant visibility condition by role interaction [$F(2,36) = 1.20$, n.s.].

TABLE 8
Mean (and standard deviation) recall scores by role and condition out of 27

	Student		Administrator		Tutor	
High vis.	14.0	(2.8)	15.7	(2.7)	13.4	(2.6)
Low vis.	15.3	(4.2)	15.9	(5.4)	11.8	(4.0)

TABLE 9
Mean (and standard deviation) recall scores divided by items mentioned in discussion, by experimental condition and information source

	Role	Admin. Info	Stud. info	Letter info
High vis.	Student	0.518 (0.376)	0.832 (0.275)	0.730 (0.221)
	Admin.	0.921 (0.380)	0.756 (0.304)	0.823 (0.322)
	Tutor	0.695 (0.297)	0.834 (0.185)	0.510 (0.237)
Low vis.	Student	0.569 (0.243)	0.811 (0.214)	0.873 (0.274)
	Admin.	0.875 (0.422)	0.737 (0.211)	0.688 (0.324)
	Tutor	0.470 (0.389)	0.732 (0.491)	0.536 (0.249)

Different groups mentioned different numbers of points during the discussion and so to obtain a more sensitive recall measure a more detailed analysis was performed in which points recalled were split according to source and then divided by the number of points mentioned in discussion from that source. Table 9 presents means for these data. Separate split-plot analyses of variance, with visibility condition as a between-groups variable and source of information as a within-groups variable, were carried out for each role's recall. Using this new dependent variable there were significant main effects of source of information for the student's recall [$F(3,36) = 9.87$, $p < 0.001$] and the tutor's recall [$F(3,36) = 3.49$, $p = 0.041$] but no other significant effects. It would seem that, even with this potentially more sensitive analysis, there is no effect of visibility condition on recall either as a visibility condition main effect or a visibility condition by source of information interaction.

It was predicted that the tutor would recall more in the high visibility condition on account of his being less peripheral. The lack of such an effect is unsurprising given the rating data in Experiments 1 and 2 show that the effect on the subjective experience of the student and not the tutor. It is thus not surprising that no such effect was observed and the main effect of visibility condition across all three roles observed in Experiment 1 can probably be dismissed as a chance result.

4. Conclusions and discussion

This paper started with an analysis of a particular form of overhearing we describe as peripheral participation. The two experiments described above successfully model peripheral participation using a role play task. In both experiments, the two participants

actively involved in the discussion of a student disciplinary case are shown to be highly aware of each other but much less aware of a legitimately present other who could not join in the conversation. In the second experiment, gaze direction was measured and shown to mirror these interpersonal awareness ratings. The primary participants looked towards each other most of the time and spent very little time looking at the peripheral participant. The role play task was also successful in engaging an interested third party. This can be seen in the recall scores for both experiments which show the peripheral participants recalling nearly as much as the primary participants, despite the fact that they only overhear the discussion of the points they have to recall. This is also seen in the ratings of interpersonal awareness. The peripheral participant is highly aware of the two primary participants.

The experiments described have thus been successful in demonstrating that the distinction between *primary* and *peripheral* participation (*participatory status*) can be operationalized in an experiment. What this means is that, under the circumstances of these experiments, the effect of participatory status on interpersonal awareness and visual attention was much larger than the effect of mediation. When the students rate their interpersonal awareness of the administrator and the tutor they are comparing a co-present peripheral participant with a remote primary participant. Being a primary participant is much more important than being in the same room. It is difficult to interpret direct comparisons of the ratings of the administrators and students. They differed in the instructions they were given to fulfil their role as well as their place in the hybrid and real workspace. However, it is interesting to note that in the low visibility condition of Experiment 2, the administrator's ratings of a peripheral and remote tutor who is not visible are comparable with the student's ratings of a peripheral but co-present tutor.

The introduction went on to relate peripheral participation to Clark's (1996) theory of language use. Clark describes how a speaker has weaker obligations to overhearers than the person to whom the utterance is addressed. These obligations are concerned with designing the utterance to take into account common ground between the speaker and those who hear it, as also to monitor the understanding of the utterance and repair trouble. Different kinds of overhearers are defined. A speaker has stronger obligations to a side participant than to a bystander or eavesdropper. On the basis of this analysis it was hypothesized that peripheral participants may experience different degrees of peripherality depending on their importance to the primary participants. To test this hypothesis the experiments manipulated the visibility of the peripheral participant to a remote primary participant.

It is not possible to assess whether a listener is a side participant, bystander or eavesdropper with regard to each utterance in a transcript of what was said in an experimental session. What one can do is to measure the indirect consequences of degree of peripherality: subjective ratings of interpersonal awareness between three participants, their memory of what was said, attempts by the peripheral participant to break into the conversation, and so on. In both the experiments, the visibility manipulation had effects on ratings of interpersonal awareness. Unexpectedly, these effects were on the ratings of the primary participant not directly affected by the manipulation. In Experiment 1, but not Experiment 2, there was also an effect on recall. These detailed results for the visibility manipulation are discussed further below.

Consider first the ratings of interpersonal awareness. We will focus on the results for Experiment 2 where the visibility manipulation was simplest. In the high visibility condition all participants could see one another. In the low visibility condition all that changed was that the administrator could not see the tutor. Surprisingly this had no effect on the ratings of the administrator. This may be due to a ceiling effect in the ratings the administrator gives to the other primary participant and a floor effect in the ratings given to the peripheral participant. The nature of the task is such that the administrator is only really aware of the student, whether or not the tutor is visible. Of course, the tutor and the student are in one room and the administrator is in another. It is thus possible that the co-presence of student and tutor weakens this floor effect for the ratings given to the tutor by the student thus allowing the visibility effect to show through. Similarly, it may be argued that a ceiling effect explains why the tutor's ratings do not show an effect, i.e. the task ensures that the peripheral participant is maximally aware of the two primary participants and so there is no scope for the manipulation to change interpersonal awareness.

A more theoretical explanation of the interpersonal awareness data needs to consider the mechanisms by which: (1) the primary participants get reinforcement for considering the peripheral participant when acting as a speaker, and (2) the peripheral participant gets reinforcement to behave like a side participant rather than a bystander or eavesdropper. Consider the primary participants first. The administrator cannot hear the peripheral participant (tutor) and so the communicative behaviour of the tutor available to the administrator is limited to facial expressions and gaze direction in the high visibility but not the low visibility condition. It would seem that this is not sufficient to make a difference in the administrator's awareness of the peripheral participant.

The peripheral participant sits next to the student. The student can hear the peripheral participant and sense his bodily movements but cannot easily see his face as they are sitting shoulder to shoulder. This is true in both visibility conditions. What differs, from the student's point of view, is that the administrator looks at the peripheral participant more in the high visibility condition. The difference between 3.5 and 0.5 s per minute may be small but it would seem to have had a large effect on the ratings of the student. The action recorder data show that the difference in looking frequency was 2.35 vs. 0.24 looks per minute respectively. It would seem that as little as two looks per minute is sufficient to convince the student that administrator considers the tutor to be a part of the conversation, where as 0.24 looks per minute is not. The student looks at the tutor very infrequently, 0.57 looks per minute in the high visibility condition and 0.29 in the low visibility condition, and so the administrator is not getting the same signal back from the student.

The interpretation, set out above for the results of Experiment 2, can be interpreted as further evidence of the power of participatory status in determining interpersonal awareness. It implies that the behaviour of a co-present peripheral participant has less effect than the behaviour of the other (remote) primary participant towards the peripheral participant.

These experiments demonstrate that relatively small manipulations of the hybrid and real workspace via seating arrangements or changes in the view one participant has of the others can change the pattern of interpersonal awareness in surprising and subtle ways. What we were not able to demonstrate was an effect on the peripheral participant.

He spends as much time looking at the administrator as the student does and yet their interpersonal awareness ratings are unaffected by the differential looking behaviour of the administrator towards him in the two visibility conditions. A possible explanation is that our manipulation of participatory status was too strong. There was no mobility of participatory status as the peripheral participant was physically prevented from communicating with the remote primary participant. The boom microphone only picked up the co-present primary participant's voice. Also the instructions made it very clear that the discussion was to be between administrator and student. By preventing the tutor from speaking to the administrator in this way we ensured that the tutor was never a speaker and seldom an addressee. This in turn could have had the effect that they were also rarely side participants, i.e they were bystanders or eavesdroppers most of the time. In terms of our analysis, someone who is a bystander or eavesdropper most of the time necessarily experiences a high degree of peripherality. Further experiments where the peripheral participant is allowed to contribute to the discussion, on an infrequent basis, are required to test this hypothesis.

Finally, a note of caution. Experiments of this kind only allow the interpretation that it is possible to demonstrate such and such an effect *under certain circumstances*. Much more analytic and empirical work is required to make generalizable statements about what these circumstances are. For this reason any generalization in terms of design guidelines must be guarded. However, it is possible to use these experiments to identify potential design issues even if one cannot make definitive pronouncements about how these issues are to be dealt with. The paper demonstrates clearly that any recommendation about how to configure an audio-visual link will depend on the task demands of the work, in terms of the number of participants, their level of participation and their visual accessibility. That the students seem to have picked up on the administrator's gaze at the tutor implies a second order to presence via accessibility. One might conceive of this as a "feed through" awareness.

Participatory status has been defined here in terms of a particular pattern of interpersonal awareness that results from particular task demands combined with constraints on how participants may communicate. To determine the relative importance of task demands vs. the constraints on how participants may communicate will require further research but they are both clearly important design issues. Similarly, a comparison of the communication equipment set-ups in Experiments 1 and 2 serves to identify various factors that may be important when designing a hybrid and real workspace for a particular task. Which participants face each other, how close to each other co-present participants are, how well can they all see and hear each other, all may have an effect. All in all, the technology-centred viewpoint, that supporting effective communication is simply a matter of providing sufficient bandwidth or "quality of service", is a most misleading oversimplification.

References

CLARK, H. H. (1996). *Using Language*. Cambridge: Cambridge University Press.

CLARK, H. H. & BRENNAN, S. E. (1991). Grounding in communication. In L. B. RESNICK, J. LEVINE, & S. D. TEASLEY, (Eds.) *Perspectives on Socially Shared Cognition*, pp. 127–149. Washington, DC: American Psychological Association.

DALY-JONES, O., MONK, A. F. & WATTS, L. A. (1998). Some advantages of video conferencing over high-quality audio conferencing: fluency and awareness of attentional focus. *International Journal of Human-Computer Studies*, **49,** 21–59.

GOFFMAN, E. (1976). Replies and responses. *Language in Society*, **5,** 257–313.

GREATBATCH, D., HEATH, C., LUFF, P., & CAMPION, P. (1995). Conversation analysis: human–computer interaction and the general practice consultation. In A. F. MONK & N. GILBERT, *Perspectives on HCI*: *Diverse Approaches*. pp. 199–222. London: Academic Press.

HARRISON, S. & DOURISH, P. (1996). Re-placing space: the roles of place and space in collaborative systems. *Paper presented at Computer Supported Cooperative Work '96*, Cambridge, MA, (pp. 76–76). New York: ACM Press.

HEATH, C., & LUFF, P. (1996). Convergent activities: line control and passenger information on the London underground. In Y. Engestrom & D. Middleton, Eds. *Cognition and Communication at Work*, pp. 96–129. Cambridge: Cambridge University Press.

HUTCHINS, E. (1994). *Cognition in the Wild*. Cambridge, MA: MIT Press.

MONK, A. F., & WATTS, L. (1997). Task analysis for collaborative work. *Paper Presented at the Human-Computer Interaction*: INTERACT'97, Sydney, Australia, pp. 593–594.

O'CONAILL, B., WHITTAKER, S., & WILBUR, S. (1993). Conversations over video conferences: an evaluation of the spoken aspects of video-mediated communication. *Human–Computer Interaction*, **8**(4)**,** 389–428.

SCHOBER, M. F., & CLARK, H. H. (1989). Understanding by addressees and overhearers. *Cognitive Psychology*, **21,** 211–232.

SELLEN, A. J. (1995). Remote conversations: the effects of mediating talk with technology. *Human–Computer Interaction*, **10,** 401–444.

SHORT, J., WILLIAMS, E. & CHRISTIE, B. (1976). *The Social Psychology of Telecommunications*. London: John Wiley and Sons.

WATTS, L. A. (1998). *Understanding interactive behaviour*: *a quantitative approach*. D. Phil. Thesis, University of York, U.K.

WATTS, L. A., & MONK, A. F. (1997). *Telemedical consultation*: *task characteristics. Paper Presented at the CHI'97 Conference on Human Factors in Computing Systems*, Atlanta, GA, U.S.A. pp. 534–535

WATTS, L. A., & MONK, A. F. (1998). Reasoning about tasks, activity and technology to support collaboration. *Ergonomics*, **41,** 1583–1606.

WATTS, L. A., & MONK, A. F. (1999). Telemedicine: what happens in teleconsultation. *International Journal of Technology Assessment in Health Care*, **15,** 220–235.

WATTS, L. A., MONK, A. F., & DALY-JONES, O. (1996). Inter-personal awareness and synchronisation of communication technologies. *International Journal of Human Computer Studies*, **44,** 849–875.

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Appendix: Scoring scheme for topic mention and topic recall

In Experiment 2, transcripts of the spoken discussion and what was written as recall were scored using the following scheme. Raters were instructed to follow a lax criterion and to mark a point as present if there was any evidence that what was said or written implied it. Some points imply others (e.g. 9 implies 8) and one phrase may imply more than one point. "L", "A" and "S" indicate the source of the point in the original material, i.e. the Letter, the Administrator's and Student's briefing materials, respectively. The numbers 1–3 identify the failed course referred to.

1. Only checking/comparing notes, not copying information. **S1**	15. Departmental penalty for late submission too strict **A3**
2. Member of staff soft on other student **L1**	16. Deduction of 15% for late submission (university norm 10%). **A3**
3. Mathematical course, similar answers inevitable **L1**	17. Student had been ill **L3**
4. First course at University—school practice different **A1**	18. Tried to work in halls while ill. **L3**
5. Student's knowledge of plagiarism rules **A1**	19. Friend's computer was unreliable and incompatible (implies 18) **L3**
6. Not technically plagiarism **A1**	20. Illness was at a critical time—cost whole of week five **S3**
7. Only one person's word against another **L1**	21. Student didn't have a sick note **L3**
8. Practical exercise in the field. **S2**	22. Medical appointment booking difficulties **L3**
9. Lots of travel needed to complete course (implies 8). **S2**	23. Geography computer systems went down **S3**
10. Student had financial hardships **S2**	24 The computer systems were a course requirement **L3**
11. Student had narrowly failed the course **S+L2**	25. A large number of other students handed in late. **A3**
12. The course had been marked too strictly **A2**	26. In total, 40% of other students handed in late. (implies 25.) **A3**
13. The student's supervision was inadequate **S+L2**	27. Not student's fault—institutional failure (additional)
14. The student's supervisor had been ill (implies 13) **S2**	