

Quiet Calls: Talking Silently on Mobile Phones

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ABSTRACT

Quiet Calls is a technology allowing mobile telephone users to respond to telephone conversations without talking aloud. QC-Hold, a Quiet Calls prototype, combines three buttons for responding to calls with a PDA/mobile phone unit to silently send pre-recorded audio directly into the phone. This permits a mixed-mode communication where callers in public settings use a quiet means of communication, and other callers experience a voice telephone call. An evaluation of QC-Hold shows that it is easily used and suggests ways in which Quiet Calls offers a new form of communication, extending the choices offered by synchronous phone calling and asynchronous voicemail.

Keywords

Interaction design; telecommunication; hand-held devices; computer mediated communication; mobile computing.

INTRODUCTION

Mobile telephones are affecting our daily lives with calls that can be made to almost anyone from almost anywhere. Mobile phones allow immediate responsiveness, but concerns of privacy and disruptiveness of overheard calls are being described as adverse consequences in the popular media (e.g., [1, 12]). We can silence the rings [2], but the talk is still noisy.

We have seen several ways that people attempt to deal with the situation of having private conversations while in a public place:

- *Be noisy.* This approach requires judgment about when privacy and disruption of an ongoing situation are not primary concerns.
- *Talk quietly.* Callers can often be seen in a corner of the room attempting to shield a conversation. This is inconvenient and again requires judgment to determine when this approach is working adequately.
- *Move the conversation elsewhere.* People often leave a room after receiving a call. However, the movement

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SIGCHI'01, March 31-April 4, 2001, Seattle, WA, USA.
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itself can be distracting and is often accompanied by fragments of conversation.

- *Don't take the call.* Voicemail is a common way of dealing with calls when engaged in another activity. However, some calls need immediate attention. Further, dependency on voicemail and pagers can draw out a conversation through many one-way exchanges.
- *Use an inaudible technology.* Switching the conversation to a different modality, such as two-way text pagers is quiet. However, all parties to the conversation must switch to that new modality.

Examples of mismatches between the mobile phone's audible attributes and public situations that we have documented include incidents of callers talking while exiting a room (e.g., meetings, movies, even a funeral), voice conversations interfering with a caller's ability to listen to other important activities (e.g., announcements in a waiting room), confusing and distracting behavior of people seemingly talking to themselves, and issues of private information being divulged (e.g., names, numbers).

The technology described here, Quiet Calls (Figure 1), is an example of what we call *mixed-mode synchronous communication*. Quiet Calls separate the medium of the caller from that of the callee, shifting the call participant in the public situation to a quiet mode of communication (e.g., keyboard, buttons, touchscreen). Other callers experience the

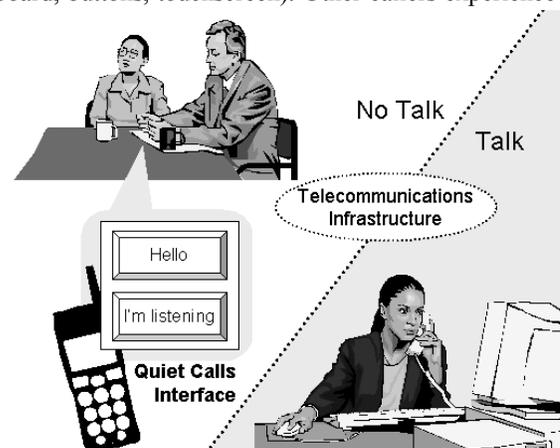


Figure 1. A Quiet Calls phone interface allows callers to select what to say silently and have that voiced only over the phone lines.

call over the normal telecommunications infrastructure. Quiet Calls provide the callee with a representation of things to say (e.g., greetings, status). Prerecorded or synthesized voice is then fed directly into the phone and the user's earpiece corresponding to the conversational elements selected non-vocally.

A scenario for a Quiet Call interaction

Ed is participating in an off-site review of his company's ongoing projects. At the same time, Ed's own project is at an important decision point. Sue, his technical lead, is 'working the numbers' with the other project members. When Sue calls, Ed recognizes her Caller ID and answers with a button press on his cell phone that sends the pre-recorded response "*Hi, I'm on my cell phone. I can listen but not talk aloud right now. Please go ahead.*" Sue talks as usual, giving him their new information. Ed signals his understanding with a button press that sends the response "*Good, I'm still listening*" and then hangs up with a message "*Thanks and bye.*" The Quiet Call system allows Ed to have the most current technical information available when he makes his own presentation.

Later Sue calls, needing a go/no-go decision from Ed. When she reaches Ed, he again answers that he is unable to talk aloud. However, when he hears what she needs, he presses a button on his cell phone that sends the pre-recorded response "*Hold on, I'll be with you in just a moment.*" As he does this, Ed quietly steps out of the meeting to talk on his cell phone as normal. The Quiet Call system allows Ed to switch conversation modes as needed while keeping the conversation flow going.

Related Work

Other forms of quiet, synchronous communication include tactile systems [3] and two-way pagers [11]. These systems require communicating parties to switch communication modes and infrastructures entirely.

Other mixed-mode communications include text-to-speech (TtS) conversion, speech recognition, and gesture recognition. TtS systems, and notably those designed for the speech disabled [8], vocalize typed text with a synthetically generated voice. TtS applications require typing in responses and then only speak in quite synthetic sounding voices. Hence, TtS does not provide speed of response needed for quick, frequent mobile phone conversations. Speech recognition [10] changes a message's mode from voice to text. However, voice input will not help with the problem of quieting phone talk. Gesture recognition [e.g., 14] allows a user's multimodal act (e.g., pointing) to generate appropriate multimodal responses (e.g., sentence completion), and is not in itself a complete means of communication.

The current form of Quiet Calls described here resulted from an iterative process that involved user observation and prototyping to inform the design. As described above, we had a general vision of being able to make noisy phone calls quiet by supporting non-vocal communication over the phone. The remaining sections of the paper describe our early field

observations, the implementation of a Quiet Calls prototype called QC-Hold, and a user study to evaluate this system. We conclude with a discussion of issues for mixed-mode communication interfaces raised by the design and use of Quiet Calls.

OBSERVATIONS OF MOBILE PHONE USE

Early observations were conducted to validate our belief that public calls were not only occurring but are a necessary part of life today. The collected user data, in the form of field observations, interviews, and collected anecdotal evidence, was intended to also inform the design of Quiet Calls.

Methods of Observations

We first directly viewed the externally visible behaviors of mobile phone users:

- What were people doing when calling or called?
- How did they respond to a call?
- How did others respond to these actions?

We undertook two observational procedures in places where public conversation was likely: restaurants, 'in line' situations such as store checkout, lobby/waiting area such as airport terminals, public business areas such as a conference/trade show floor and store aisles, and social areas such as lounges. The first observations we called Detailed Area Observations, in which one or two observers would stay in a public area and note all phone related activity for 30 minutes to an hour. The other kind of observation we called the Ten-Minute Slice. One or two observers would visit an area for exactly 10 minutes, note all phone use, and then move on. All observations occurred during February 2000.

In a follow-up second phase of our investigation, we interviewed 16 frequent mobile phone users. Our purpose was to use the interviews to get ideas about their attitudes and use of mobile phones. Twenty-seven questions covered a person's experience with making and receiving phone calls and experiences with other's phone calls while in public settings. We also asked about pager use based on our observation of their role in mobile contact.

We talked to people whose activities required them to be available by phone, including consultants, contractors, employment recruiters, managers, police, realtors, students and salespeople. Our participants included four men and 12 women. Age ranges were under 25 years old (2 interviewees), 25 to 39 years (5 interviewees) and 40 and older (9 interviewees).

Finally, throughout this activity, we collected eyewitness accounts from co-workers, acquaintances, and people we met in public places. This activity netted more illustrative examples of mobile phone situations than we could observe directly or were covered in the interviews.

Results and Implications for Design

Our findings indicate the following assessment of the problem of noisy phone calls in public and the design implications for Quiet Calls.

Mobile phone activity is easily detectable in many public settings. One hundred calls were documented in almost seven hours of field observation. An average of 15 calls per hour was seen in a range of areas, from quiet (e.g., reading lounge) to noisy (e.g., convention floor). We noted that calls are frequently received, as well as sent, in public. By hearing or seeing the ring and answer, we know that a minimum of one fourth of all calls observed were calls received. Five incidents were recorded where the observer could not help but overhear personal information (e.g., names, numbers, places, times, etc.). Accounts of privacy and disruption were related to us in many settings (e.g., church, meetings, theaters).

A quiet means for communicating voice over a telephone connection could be an attractive new capability for people who must be responsive to other people while engaged in public activities. Interviewees reported that being ‘on call’ was the primary reason they needed to leave their phone on and take calls. The stated reasons for this were people’s livelihoods depending on being responsive to others and also the health and safety of others depending on their accessibility. We refer to this group of mobile phone users as *providers-on-call*. Variations for being on call were reported, including being on call through a pager, being on call when not engaged in anything else, being reachable during critical situations such as the scene of an accident, and being always reachable for work and personal reasons.

The content of calls often deals with identifying a call’s purpose and responding accordingly. Currently, people either talk into the phone while exiting a public situation; choose not to answer the phone based on caller ID; or leave the phone off and check voicemail as soon as they get to it. This behavior can lead to increased disruption, missed important calls, or ‘phone tag’ (multiple exchanges in voicemail and pagers in order to interact). Anecdotes were also collected concerning the insufficiency of Caller ID to convey urgency (e.g., a call from a child may involve their whereabouts or only be a routine question).

The observed need to deal with other activities concurrently with calling also suggests that an easy means for deferring talk is needed. For example, we observed announcements (fog delays at the airport or roll call in a jury room) being made that stopped all conversation including phone calls. Many stories of dealing with talk and traffic were reported.

Finally, technology introduced for mobile telecommunications use must be designed to accommodate a caller’s private uses of public space. This use seems influenced by a number of factors including body orientation and motion, local landscape, direction of attention, and orientation towards belongings. People react quickly to physically move or re-orient themselves and maintain a separation as the environment changes. Over half of the

callers observed in the field had and were occupied with more than just the phone in their belongings. Items included bags, briefcases, napkins, notebooks, laptops, pagers, papers, pens, a towel, and a shopping cart. We observed people watching their briefcases and other belongings while they talked. People would use counters or flat areas to place items for use and oversight while talking.

QUIET CALLS PROTOTYPING

As a first step toward implementing Quiet Calls, we investigated the feasibility of mixed-mode synchronous voice communication. Quiet Calls are made possible by integrating mobile phones with other commonly available computing platforms. Configurations we built included graphical user interfaces (GUI) on a personal computer, personal digital assistant with a small pen interface and audio playback card, and several phone accessories built from record/playback chips that provide a few buttons to trigger pre-recorded talk. In each case, the sound equipment was electrically connected to the voice input of the phone (e.g., hands-free jack) and an earpiece allowed the Quiet Calls user to hear both the other caller and any generated audio from the Quiet Calls support hardware.

In general we found that more capable platforms support more expressive representations. A GUI can organize a set of conversational structures (e.g., as a hyper-linked document). However, decreased complexity requires less attention of a user, as with a one button accessory that conveys limited talk (e.g., “I’ll be with you in a moment”).

Design

Our current design, QC-Hold, is a prototype system suitable for user testing of one selected Quiet Calls capability, namely *interactive call hold*. This capability supports a person who is in a situation of attending to an activity (e.g. a meeting) while time-critical calls may be received. The purpose of the incoming call is identified by answering and listening. Further, the recipient of the call then is able to hold the caller’s attention interactively even when unable to speak aloud.

In QC-Hold, a mobile phone user may quietly receive a call and choose to interact with pre-recorded responses organized in three ways (Figure 2):

ENGAGE (▶): Hold the caller while moving to an area suitable for talk.

LISTEN (●): Listen to the caller without vocalizing.

DISENGAGE (◀): Politely defer a call to a later time.

Expressiveness allowed by a few buttons is not sufficient to produce unconstrained conversation [as in 5]. However, we wanted to preserve elements of a conversational style in an attempt to better match the expectations of the other caller who wants to talk. In particular, sufficient utterances should be available so that no party becomes stranded in the interaction without knowing what to do next. Further, making one choice of utterance should not predetermine the future



Figure 2. A three-button design allows users to respond with button presses rather than by speaking aloud.

course of the conversation or even the next utterance [13]. For example, saying “I’d better go now” or “Goodbye” does not necessarily mean that conversation will immediately stop (e.g., the response might be “Just one more thing...”). Lastly, some variability of expression was desired to make the system seem less mechanical.

Implementation

The combination of a limited number of buttons and the possibility of changing conversation direction suggest that the Quiet Calls interface follow a state transition process, namely, overloading the buttons with multiple meanings over the course of the call. However, care must be taken to make it easy to understand and work within the system states [9]. Thus, the states are designed to take advantage of a usual calling sequence, namely, give greetings before other talk. Further, each button press should produce a specific kind of utterance that conveys a consistent intent, even if the actual words differ somewhat (e.g., a LISTEN press should say something about the activity of listening).

We employed what we call a ‘Talk As Motion’ metaphor to organize the utterances. Communication is supported in three ‘directions’: move in to the call by engaging the caller verbally (involving a corresponding physical motion to an area appropriate for speech); move out of the call by disengaging; and in between these opposites stay in place by listening to the caller. This approach organized seven unique utterances bound to the three buttons (Table 1).

We chose an integrated PDA/mobile phone unit (Figure 3) with a programmable display and a telephony software interface (i.e., Qualcomm pdQ Smartphone 1900 [6]) as a development platform. The pdQ display has been reprogrammed for the three buttons and also shows caller ID. A wireless serial connection communicates button selections to a sound source, in this case a PC running a Visual Basic sound playing application. The player waits for button pushes and plays the pre-recorded utterances in a third person voice (two sets for male and female voices stored as WAV files). The sound is fed back into the phone circuitry through a modified hands-free phone accessory. The accessory’s microphone was replaced by an impedance matching circuit

Event	Say for ◀	Say for ●	Say for ▶
Incoming Call	Not used	Hello, N is listening	Hello, N will be right there
Pushed any button before	N has to hang up	N is still listening	N will be right there
Same button push repeated	Good bye	N is still here	N will be right there

Table 1. Three buttons trigger up to 9 phrases.

and connection to the PC’s headphone jack. In addition to private audible feedback to the user, the last button pushed is indicated on the display.

This configuration produces an efficient and simple system. Button selection produces a voiced response without noticeable delay. A user is permitted fairly unconstrained motion, having only one thin wire physically connecting the sound source and phone. Switching from quiet to talking mode only involves unplugging the hands-free jack, and then using the phone as normal.

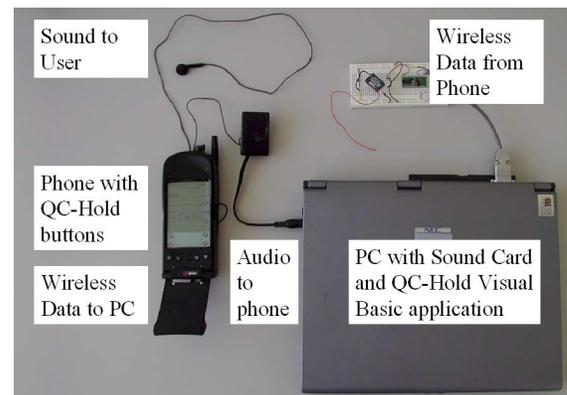


Figure 3. QC-Hold study configuration of ‘one wire’ from PC sound card to Smartphone and radio serial data link for communicating user button selections.

USER EVALUATION OF QUIET CALLS

An in-house lab study evaluated QC-Hold with participants engaged in a variety of tasks and discussions about the use of the system. Overall, the participants were enthusiastic about the possibilities of the technology with appropriate suggestions about its use. All participants quickly understood the QC-Hold features and successfully used its buttons to receive several calls. They also were able to conduct conversations when they initiated calls to people who responded with QC-Hold, occasionally even using the technology in new ways for their own purposes.

Method

Nine participants from outside the research lab (see Table 2) evaluated QC-Hold in individual one-hour sessions. The intent was to gain feedback from observing each participant using the system in realistic situations and from open-ended questions and discussion.

	M/F	Incoming Calls?	Job
P1	M	~ every 2 days	Principle, Venture Lab
P2	F	~ every 2 days	Director, Business Development
P3	M	> 2-3 times daily	Senior Video Specialist
P4	M	> 2-3 times daily	Manager
P5	M	2-3 times daily	Senior Acct Manager
P6	F	Never	Operations Analyst
P7	F	2-3 times daily	Executive Administrator
P8	F	2-3 times daily	Intern
P9	M	> 2-3 times daily	Systems Engineer

Table 2: Participant Demographics

The evaluation consisted of four phases: a training session, a meeting situation with incoming calls, calls to people in meeting situations, and a summary discussion.

Training: Participants were given a brief introduction to QC-Hold and then received three calls. The first could be completed with QC-Hold buttons alone. The second required speaking aloud, and participants were instructed how to leave the room to continue a conversation. For the third call, they were free to respond as they wished. Participants were allowed to adjust the earpiece as they wished, either leaving it in their ear or by the phone.

Meeting with incoming calls: Participants were asked to pretend they were in a meeting with their colleagues. A video provided a presentation and a point of focus for session. Participants were told they would be responsible for answering questions about the presentation.

The participants were told that they might receive calls but that the meeting room should remain quiet. They were free to choose how to answer the calls, leaving the room if they desired. Participants were not given any information about the calls other than the list of possible callers who would be familiar with Quiet Calls: Sam, a very important client; Jim, a colleague; and Steve, a visiting student from Denmark.

Each participant received six calls in random order as shown in Table 3 using the same six call scripts for all participants. Study facilitators played the roles of Sam, Jim, and Steve. Figure 4 shows the script for the call B1 from Jim regarding a meeting time. The calls were arranged in three groups with different expected call behaviors based on the type of call. After the conclusion of each call, the presentation was halted and the participant was asked open-ended questions about the call. Afterward the presentation continued.

Calls to others: The participant was asked to make two calls to colleagues. These colleagues were in meetings themselves and used QC-Hold to handle the calls. The first call was to Jim to give him a brief overview of the presentation. The second was to Sam to schedule a meeting time for the following morning, making sure there was an agreed-upon time before ending the call.

Summary discussion: Participants were asked a series of open-ended questions to elicit their perceptions and feedback on QC-Hold.

ID	Caller	Calling about...	Expectation
A1	Jim	a laptop	Not important
A2	Steve	dinner plans	Not important
B1	Jim	a meeting time	Timely but no response needed
B2	Sam	finding information	Timely but no response needed
C1	Sam	sending an order	Response required
C2	Steve	driving directions	Response required

Table 3: Calls to participant during the meeting.

Data

Data consists of videotapes, logs of all of the QC-Hold actions and call timing, and written summaries of the discussions and feedback for each study session. Overall, the button hits worked as expected. Only 6 of the 54 meeting calls were made twice due to technical difficulties. There were no problems with the outgoing calls. Only once in all 54 calls did a participant hit the wrong button (P3 in the C1 call). It was the first call P3 received in the meeting and he said he was trying to focus on two things (the presentation and the incoming calls). He subsequently pressed the intended button and continued the call.

Participant Responses to Calls

Table 4 summarizes the participant responses to each of the six calls. The response sequences show the QC-Hold interactions used by the call recipient (i.e. the study participant) for each call: **D**, Disengage button press; **L**, Listen button press; **E**, Engage button press; and **O**, participant goes out of the room and speaks to the caller.

Jim dials Participant (Px); Px answers:

Px: Hello, [Px] is on a cell phone. S/he is listening but is not able to talk aloud right now. So please go ahead.

Jim: Hi, this is Jim again. I know you're busy but I wanted to let you know that I have to change the meeting we set up for later today. The boss called with a new client and I can't put off meeting him.

Jim pauses about 1 second.

a) If no response from Px

Jim: I'll assume it will be okay with you if we set up a new time to meet about the contract. Thanks. Bye. [Hang up]

b) If Px responds

Px: S/he is still listening (i.e. LISTENING) or

Px: S/he has to hang up now. (i.e. DISENGAGE)

Jim: Leave me a message on my voicemail about a time that would be good for you. I'm free all afternoon tomorrow. Bye. [Hang up]

c) If Px responds

Px: S/he will be with you in just a moment. (i.e. ENGAGE)

Jim: Hope this isn't a problem for you. Is sometime tomorrow afternoon a good time to meet?

Jim continues as appropriate, then hangs up.

Figure 4: Call B1 is from Jim to Participant.

	A1	A2	B1	B2	C1	C2
P1	LDD	LD	L	LEO	LEO	LEO
P2	LD	ED	LEO	EEO	LEO	D
P3	LDD	LLDDD	LLD	LDDD	LDEO	LEO
P4	LDD	LDD	LEDD	LLDD	LEO	LLLELO
P5	LD	LLDD	LEO	LDD	LEO	LEO
P6	LD	LDD	LDD	LEO	LEO	LEO
P7	L	LL	LL	LL	LO	LEO
P8	LDL	LLD	LLEO	LLD	LLEO	LEO
P9	LDD	LDD	LDD	LEEO	LEO	LLEO

Table 4: Responses to Incoming Calls.

In the ‘unimportant’ calls A1 and A2, the participants handled the calls without leaving the room to speak aloud, using only QC-Hold buttons for interaction. Calls were relatively brief (average call time was 26 seconds). In most instances (11 of the 18), calls were answered with a Listen-Disengage button sequence. That is, the recipient answered the call with the “S/he’s listening” response, heard the caller’s comments, and then moved to disengage with the “S/he has to hang up now” (and often “Good-bye”) response.

In the ‘timely’ calls B1 and B2, the participants handled the calls without speaking aloud, using only the buttons for interaction in 12 instances. These calls were again relatively brief though somewhat longer (average call time was 33 seconds). Seven of these 12 were the Listen-Disengage sequence. Other responses included repeating the Listen button, i.e. “I’m still listening,” or some other form of continued interaction. Of the seven calls for which the recipient chose to engage in spoken communication, four were calls from Sam. As one participant explained, “it’s a very important client” and that alone was sufficient reason to take the call personally.

In the ‘response required’ calls C1 and C2, the participants did exit the room and engage in spoken conversations with the callers in all but one case. In the exception, P2 identified the caller as Steve (the student) and immediately disengaged without listening. P2 said that in this case, she wanted the call to go directly to voicemail. She did not choose to let the student interrupt the meeting. Thirteen of the 18 calls were handled with a Listen-Engage sequence. Only in one call (P4 on call C2), did the participant use several responses before deciding to leave the meeting and speak to the caller. Calls were again longer in time, but all less than a minute.

Calls Initiated by Participant

Each participant initiated two calls, one to Jim and one to Sam who were both using QC-Hold technology. In the calls to Jim, seven of the participants gave a short summary of the presentation and then ended the call. Two (P1 and P3) tried to engage Jim in conversations. In the calls to Sam (to determine a meeting time), all but one of the participants (P7) engaged verbally.

Four of participants appeared to take advantage of their knowledge of QC-Hold to direct the conversation in the call

so that Sam did not have to move and speak aloud. P1, P3, P4, and P7 suggested a particular time for the meeting so that a “yes” or “no” would have sufficed. P3 suggested that Sam hit “keep listening” button twice if the suggested time was okay. P7 hung up after suggesting a time, saying that Sam could call her voicemail if the time didn’t work.

Findings

The study suggests that the QC-Hold design meets its objective of being easily understood and used. Participants were able to choose among the QC-Hold buttons quickly and appropriately; they had no problems with different modes on the buttons. Participants were also able to call and converse with others using QC-Hold. Participants generally liked using QC-Hold and had many suggestions for customizing and extending the possible responses using QC-Hold. Overall, participants liked QC-Hold with 6 of the 9 participants being very positive about the use of QC-Hold and no one disliking it. The findings are discussed in more detail for each goal of the study.

1. Participants grasped QC-Hold usage quickly.

After only three training calls, participants were readily receiving calls using the QC-Hold buttons. They generally navigated the interface and reacted to the calls as expected. Participants frequently used only 1-3 buttons to interact and complete a call in a short period of time. When asked about the calls, participants regularly said the buttons worked as they expected. As P5 said, “No glitches.”

2. Participants had few problems with different modes.

No one indicated confusion with the fact that a button press could produce different responses at different times in the interaction. P3 commented that the “still listening/still here” responses seemed “more conversational” and P7 said that using the “still listening” repeatedly gave the caller the impression that the recipient was indeed busy.

3. Participants liked QC-Hold and had helpful suggestions.

Participants generally liked QC-Hold. For example, P9 said

It’s pretty handy. I’m expected to take calls...It’s important to answer and let them know that you’ll be with them quickly or give them some solution over the phone. Putting them off creates more anxiety with the user...some acknowledgement of their problems will be better than no reply.

Four of the nine participants specifically raised concerns about being intrusive in meeting and other public situations. Some feel that the current practice of checking Caller ID and leaving the room if the call is important is sufficient to minimize interruption. As P2 said,

I would either decide to take the call or not because I don’t want to have them deal with a recorded message... In general I would just decide whether to take the call or not.”

Participants had several suggestions for expanding the use of QC-Hold. Several specifically wanted a way to get from QC-Hold to voicemail. They noted that QC-Hold would give them a chance 1) to determine the importance of the message

before it went to voicemail, 2) to let them know that there was an important message that would be waiting on voicemail, 3) to let the caller know that they were aware of the call, and 4) to let them use voicemail as a record of the call. P8 noted that this gives her the option to categorize. P3 said:

I want to know who it is and to have some initial contact before sending it off to voicemail. It gives the caller feedback that it's not going to empty voicemail. This system would give some personal interaction, that personal touch ... It lets the caller know you know the message is there.

4. Participants have many ideas for additional messages.

All nine participants agreed that it was important to be able to record the QC-Hold responses in their own voices and to be able to modify the wording of the responses if desired. As P3 said, he would prefer that it be first person if it's really supposed to be him listening. However, several also said that some canned responses would be helpful. Seven of the participants specifically mentioned that they found the Disengage response, "S/he has to hang up now," insulting and would not want it on their phones.

Participants had many ideas for adding to the responses. Only P7 said that the three buttons were sufficient. The remaining eight participants suggested a variety of possible responses to be presented as options, possibly in combination with buttons and possibly as a drop-down list. Suggested messages include additional simple responses (e.g. "yes," "no"), suggestions for future contact (e.g. "I'll call you later."), and ways to redirect the call (e.g. "Send me an email," "Call my admin"). Four of the participants suggested that it would be nice to have customized responses for specific calls they were expecting.

5. Participants easily called others.

Participants had no trouble making calls to people who responded with QC-Hold, and no one seemed frustrated by the interaction that followed. However, several noted that they did feel strange hearing a recorded message but knowing someone was actually listening. P2 said

I think that was a very positive experience ...I think it was fine for me to adjust to his system. So I'd say that was positive.

The fact that four of participants actively tried to direct the use of QC-Hold is interesting. Appropriating technology is a good indication that people are familiar enough with its use to try adjusting it to their own purposes.

DISCUSSION

QC-Hold offers one option to help users in the balancing act where one feels obligated to attend to an incoming call while feeling obligated to respect the social context of the local situation. In addition to the next iteration of development suggested by our user studies, the work-to-date also raises a number of issues for Quiet Calls more generally. We pose three such issues here. Can Quiet Calls help in real situations where people must respond to phone calls in public situations? Can mixed-mode conversation offer satisfactory long-term interaction? Lastly, does Quiet Calls provide a new

use of telephones as a bridge between synchronous conversation and asynchronous voicemail?

Can Quiet Calls help alleviate cell phone intrusions?

The fact that study participants used QC-Hold easily, wanted to customize QC-Hold messages in their own voices, and had many ideas for extending QC-Hold suggests that the capabilities of QC-Hold could be a good fit with people's existing telephone practices. It is a first step in offering people options for telephone use that are appropriate to the situation.

A new prototype using the touch-tone buttons on any mobile phone model has been implemented in preparation for extended user testing. Furthermore, we are implementing increased interaction between Quiet Calls and voicemail (e.g., redirecting calls in progress). Recording features will be added so people may create and update recordings in their own voice (through a dial-up interface). We are considering ways to allow users to reconfigure the interface, for example, letting users set up custom configurations to handle specific situations. Based on our feedback to date, we believe these changes can foster emergent uses of the technology for new communication possibilities.

What is mixed-mode synchronous communication?

We see that mixed-mode, synchronous communication allows interaction with people who are unable to talk aloud. However, long-term use will be necessary to understand how expressive this technology can be. We employed a simple metaphor to successfully organize seven utterances to be bound to the three buttons. The expressiveness of these utterances extends the repertoire of synchronous actions available to phone callers from two (answer, don't answer) to five (answer, don't answer, listen to information, defer the caller for a moment, acknowledge but defer the caller for another time).

The link between speech and available actions suggest a possible relationship with message support based on Speech Act Theory (SAT) [6, 4]. Expressiveness of such language subsets is apparently large, but not fully characterized. The SAT technique of language restriction might well be used to define support for other types of specific phone calling tasks suitable for Quiet Calls (e.g., request and response, question and answer, approval).

Do Quiet Calls signal a new genre of telephone use?

Today when receiving an incoming call, telephone users know their current situation and who is calling. Quiet Calls adds the ability to consider the subject matter, as well as the person calling and the local situation, when deciding whether to engage in a synchronous conversation, listen quietly, or disengage (possibly moving the caller to voicemail). Thus, Quiet Calls becomes a bridge between synchronous talk and asynchronous voicemail.

While Quiet Calls is not in itself a 'context-aware' technology, it is a technology capable of accommodating users in different contexts and in transitions

between these contexts. Other technologies, for example Q-Zone [2], attempt to infer context from location and automatically define certain places as “quiet zones” that are not appropriate for taking phone calls. Quiet Calls takes a different approach by relying on people’s skills in making context-sensitive decisions when presented with the appropriate information. Quiet Calls thereby supplements people’s ability to make context-sensitive decisions rather than automate and take over the decision making process.

CONCLUSION

Many people are dealing with the situation of being available for phone conversations with remote parties while having to attend to activities in their immediate physical environment at the same time. Whenever a phone call arrives, a decision of whether to attend to local activities or to drop out of those activities and take the call has to be made. Quiet Calls technology is an attempt to increase the information available for making a decision about taking a call or not, and to offer that information in a quiet and minimally intrusive way.

The QC-Hold prototype specifically addresses the problem of receiving phone calls in public places where talking aloud is intrusive or inappropriate. Voicemail currently gives the immediate situation priority without allowing discrimination among incoming phone calls. Caller ID now enables balancing priorities between the immediate situation and obligations toward the person calling. However, Caller ID does not discriminate among phone calls made by any one person. QC-Hold goes beyond Caller ID and voicemail, allowing the call recipient to make decisions based not only on the person calling and the situation, but also the subject matter of the call. The mixed-mode synchronous communication of Quiet Calls allows each person in a telephone call to respond appropriately for his or her own situation while maintaining a synchronous interaction.

ACKNOWLEDGMENTS

We thank the study participants from Xerox International Partners, Xerox Venture Lab, and Xerox PARC for their willingness to try QC-Hold and offer feedback. We thank our interviewees in the greater business community. We thank John Boreczky for critical audio/video assistance during the QC-Hold study. We thank Kathe Nelson for final edits of this paper.

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