Not Really There: Understanding Embodied Communication Affordances in Team Perception and Participation

ABSTRACT

In this paper, we report findings from a study that compared basic video-conferencing, emergent kinetic video-conferencing techniques, and face-to-face meetings. In our study, remote and co-located participants worked together in groups of three. We show, in agreement with prior literature, the strong adverse impact of being remote on participation-levels. We also show that local and remote participants perceived differently their own contributions and others'. Extending prior work, we also show that local participants exhibited significantly more overlapping speech with remote participants who used an embodied proxy, than with remote participants in basic-video conferencing (and at a rate similar to overlapping speech for co-located groups). We also describe differences in how the technologies were used to follow conversation. We discuss how these findings extend our understanding of the promise and potential limitations of embodied video-conferencing solutions.

Author Keywords

Telepresence, Video Conferencing, Embodied Proxies

ACM Classification Keywords

H.5.3 [Group and Organization Interfaces]: Computer-supported cooperative work.

INTRODUCTION

Advances in processing hardware, encoding techniques, and broadband networks are driving a rise in the adoption of video-based communication technologies, especially in the workplace. These technologies have been shown to increase the frequency of communication between co-workers and, in some cases, improve productivity [25]. A recent industry survey of human-resource executives illustrates the disruptive nature of this technology and boldly postulates that video-based communication tools will be preferred over email in the workplace by 2016 [21].

Although world travel has been steadily growing [12], recent reports on corporate travel budgets show a 17% overall decline [33] and an increase in travel-related costs of 3-9% [14]. This suggests an economic driving-force for adoption of video-based communication.

Despite the benefits, limitations still exist. Past work in this community has shown that remote users still face a disadvantage when compared to their co-located colleagues. Remote collaborators participate less in conversations, take less dominant roles in groups, and feel less connected to distant coworkers. A new class of technologies has emerged that seek to mitigate the social disadvantages of video-based communication by providing remote collaborators with a local embodiment. These technologies range from fully mobile robots, to smaller devices that sit on a meeting room table.

Studies of these embodied telepresence devices show that they provide distributed teams with an increased sense of their remote colleagues' presence in the local environment and a reciprocal sense of "being there" for that remote worker. Studies have also shown that using these devices can change collaborative behavior. For example, [27] found that their use led to more opportunistic interactions among distant workers.

While the impact of introducing these technologies has been explored at a group level, few studies have investigated about how they impact an actual collaborative engagement (e.g. a workplace meeting). Further, there is need to extend classic work (e.g. [23]), to account for the capabilities introduced by modern embodied devices.

In this work, we performed a lab study that directly compares the use of an embodied telepresence device, a traditional video conferencing configuration, and fully co-located baseline to complete a specific, collaborative task. Our results provide insights into how these embodied devices impact group behavior. We found that while the experience and task performance are similar, there are nuanced behavior shifts in-group interaction. We believe the results and insights from our work strengthen the findings of past studies, while providing a much needed comparative baseline across technologies. Using our comparative result, we also offer design insight for improving the current state-of-the-art embodied telepresence devices.

RELATED WORK

Studies of group work have shown the importance of providing access, presence, and a sense belonging across members of distributed teams [10, 31].

Pioneering work, like PARC's Portholes, which shared photo snapshots of colleagues' in their offices, found that this type of sharing improved awareness and a "sense of community" with the team [6]. Erickson and Kellogg [7] describe the phenomenon as Social Translucence and argue its importance in the design of computer mediated communication tools.

Fostering stronger connections in distributed teams has been the focus of many research systems. These include physical presence tools (e.g. [9, 15, 26]), as well as those that attempt to facilitate interaction explicitly. Cruiser [8], for example, presents users with short, symmetric glimpses into co-workers offices to simulate the effect of walking down a hall of open office doors. Tools like MyUnity [32] combine physical presence with structured messaging to facilitate interactions that are thought to be context and location ideal.

A large body of research exists aimed at improving video collaboration. The Hydra system, for example, used "video surrogates" to represent individuals in a 4-way video conference [23] and compared its use to a traditional video conferencing setup and to face-to-face collaboration. More recently, the Embodied Social Proxies (ESP) work [27] presented a video conferencing cart that can be moved and reconfigured in a workspace. This embodied device was deployed for several months within distributed teams. ESP was found to have a profound impact on the remote worker's membership and participation with the team. Particularly, local team members developed stronger affinity towards, and gave more attention to remote workers. A key finding was that "improved interpersonal social connections" were established through the proxy's continuous physical presence.

Embodied presence through physical movement has surged in both commercial and research landscapes. These include small, on desk devices, such as the AnyBot [2], Kubi [13], MeBot [1], and Porta-Person [34]. Such devices are typically intended to be placed on a table in a conference room to provide a fixed proxy for a remote person or location. These also include fully mobile robots like the Beam [3], VGo [28], and PRoP [16], that can be maneuvered around an office environment, but that also have greater physical presence in the local environment.

In [19], Rae *et al.* showed that physical presence impacted the group dynamics in 1:1 tasks. In [20] compared the use of embodied (telepresence robot) and non-embodied (tablet) tele-mediated collaboration in support of 1:1 tasks. Embodiment and the ability for the local person to control view were found to foster trust between the users. Recently, [18] examined the use of a mobile embodied device to allow remote participants to assist a local person (a confederate) with tasks of varied mobility. Their findings showed that remote users had a greater sense of presence with the local participant when performing a high-mobility task, but highlighted the burden of maneuvering the device.

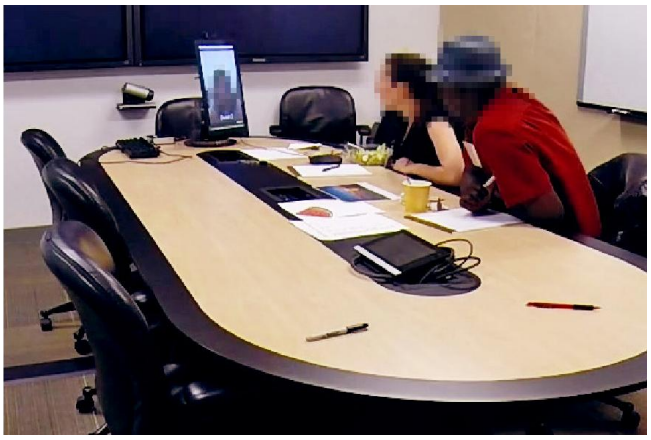


Figure 1. A group discussion in the Kinetic condition, with two co-located participants and a single remote participant using the Jarvis embodied device.

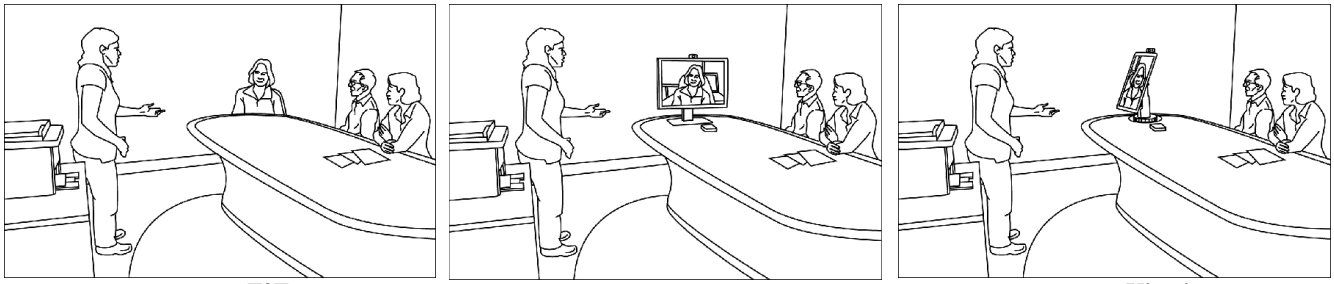
Closely related to our work, [24] created a kinetic videoconferencing proxy that allows a remote user to pan the remote display. In a controlled study, they examined the influence of different motion control schemas (in which the controller was a confederate) on group participation and attitudes. They showed higher engagement in conversation, higher user rankings, and improved attention awareness with the kinetic version.

While these past studies provide evidence that embodied devices may assist in breaking down known barriers in distributed collaboration (e.g. member isolation [4], local sub-teams [30]), many questions still remain.

In this paper, we extend the exploration of these new technologies for group meetings in distributed workplaces, compared to traditional forms of non-embodied video-based communication as well as to face-to-face collaboration. Using a between-subject study, we explore group dynamics in co-located and distributed settings. This allowed us to examine the effect of kinetic embodied devices (similar to [24]), while keeping participants unaware of the mediation manipulation. As such, our work creates a relevant, much needed link between the classic comparative work on video and face-to-face collaboration, and recent explorations into kinetic embodied devices.

STUDY

To capture group communication and task engagement, we conducted a between-subject group collaboration study in which some participants were co-located and others remote. Similar to [18, 24], our study employed a confederate. In our study, groups of three participants evaluated a junior sales-trainee (the confederate) on a short sales presentation.



a. F2F b. Static c. Kinetic

Figure 2. Study setup with a presenter and three participants. In the Static (b) and Kinetic (c) conditions, one participant is remote.

Task

The groups' task – evaluating a junior sales-trainee – consisted of three phases: *Presentation*, *Discussion*, and *Feedback*.

In the *Presentation* phase, the sales trainee gave a short sales presentation about a specific multifunction printer for home and small-office use. (We chose printers because they are one of the product-categories made by our company.) In order to keep the task consistent across all groups and conditions, we hired a professionally trained actor to play the role of the trainee. The actor was instructed to "play the same character" in all sessions, including consistently performing the same non-verbal behaviors, body posture, and vocal delivery. Scripted content and behaviors gave the appearance of a young, naïve sales trainee who had many faults and struggles in her presentation.

After the presentation was done and the presenter excused from the room, a *Discussion* phase began, in which participants privately discussed the presenter's performance (see Figure 1). Finally, the presenter was brought back into the room for the *Feedback* phase, and participants provided her with feedback.

Conditions

Our study consisted of three group-level conditions used to understand how groups performed an authentic task where group communication was mediated through different technologies: a baseline condition (*F2F*), with all 3 participants co-located, and two conditions (*Static* and *Kinetic*) where one participant was "remote" and the other two in the same room. This is similar to the *hub-and-satellite* meeting paradigm used in [24].

In the *F2F* condition, which served as baseline, all 3 participants (say, participants A, B, and C) were co-located and sat around a medium-sized meeting table (see Figure 2a). In the *Static* and *Kinetic* conditions, however, participant C was in a different room (as a "*Remote*" participant), and communicated via a two-party video call. The video call was provided by Vidyo [29], an enterprise commercial video conferencing technology.

In the *Static* condition, which represents current practices for business video conferencing, participant C was in a different room, and communicated with the group via a two-party video call. A large, 30" display with an HD camera was placed on the meeting table in the approximate position of participant C in the F2F condition (Figure 2b).

In the *Kinetic* condition (Figure 2c), chosen to represent the emerging class of embodied telepresence devices, participant C communicated with the group using a prototype desktop telepresence device called *Jarvis* (see Figure 3). The device uses a large, portrait-oriented 18" tablet to display the participant. A HD camera is built into the top of the robot, creating a direct mapping between display orientation and remote view direction and angle. Motors enable the remote participant to pan and tilt the display by clicking on the remote video, which re-centered the camera view at the click point. Similar to the Static condition, Jarvis was placed on the meeting table in the approximate position of participant C in the F2F condition,

Procedure

Upon arriving at our lab, participants were shown to a meeting room. For the Kinetic and Static conditions, the first participant to arrive at the lab was whisked to a separate room and assigned the role of *Remote* participant. They all completed informed consent, demographic, and pre-study questionnaires.

Participants were told that their task was to evaluate a junior sales trainee who, as part of her training, had to make a short sales pitch in front of a live audience. The three phases of the task were described and the presenter was brought to the room.

After a short introduction, the confederate began her presentation, following a script that covered the features, functionality, and characteristics of the printer. Participants were allowed to interrupt and ask questions, but the actress was instructed to keep to and return to her script as much as possible. The presenter was then excused from the room and the group began their private discussion. Participants were told that they are allowed to move around the table or reposition the display if they so wished and that they could take as much time as they needed. When participants informed the researcher that they were done, the presenter was brought back and the group provided feedback.

Participants were then taken to separate rooms to complete post-study questionnaires, where they rated the

Figure 3. Jarvis: A desktop pan & tilt telepresence robot equipped with an 18" screen and HD video camera.

performance of the presenter, as well as their own and fellow evaluators' performance. Finally, we asked remote participants to comment on the challenges of working as a group through mediated communication.

Participants

We recruited participants via fliers and postings to community bulletin boards (e.g. Craigslist). The call indicated that participants would be given an Amazon gift card in return for an hour of their time to evaluate a sales presentation. 27 participants were recruited (11 women), with an average age of 44 (SD=13.8). Participants were randomly assigned to one of the three Group conditions, with three groups per condition. Participants did not know each other.

Measures

We collected a variety of subjective and objective measures, which included:

- *Performance questionnaire*. Participants rated the quality of the trainee's presentation across several dimensions. They also rated their own performance as evaluators, as well as the performance of fellow evaluators. The questions were modeled after existing shared identity, reciprocity, and group efficacy questionnaires [5, 11, 17].
- *Video analysis*. We recorded each session using multiple cameras (local and remote, when applicable) and coded for speech, gestures, and manipulation of artifacts and devices (including display and robot).
- *Open-ended post-study questions*. We examined comments from participants in the Static and Kinetic conditions on the challenges of working as a group through mediated communication.

RESULTS

A total of 4.5 hours of video were recorded (30 minutes per group, on average). The average length, in minutes, for Discussion and Feedback were 9:47 (SD=5.2) and 10:26 (SD=7.6), respectively. Length varied across groups because we allowed participants to take as long as they wished for their discussion and the feedback.

We now report observations from the performance questionnaires, analysis of the videos, and the post-study interviews. We compare the behavior and attitudes of remote and co-located participants then report some surprising behavioral differences between our conditions. Finally, we examine whether (and how) participants took advantage of the ability to adjust the point-of-view (POV).

Participation and Perceived Performance

We examined if being a remote participant affected participation and perception. As highlighted by [30] and other work, remote participants are often at risk of becoming isolates. Indeed, we found that participation levels of remote participants were significantly lower than their co-located counterparts. Remote participants took the floor 22% of the time, on average, compared to 37% for local participants ($t(25)=2.184$; $p<0.05$).

The reduced participation (or perceived ability to contribute) was further reflected in participants' responses in the performance questionnaire; Remote participants rated their own contribution significantly lower than local participants did (4.3 vs. 6.1; $F(1,5)=11.41$, $p=0.02$, with Group as a random factor). Additionally, looking at how local participants in the Kinetic and Static conditions rated the contribution of teammates showed a marginally significant effect with remote teammates receiving lower ratings than co-located (5.1 vs 6.25; $t(5)=1.99$, $p=.052$). Finally, when asked to rank-order the group from most contributing member (1) to least contributing member (3), not a single remote participant ranked themselves as most helpful, while 62% of local participants did. (In fact, 83% of remote participants ranked themselves as least helpful.)

Interestingly, remote participants, in both Kinetic and Static conditions, rated the sales presentation significantly less favorably (2.3 vs. 3.4; $F(1,5)=12.3$, $p<0.02$, with group as random factor). Asked to rate whether they thought the trainee will be a successful sales professional, remote participants gave significantly lower rating than co-located participants (M=3.0 vs. 5.1; $F(1,5)=12.00$, $p<0.02$, with Group a random factor). In their post-study interview, a remote participants in the *Static* condition stated "*I was able to observe more objectively maybe, listen to what they're saying.*" We saw no difference in ratings of the presentation and presenter between the remote conditions.

Although we do note the differences mentioned above between remote and co-located participants, we found no significant performance and perception differences between the three conditions.

Talk and Overlapping Talk

Next, we used recorded videos to code the start and end times of participants' speech. We also coded for overlapping talk (i.e., whether a participant started speaking over a participant that was already speaking [19]). To investigate group turn taking and overlapping talk absent the presenter's (confederate) influence, we focus our analysis on the Discussion phase (during which, the presenter was not in the room).

Turn Taking

Analysis of turns taken per minute showed no significant difference across conditions (Kinetic M=1.65, SD=0.93, Static M=1.51, SD=0.76, and *F2F* M=2.11, SD=1.04). Turn *length* did show a marginal difference across conditions; turn length was greater on average in the Static condition (15.5s, SD=19.41) compared to F2F (11.8s, SD=11.78) and Kinetic conditions (11.7s, SD=14.10; $F(2,410)=2.693$, $p=0.07$). However, comparing length of turns taken by remote participants, shows a significant difference between conditions, with Kinetic participants in having significantly shorter turns than Static participants (8.5s vs. 20.2s; $t(50)=2.078$, $p<0.05$).

Overlapping Talk

While there was no overall difference in the rate of overlapping talk across conditions (with M=47.8%, SD=13.8%), an analysis of the involvement of remote participants in overlapping talk revealed remote participants were nearly three times as likely to be interrupted in the Kinetic condition compared to remote participants in the Static condition (50% vs. 18%; $t(4)=7.47$, $p<0.01$). This is similar to the rate that local participants interrupted one another (M=49.7%, SD=16.5%). No difference was found between conditions when the remote participant was the one interrupting (49% vs. 37%, SD=0.4 for the Kinetic and Static conditions, respectively).

Manipulating the Remote View

The ability of a remote participant to adjust their point-of-view (POV) was a key difference between the Kinetic and Static conditions. Unlike in [24], where a confederate operated the embodied proxy, our study allowed participants to use this capability as their own discretion. Thus, we ask: Was this ability even used? For what purpose? What was the behavior in the Static condition, when the capability was unavailable?

Through examination of recorded video, we saw that remote participants exhibited varying degrees of use. While one remote participant changed their POV only twice: at the beginning of the Discussion phase, and at the beginning of the Feedback phase, another remote participant adjusted their POV 22 times in a 40-minute session. (The remaining remote participant changed their POV 6 times in that group's 30-minute session.)

As expected, a large portion (43%) of all changes in POV were made to be able to see the person(s) speaking (since co-located participants rarely moved, orienting the POV to the person speaking was relatively easy). Another trigger to change the POV was when the focus of attention of the co-located participants has shifted. This included non-verbal shift – e.g., when co-located participants look towards the presenter who's returned to the room for the Feedback session – or when the subject of the conversation was out of view – e.g., when features of the printer were discussed. Finally, in two cases, changing POV was also used to visually track a local participant moving around the room (e.g., to inspect the printer).

Adjusting POV in the Static condition

At the end of the Presentation phase, participants were told that they should feel free to move around or turn the screen around. However, unlike the Kinetic condition, remote participants in the Static condition could not adjust their POV. As stated by one of the participants "*they can hear me, they can see me, but I could only see [one of the local participants]* ***or*** *[the presenter]*." Thus, these participants had to rely on co-located group members to change their POV. Through examination of recorded video we observed that in all groups in the Static condition, co-located users manually adjusted the display and camera of the remote participant to afford them a better view of the participants (Discussion phase) or presenter (Feedback phase). In fact, one of the Static groups deliberately asked the presenter to sit at a seat at the opposite end from the remote participant for the Feedback phase, such that participants and presenter could be in view. These observations are important as they highlight the groups' need for adjusting the remote person's POV as meeting circumstances change. This supports findings from [27], that local participants moved the embodied remote participant to foster inclusion in the group. Interestingly, manually adjusting a remote person's POV was sometimes accompanied with a statement such as "*We're going to move you now*" (local participant to remote participant).

DISCUSSION

Our study compared an embodied technology against both a non-embodied technology *and* a baseline face-to-face, all co-located group configuration. Our results highlight a likely understood, but not often discussed assessment of the state-of-the-art; despite many advantages, embodied technologies still exhibit many of the known negative effects introduced by a mediated communication channel. Remote participants (in both conditions) contributed less, rated the experience poorer, and generally felt less connected than their co-located peers. Further, these negative findings were not significantly different between the two remote conditions. This suggests that being remote has a much greater impact on participation than the ability of embodiment to overcome it.

In [24] a confederate was used as the operator of a proxy when studying the impact of different forms of kinetic motion, while in [18] a confederate was used as the local participant. In contrast, our study used both local and

remote participants. Our observations suggest that, when the use of the kinetic capability is left up to a participant, one will observe a wide range of usages of the medium. Our findings further suggest that the advantages of kinetic embodiment may be suppressed by the larger, negative impacts of the mediated channel.

Prior work (e.g. [27]) showed that in addition to improved group collaborations, embodied technologies facilitated social integration and team building over time. Our study, by contrast, used participants who did not know one another, and yielded several different findings. While work team members in the real world are likely to be familiar with one another, the difference in findings suggests that embodied technologies may not directly impact group collaboration, but the stronger social connections fostered by the technology are what direct impacts collaboration quality. This consideration certainly needs further exploration. However, if true, it has strong implications for the use of these technologies. Specifically, loosely affiliated or one time groups (e.g. a product evaluation panel demonstrated in our study) may not be the ideal user population of embodied technologies.

While we did not find many differences between the Kinetic and Static conditions with respect to perceptions of group performance, we did find several interesting nuanced differences. It was particularly interesting to examine how and why the remote participant adjusted their point of view (POV), contrasted with reliance on local participants in the Static condition. Kinetic remote participants used and appreciated the capability – it assisted in focusing conversation and conveyance of visual attention. Local participants appreciated the impact on group dynamic as well. One local participant noted, *"to use this [referring to the embodied device] in a group setting, for meetings like this, that's great that he can, you know, move around and see everyone."* In comparison, the Static condition placed a burden on local participants, and as local participants explained, the *"[she] was so far away"* and *"[he] only had one point of view."* In contrast to prior findings [20], the differences in behavior and perception we observed suggests that for larger, unbalanced teams relying on local teammates to adjust the POV might not support equitable group interaction.

Another surprising result was the difference in turn taking behavior between Kinetic and Static remote participants. Kinetic remote participants turn taking behavior more closely matches that of their co-located counterparts. A difference was also found in the frequency of over speaking. Particularly, the rate of interruptions of remote participants by local participants in the Kinetic condition was similar to rates of interruption between co-located participants. This is in contrast to the Static condition where interruptions we far fewer. The combined observation of turn taking and over speak suggests that co-located participants may have had a more natural interaction with their remote counterpart when using the embodied device. Considering the potential implications for use, this phenomenon needs deeper exploration and analysis.

Finally, qualitative feedback in the post-study interviews also indicated a subtle shift in how the disadvantages of the mediated channel were perceived by local participants. In the *Static* condition, local participants were sympathetic to the remote participants. As one local participant put it, *"We could adjust to the situation. We can just jump in. He [remote participant] can't."* Another stated *"it's harder for the person on that end [remote participant] to get a good idea of what's really going on."*

This was in contrast to the Kinetic condition, where participants' feedback did not directly discount the affordances of the remote participant. For instance, one participant stated he *"…recognized there were three people here, he [remote participant] wasn't more or less included."* Another participant stated *"every time he [remote participant] had a question we would address him without any problem."* Some participants even attributed the reduced remote participation to the personality of the remote participant – *"he [remote participant] was more non-talkative than he should have been. Which, of course, this would affect you interacting with anyone. So I don't think that this was the technology, just the person who is using it."* These observations may be early evidence of the embodied device's ability to support stronger social integration and team bonding that was previously discovered by [27].

CONCLUSIONS AND FUTURE WORK

In this work, we compared basic video-conferencing, emergent kinetic video-conferencing techniques, and face-to-face meetings. Our findings build upon previous research, showing the adverse impact of being remote on participation-levels and perception of contribution. We also showed an interesting difference in overlapping speech between the conditions. We then showed the potential of kinetic embodied proxies to impact behaviors exhibited by local participants in video conferencing meetings.

Still, a better understanding is needed of the work tasks that benefit (or suffer) from use of kinetic telepresence, and the types of work teams for whom such proxies are most appropriate. As such, we plan to investigate the use of a proxy similar to Jarvis in across a variety of tasks and settings using methodology similar to ESP [27].

Lastly, a key limitation of telepresence proxies, such as the one used in this study and others (e.g., [1, 18, 24]) is that, while they create an embodiment of the remote person in the local space, the remote person still experiences the space the same way – as a video on the screen (albeit with an ability to adjust their POV). In future work, we plan to explore mechanisms (such as a 3rd person view of their proxy) to provide the remote person a sense of their representation in the local space, and examine its effect on their sense of presence.

REFERENCES

1. Adalgeirsson, S. O., & Breazeal, C. MeBot: a robotic platform for socially embodied presence. *In Proc. HRI 2010*. IEEE Press (2010), 15-22.
2. AnyBots. http://www.anybots.com.
3. Beam. https://www.suitabletech.com/beam/
4. Bos, N., Shami, N. S., Olson, J. S., Cheshin, A., and Nan, N. In-group/out-group effects in distributed teams: an experimental simulation. *In Proc. CHI 2004*. ACM Press (2004), 429-436.
5. Carroll, J., Rosson, M.B. and Zhou, J. Collective efficacy as a measure of community. *In Proc. CHI 2005*. ACM Press (2005), 1–10.
6. Dourish, P., and Bly, S. Portholes: Supporting Awareness in a Distributed Group. *In Proc. CHI 1992*, ACM Press (1992), 541-547.
7. Erickson, T., and Kellogg, W.A. Social Translucence: An approach to designing a system that supports social processes. *ACM TOCHI*, 7,1 (2000), 59-83.
8. Fish, R., Kraut, R., Root, R., and Rice, R. Evaluating video as a technology for informal communication. *In Proc. CHI 1992*, ACM Press (1992), 37-48.
9. Fogarty, J., Lai, J., and Christensen, J. Presence versus availability: the design and evaluation of a context-aware communication client. *IJHCS*, 61 (2004), 299-317.
10. Fussell, S.R. Kraut, R.E. and Siegel, J. Coordination of communication: effects of shared visual context on collaborative work. *In Proc. CSCW 2000*. ACM Press (2000), 21-30.
11. Henry, K.B., Arrow, H. and Carini, B. (1999) A tripartite model of group identity. *Small Group Research*, 30, 5 (1999), 558–581.
12. ITB Library. *ITB world trends report 2013*. http://www.itb-berlin.de/media/itbk/itbk_media/itbk_pdf/WTTR_Report_2013_web.pdf (2013).
13. Kubi. http://www.kubi.me.
14. Kwoh, L, and Kornat, M. *CEOs fly coach? Business travel turns frugal*. http://online.wsj.com/news/articles/SB10001424127887323511804578300181289786570 (2013).
15. McEwan, G., and Greenberg, S. Supporting social worlds with the community bar. *In Proc. GROUP* 2005, ACM Press (2005), 21-30.
16. Paulos, E., and Canny, J. PRoP: personal roving presence. *In Proc. CHI 1998*. ACM Press (1998), 296-303.
17. Perugini, N., Gallucci, M., Presaghi, F., and Ercolani, A.P. The personal norm of reciprocity. *European Journal of Personality*, 17, 4 (2002), 251–283.
18. Rae, I., Mutlu, B., and Takayama, L. Bodies in Motion: Mobility, presence, and task awareness in telepresence. *In Proc. CHI 2014*. ACM Press (2014), 2153-2162.
19. Rae, I., Takayama, L., and Mutlu, B. One of the gang: Supporting in-group behavior for embodied mediated communication. *In Proc. CHI 2012*. ACM Press (2012), 3091-3100.
20. Rae, I., Takayama, L. and Mutlu, B. In-body experiences: Embodiment, control, and trust in robot-mediated communication. *In Proc. CHI 2013*. ACM Press (2013), 1921-1930.
21. Redshift Research. *Global View: Business Video Conferencing Usage and Trends*. (2014) http://www.polycom.com/company/news/press-releases/2014/20140318.html
22. Schegloff, E.A., Overlapping talk and the organization of turn-taking for conversation. *Language in Society*, 29, Cambridge Press (2000), 1-63.
23. Sellen, A. J. Speech patterns in video-mediated conversations. *In Proc. CHI 1992*. ACM Press (1992), 49-59.
24. Sirkin, D., Venolia, G. Tang, J.C., Robertson, G.G., Kim, T., Inkpen, K., Sedlins, M., Lee, B., and Sinclair, M. Motion and attention in a kinetic videoconferencing proxy. *In Proc. INTERACT 2011*. IFIP (2011), 162-180.
25. Stofega, W. *Seeing is believing: The value of video collaboration.* Technical Report, International Data Corporation (2007).
26. Tang, J., Yankelovich, N., Begole, J., Kleek, M., Li, F., and Bhalodia, J. ConNexus to awarenex: extending awareness to mobile users. *In Proc. CHI 2001*, ACM Press (2001), 221-228.
27. Venolia, G., Tang, J., Cervantes, R., Bly, S., Robertson, G., Lee, B., and Inkpen, K. Embodied social proxy: mediated interpersonal connection in hub-and-satellite teams. *In Proc. CHI 2010*, ACM Press (2010), 1049-1058.
28. VGo. http://www.vgocom.com.
29. Vidyo. http://www.vidyo.com.
30. Voida, A., Bos, N.D., Olson, J.S., Olson, G.M. and Dunning, L. Cross-cutting faultlines of location and shared identity in the intergroup cooperation of partially distributed groups. *In Proc. CHI 2012*. ACM Press (2012), 3101-3110.
31. Whittaker, S., Frohlich, D., and Daly-Jones, O. Informal communication: what is it like and how might we support it? *In Proc. CHI 1994*, ACM Press (1994), 130-137.
32. Wiese, J., Biehl, J.T., Turner, T., van Melle, W., and Girgensohn, A. Beyond 'yesterday's tomorrow': towards the design of awareness technologies for the contemporary worker. *In Proc. MobileHCI 2011*. ACM Press (2011), 455-464.
33. Winston, A. *Will video conferencing kill business class travel?* http://blogs.hbr.org/2009/08/will-video-conferencing-kill-bisiness-class/ (2009).
34. Yankelovich, N., Simpson, N., Kaplan, J. and Provino, J. Porta-person: telepresence for the connected conference room. *Ext. Abstracts CHI 2007*, ACM Press (2007), 2789-2794.