

# Electronic Communication by Deaf Teenagers

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## Abstract

We present a qualitative, exploratory study to examine the space of electronic based communication (e.g. instant messaging, short message service, email) by Deaf teenagers in the greater Atlanta metro area. We answer the basic questions of who, what, where, when, and how to understand Deaf teenage use of electronic, mobile communication technologies. Our findings reveal that both Deaf and hearing teens share similar communication goals such as communicating quickly, effectively, and with a variety of people. Distinctions between the two populations emerge from language differences. The teenagers' perspectives allow us to view electronic communication not from a technologist's point of view, but from the "use-centric" view of teenagers who are indifferent to the underlying infrastructure supporting this communication. This study suggests several unique features of the Deaf teens' communication as well as further research questions and directions for study.

## 1 Introduction

In 1982 Barbara Wagreich, a deaf-blind computer professional wrote an article about the possibilities of a new technology, email, and how it might prove beneficial for people with disabilities, particularly the deaf [36]. Her study, conducted from 1978–1981 involved distributing terminals and access to electronic message servers to both deaf and hearing individuals in the greater Boston area, facilitating easy and asynchronous communication. Email was not only a formal medium for business meetings and communications, but also an informal tool for maintaining friendships and furthering acquaintances.

Twenty-four years later email is complemented by the newer technologies of Instant Messaging (IM) and Short Message Service (SMS) or text messaging. These technologies have been widely adopted by the hearing population [17, 20, 24], in particular

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<sup>0</sup>Valerie Henderson, Rebecca Grinter, and Thad Starner. Electronic Communication by Deaf Teenagers. *Technical Report GIT-GVU-05-34*, Georgia Institute of Technology, GVU Center, College of Computing, October 2005.

by teenagers [8, 9, 29]. It is unclear how these new methods of communication are being used by the Deaf community. While many sources report that the Deaf are often early adopters of technology [1, 13, 28], there is very little formalized work studying the use of communication technologies. We begin to fill this void with an exploratory study to understand the uniqueness of Deaf teenagers electronic communication and to suggest further research directions. We begin with related work on both teenage communication patterns and language issues for those who are deaf. We then discuss our study, the participants, and the data obtained from it. We end with a discussion of that data and some conclusions.

## 2 Related Work: Deafness and Language

While it might seem that work surveying the use of electronic communication methods among hearing teenagers [8, 9, 29] would be sufficient to understand Deaf teens communication, there are distinct linguistic differences between hearing and Deaf teens which bear further exploration. For many people who are born deaf, their native language is American Sign Language (ASL) instead of English. Additionally, unlike English, ASL does not have a written language form. It is this written form which enables electronic communication such as SMS, IM, email, etc. to exist. At first glance, Deaf reliance on a medium which requires the use of a foreign language seems improbable. However, Bakken [1] found that Deaf teens in Norway relied on SMS messaging just as their hearing counterparts did for building social networks, maintaining those networks, and for keeping abreast of trends and gossip. However, Bakken's work may not generalize to the United States population due to the differences between Europe and the US in SMS use and mobile device adoption.

In order to understand Deaf teenagers' use of electronic, written communication, it is necessary to understand some facts about their native language, ASL. ASL, the dominant sign language of North America, is a gesture based language which uses different hand, face, and body gestures to communicate. ASL's grammar is different from English, and it uses a spatial structure for many linguistic constructs. For a full discussion of ASL, readers are referred to [18] and [35].

It is also worthwhile to understand some of the linguistic issues which can arise from being born deaf in the United States. Linguists have identified the existence of a "critical period" for language development – a period during which a child must be exposed to and immersed in a language. Although originally thought to exist only for spoken languages, research has shown that this critical period also applies to ASL acquisition [23, 25]. Mayberry showed that even after 20 consecutive years of signing ASL, normative (i.e. deaf children of hearing parents) signers performed poorer on generative tasks after watching 30 long and complex sentences in ASL than did native (i.e. deaf children of deaf parents) signers. In fact, performance on the tasks declined as a linear function of age of ASL acquisition [23]. This indicates that a need for early immersion in ASL is critical, and effects of delaying language acquisition follow a deaf child throughout his or her life. For those whose primary mode of communication is sign language, this can lead to a lifetime of difficulty communicating with people. In 1988, children born with a hearing loss were identified at an average age of 2<sup>1</sup>/<sub>2</sub>-3 years

old with many not being identified until age 5 or 6 [26]. Although newborn screening for hearing loss has improved drastically in recent years, many middle and high school age deaf students were identified later than necessary for early intervention.

Ninety percent of deaf children are born to hearing parents who may not know sign language [16]. Often these children's only exposure to language is signing at school. This differs from hearing children who are immersed in spoken English from birth. By two years of age, hearing children learning a spoken language are combining words in expressive communication [37]. By one and a half years, deaf signing children of deaf parents are also combining signs to communicate. A third group, deaf children of hearing parents, develop language in the same sequence as the first two groups but at a much slower pace. The slower linguistic development of this group has been attributed to incomplete language models and lack of daily interaction using a language [12, 32]. Studies have linked delayed language acquisition with delayed short term memory development [11]. Due to this delayed linguistic development, the fact that English is a second language to many deaf students, and a myriad of other factors, the average 17–18 year old deaf student reads at a 4<sup>th</sup> grade level [14].

At this point, it is worth a slight digression to explain the usage of the word “deaf” in this paper. Deaf can have several meanings, but here we concentrate on the medical and cultural definitions. Medical deafness focuses on the severity and cause of a hearing loss. This is a classification that is often used in legal and medical terminology and is denoted with a lowercase ‘d,’ “deaf.” The cultural definition of Deaf, with an uppercase ‘D’, is a voluntary classification and refers to the community formed by individuals whose primary method of communication is ASL. Using a language other than English differentiates these individuals from the larger hearing-based population in the US and allows them to form strong bonds of community. All of the participants in this study were deaf. Most identified themselves as Deaf. As most of the twelve participants identified themselves as Deaf, I have used that term when referring to the students in the collective sense. For a full discussion of deafness vs. Deafness, readers are referred to [15].

Having introduced the language issues that congenital deafness may cause, we now turn to a description of our study methods, participants, and methodological issues.

### **3 Study Design: Methods**

The study, conducted in April and May of 2005, had three phases designed to survey different aspects of the role of electronic communication in Deaf teenager's lives. The three phases were a social mapping activity, a diary study, and semi-structured interviews, and these are described in more detail below.

The students were offered financial incentive to participate and complete the entire study. Students were paid a total of \$25 to participate; however, we offered \$5 for completing the social mapping activity, \$10 for completing the journal activity, and \$10 for completing the interview.

The teenagers were given a very brief demographic form and asked to self-report their language preference (ASL, English, or both) as well as whether their parents were

hearing or deaf. They were also asked some brief questions about their computing usage at home and at school.

### 3.1 Social Mapping Activity

The social mapping activity was designed to elicit the teenagers social networks and give us an idea who they communicated with, whether those people were hearing or deaf, and the main techniques for communicating with those people.

★	AUNT	H	Write	Relay
■	BB	H	Talk	IM
●	ALEX	D	Sign	IM
●	BEN	D	Sign	IM
●	MARIA	D	Sign	N/A
★	MY BROTHER	H	Talk	Email
~~~~~				
■	Church			
●	School Friends			
★	Family			

Figure 1: Example of a Social Network

While this was based upon the work of Smith, Rodgers, and Brady [31], it was more structured to make it easier for the teens to understand. The teens were given a large sheet of paper (easel size) and pencils. They were first asked to list everyone with whom they felt it was important to communicate. The definition of “important” was largely left up the participants. However, we asked them to consider if they would be upset or unhappy if they could not communicate with a person. They were also told that they could think about their list overnight and add people to it the next day if they felt they had forgotten someone. Second, the students were asked to label each person on their list as “hearing” or “deaf.” After that, they were asked to go through their list and write down how they would communicate with that person if they were face-to-face with that person. In a similar fashion, they were asked to write down how they would communicate if the person was not in the same room or was somewhere far away. They were asked to write N/A or “Nothing” if they did not communicate with a contact. Lastly, the students were given packs of colored markers and asked to group and categorize their contacts in any way they felt appropriate, for example “Family” and “School Friends” were common categories. Figure 1 shows an example of a social network similar to those generated by the students, with the contacts and their characteristics listed in the top half of the figure and the categories listed on the bottom.

### 3.2 Diary Study

The diary study phase involved students recording when and where they used electronic communication. Based on the work of Grinter and Eldridge [8, 9], it was designed to give a clear picture of the teenagers' lives on a daily basis and how electronic communication fit into it. The students were told that if they were in doubt about an activity to record it.

This form began at 5am with 12 hours on the front of the page and 12 hours on the back of the page, thus allowing the students to record one day per page. In the middle of the page is a list of times. Each hour is subdivided into 4 15-minute blocks. To the left of the list of times is a space for the students to record their physical location. In a space to the right of the list of times they were told to record their electronic communication. Figure 2 gives an example of the form the students used.

Date: \_\_\_\_\_

Location:	Electronic Communication:
5am	[Lined area for recording electronic communication]
6am	
7am	

Figure 2: Example of Daily Diary Form

The students were given one sheet during a class period and completed a log form for the previous day with assistance from the researchers. This allowed the students to ask questions and receive immediate feedback rather attempting to work with just an explanation and an example. After this in-class example, they were given a booklet containing 7 forms, one for each day for a week. They were instructed to fill out a form each night for a week and return the booklets to their teachers at the end of the week.

### 3.3 Semi-structured Interviews

After the social mapping activity and week-long diary activity, the students were interviewed. The interviews were conducted in two groups based on the student's class sections. Thus, they were with people they already knew and with whom they were comfortable talking. The interview questions were largely determined using data from the social maps and weekly diaries. We also allowed the students to highlight other topics they felt relevant. Because an interpreter was voicing for the students, audio recording was insufficient for identifying the speaker. Thus, we chose to video record all the interviews.

## 4 Study Design: Participants

To study the electronic communication patterns of Deaf teenagers, we recruited twelve participants with the cooperation of the Atlanta Area School for the Deaf (AASD). This is a public, K-12 school for students who are deaf, and its enrollment area covers the majority of North Georgia, including the Atlanta metro area. On average, the students lived almost 30 miles from AASD. The maximum distance between students was almost 100 miles. This distance, both from school and from their friends, precludes many usual teenage socialization activities in the US such as after school clubs or sports or hanging out with friends at the local mall. Additionally, it is often difficult to communicate with hearing peers in their neighborhood. We found that these factors greatly influenced the role electronic communication played in the teens lives.

The twelve participants (listed in Table 1) ranged in age from 14–17 with an average age of 16. There were six females and six males, although one male student left the study after the first activity. Students were also asked whether they preferred ASL or English.

Participant	Gender	Language Preference
P1*	F	Both
P2	M	ASL
P3	M	ASL
P4*	F	English
P5*	M	ASL
P6	F	ASL
P7	F	ASL
P8	F	ASL
P9*	M	English
P10	M	Both
P11	F	English
P12	M	Both

Table 1: Participant Data

Several of the students had some residual hearing, but not enough to make a school with auditory instruction feasible. Four students (one of whom left the study) had enough residual hearing as to have some speech and to use oral communication with some degree of success. They are marked with a ‘\*’ in Table 1.

The subjects were recruited through their participation in a science class. Students were given the choice of participating in the study or completing other elective activities. No academic credit was given for participating, although class time was used. Of the fourteen students, twelve chose to participate.

## **5 Study Design: Methodological Issues**

This study presented several interesting logistical issues. The most prominent issue was the language barrier between the students and researchers. Additionally, this study relied on a visual language, ASL, and involved the participants recording study data in their second language of written English. Moreover, the delayed linguistic development of many of these students required instructions to be short, with concrete examples and subtasks to ensure completion.

### **5.1 Working with Second Language Issues**

The first language of most of the participants was ASL, not English. This meant that someone fluent in ASL and English needed to be present at all times to facilitate communication between the researcher and students. In most cases, this was the classroom teacher from AASD; however, in one case, a certified interpreter helped with the interview sessions. This language barrier did not seem to hinder rapport. While not fluent, the first author of the paper is conversational in ASL. The teens seemed to see this as a goodwill gesture and tried to communicate with the researcher via ASL when possible.

### **5.2 Task Analysis and Decomposition**

As mentioned earlier, many of the students have linguistic difficulties. The linguistic complexity of our three tasks had to be carefully considered so as not to present methodological problems. Before presenting an activity to the students, researchers performed a task decomposition on it. This helped the students comprehend the activity and gave them measurable progress towards completing each activity.

Task decomposition is a standard technique used in teaching assistive technologies in a special education setting [5]. For example a high level goal was for each student to make a social map. However, the teacher felt this would be overwhelming to the students when presented as an open-ended, free-form project. Instead, we defined the five subtasks detailed earlier, each with concrete and measurable goals. We found this practice invaluable. It not only helped the students complete the activity, but it also helped us define exactly what elements of the social map and network we were interested in learning more about and why.

### **5.3 Importance of Visual Attention**

The importance of visual attention in ASL also presented a problem for the researchers during the interview portion of the study. The researchers tried to take notes, but abandoned the effort after the students perceived it as rude. ASL is a highly visual language. As the children could not hear the interviewer making acknowledgments such as “um-hum” or “yeah”, which Brennan and Clarke have stated are crucial for developing a common ground and a mutual understanding [6], the students interpreted the interviewer looking down to take notes as a sign of not paying attention and became self-conscious about their answers. Given the difficulty in balancing rapport

with exhaustive note taking, we chose rapport to be more important and relied on the videotapes of the interviews.

## 6 Results

In this section, we discuss the results of our study. We begin with a discussion of the students' preferred methods of communication with people who are collocated and people who are remote. We then proceed to an in-depth look at different methods of electronic communication and how the students utilized them.

### 6.1 Preferences in Collocated and Remote Methods

When analyzing the data from the social maps, we found it interesting to examine the difference in how the teenagers communicated with their hearing and deaf friends, both in face-to-face communication and when not collocated.

Figure 3 shows a graph of the data obtained from the teenagers' social maps. The top node shows the total of 419 contacts the teens listed in their maps. These were broken into four main categories based on the students' contacts' hearing ability: Hearing Contacts, Deaf Contacts, Hard of Hearing Contacts, and Unknown. Each of these categories were further split into methods of communication: Face-to-Face and Remote. The methods of communication were then listed in order of preference. For example, Figure 3 shows that 190 of the 419 contacts were deaf. For 179 of those 190 contacts, ASL was the preferred method for face-to-face communication, and for 107 of 190 contacts, IM was the preferred method of remote communication.

While this data should not be widely generalized due to the limited number of participants, several interesting things can be seen from this chart. An interesting trend is the differences in remote communication methods between the students' deaf contacts and hearing contacts. IM is the preferred communication method between the Deaf teenagers and other deaf people, used for 107 of 190 contacts. However, there is no clear preference for their hearing contacts who are not collocated, with the Deaf teens having no remote contact with 68 of 214 hearing contacts.

The category of friends the students do not communicate with face-to-face (i.e. the "None" classification under the four face-to-face communication paths in Figure 3) also bears closer examination. There were 39 contacts that the students listed that they did not have any face-to-face communication with regardless of hearing status. However, the students communicated with 36 out of those 39 people via the electronic methods of email and IM. Before electronic communication existed and was widely available, remote communication with a person you had not met face-to-face would have taken the form of written letters. However, the teens today are using email and IM to fill this gap and maintain relationships in a more casual fashion.

The students averaged 37 (SD=11.4) contacts each with a high of 54 and a low of 18. For comparison, Smith et al. found that the teenagers in their 2002 study had an average of 59 contacts (SD=26.4) [31], which may indicate a trend of Deaf teens having a smaller social network. The most prominent groups were "family" and

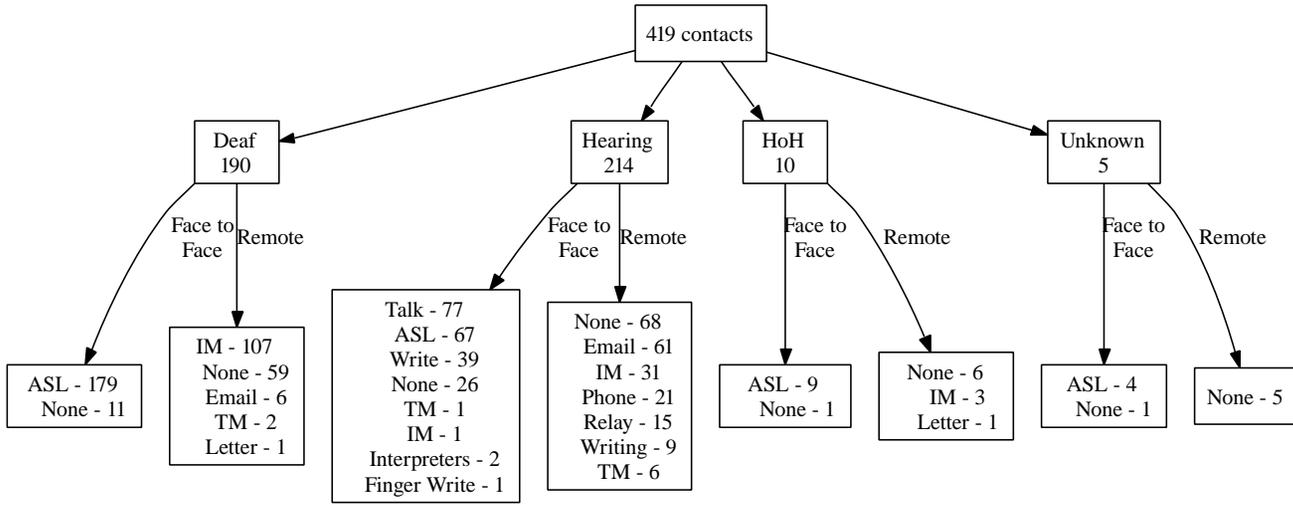


Figure 3: Results for Social Networking Study

“school friends.”

## **6.2 Communication Patterns and Preferences**

To give a more nuanced picture of the teens communication, we now present an in-depth look at a variety of technologies the teens used, including TTY and relay, computer based applications, text messaging, mobile IM, and away messages.

### **6.2.1 TTY and relay**

Teletypewriters or TTYs (also called TDDs or TTs) have been an accepted way for deaf individuals to communicate in the United States [19]. Communication via a TTY requires turn taking and a specialized vocabulary in addition to the more familiar abbreviations often seen in email or instant messaging [22]. If each person has a TTY, they can type messages back and forth using TTYs connected to standard telephone lines. To communicate with a hearing person via a TTY, a deaf person could utilize the Telecommunications Relay Service (TRS). The person who has a TTY dials a relay operator who also has a device. The operator in turn connects to the hearing participant via a voice connection. The operator then relays the turns of the conversation via either voice or TTY. Recently, computers have begun to replace TTY devices, allowing for direct text connections without an operator.

Although relay is the accepted standard for non-collocated communication between deaf people and hearing people, none of the teenagers reported significant relay usage. Many of them rarely or never used relay. Some of them simply didn't like using relay, while other reported problems learning the system. “I don't have much experience with relay. I tried to get experience with a relay and then I need more information and I don't know...” (P2). One student, reported using relay but also using the phone because he had partial hearing and speech. These accounts were corroborated by the data obtained from the students' week-long diaries which showed only 3 of the 11 students using relay during the week, and only one of those was a for a large amount of time. When speaking about her lack of relay use, one student succinctly noted, “I don't have a whole lot of calls to do with friends. I use my Sidekick” (P1).

### **6.2.2 General electronic communication preferences**

While in many ways they were different than their hearing peers, the Deaf teens were also very similar and wanted the same things any teenager wants. The teens enjoyed meeting new people. In the past, keeping in touch with new acquaintances meant a complicated and laborious method had to be devised which would be acceptable to both participants. The teens we interviewed overwhelmingly favored establishing electronic means to continue their communication. Most expressed a preference for exchanging email addresses or IM screen names. One student noted that many hearing people asked for an email address or a phone number for text messaging. Since he could never remember his phone number, he simply gave them his email address instead (P12). Only one student disliked giving out personal contact information. As email was to

Wagreich in 1982, the mobile platform has become to the Deaf teens today. It levels the playing field by lowering the barrier of participation and allows them maintain their friendships in ways that are convenient and simple for both people. The students recognized the importance of the give-and-take of personal contact information from a practical level as well:

Most of the time, I give them my address. And I want, you know, the contact information so that I don't forget who they are. You know the address book you have in there? ... Things that will help me remember who they are.

– P6

When students needed to communicate with someone they knew to be nearby, they would usually seek them out in person. When unsure of a person's location or when the person was far away, the students usually turned to an electronic method of communication rather than the more traditional method of relay or TTY.

The most prized mobile device among the teenagers was clearly the T-Mobile Sidekick<sup>®</sup>. Many of the teens already owned this device, and some expressed a desire to upgrade, and those that did not have one expressed a desire for one. However, none of them paid for it themselves. The Sidekick has become so ingrained in the teens' lives that it has a unique sign in ASL which mimics the screen popping up on the device.

The Sidekick is a device marketed in the US by the service provider T-Mobile and manufactured by Danger, Inc. under the name hiptop<sup>®</sup>. It is designed as an out-of-the-box Internet platform. It has a flip screen, and a mini QWERTY keyboard for text entry. Different versions come with software for web browsing, instant messaging (specifically AOL Instant Messenger or AIM), email, calendar functionality, address book, SMS, a note/to-do pad, as well as voice telephony capabilities. T-Mobile also offers unlimited, data-only service for this device, making it attractive to deaf students who do not need the voice capabilities.

All the students considered communication with hearing friends and relatives to be an important component of their lives. Some students saw a mobile device as a means to enable that communication. When asked why he wanted a Sidekick, a student said he simply wanted to communicate. The method of communication was less important than the ability to convey their meaning. In the words of one student, "The important thing is that people understand what I'm saying" (P6).

### **6.2.3 Text messaging**

Some students reported using their mobile device for text messaging. Other studies [8, 9] have confirmed that text messaging and SMS use are major functions of teenage mobile phone use. However, our teenagers displayed a lack of enthusiasm for text messaging in some cases and in others, a lack of understanding about exactly what text messaging involved. In one case, a student had never even heard of text messaging. When asked what text messaging was, many of them responded from a use-centric perspective. That is, the student's definition of a service and infrastructure was focused on the characteristics of its use, in this case, the time to send and receive a message.

Text messaging is “pretty fast” and “you’re kinda talking” (P2). “...You kinda write a long thing out and then you send it and then you wait a minute and it comes back” (P2).

Other students saw text messaging as a backup communication medium or something to be used only as a last resort. Moreover, text messaging was something to be used only if the other person lacked some vital functionality. For example, the students might use text messaging if someone didn’t have IM or email, if a friend wasn’t online, or if a friend wasn’t in a position to check email. One participant identified text messaging as a feature central to mobile phones and said that she used text messaging because most other people had a cell phone and she could use that to get in touch with them. Another posited that he might use text messaging in an emergency situation.

#### **6.2.4 Computer based applications**

Some of the students in our study did not have a mobile device, but did have a family computer. Several students with mobile devices commented that they disliked computers. Two specific complaints were that “you’re stuck in one place” (P8) and that computers had “a lot of things going on” (P1). Interestingly, one student noted that a legacy technology kept him tied to the computer. He had an old screen name through a service which did not work on his mobile device. He used his old screen name on the computer and his new one on his mobile device. The use of the computer for communication was drastically different from the use of mobile devices. Students reported only occasional, not constant communication via IM or email from a computer. When they did use email, they responded to emails as soon as they received them, but complained that email was much slower than IM and “it takes a whole day to get it maybe” (P7).

#### **6.2.5 Mobile instant messaging and Sidekicks**

As stated earlier, mobile instant messaging via the T-Mobile Sidekick was the preferred method of electronic communication for many of the teens. While a majority of the teens owned a device, several did not. One teen stated his parents would not allow him to have one due to the expense and possibility of losing it, but had hinted he might get one if he kept his grades up. Unlike other studies of hearing teenagers [33], very few of the students reported that their parents used the device as a tool to enforce discipline. Most students reported that their parents put few or no restrictions on the use of the device at home, including mealtimes or curfews. Six students reported that their parents didn’t restrict their use at all, while another 2 reported some restrictions such as not using the device after a certain time on school nights or putting it away at mealtimes. However, one teen admitted she sometimes turned it on after her curfew anyway. One student’s parents had taken away the Sidekick as punishment for a week, but this was a rarity. One student pointed out, “Mom is fine because she knows, like, I’m Deaf and I want to communicate with people. And she knows it’s OK. It’s not wasting our time” (P5).

The school, however, banned the use of the devices. Students were not allowed to use the device during class hours and were instead limited to breakfast or lunch times

at school. The rule had recently been strengthened, requiring parents to come and pick up the device if it was taken away from their child for messaging during school hours. Since these rules had been implemented, several students reported they had gotten in trouble for using the device at school. In fact, many told us that they now left their Sidekicks at home to avoid the problem all together. However, the students who regularly had their devices on them at all times noted that any time without the device felt strange. They were also keenly aware that loaning their device out could lead to it being taken away. One student reported getting in trouble while borrowing another student's Sidekick. Another reported loaning his Sidekick out and many students borrowing from each other, so he was not likely to loan it out anymore.

Other than school and home, the teens used their Sidekicks in a variety of places. Some would use it in stores to locate their family if they became separated. Another volunteered that he would use it on vacation to get messages right away. The teens had a keen sense of socially inappropriate places to use their devices, such as during church, although they still used them. Taylor has termed concealing the device in social settings as "subversion" [34], and we found many examples of it by the Deaf teens. They had developed techniques to avoid detection, such as pulling up the hood of a jacket, pretending to be asleep to disguise their gaze direction, and hiding the device in their laps. The students were particularly aware that their eyes could be a giveaway as evidenced by this quote from P5, "...if people are looking at me and my eyes are going up and down... You have to be careful with your eyes or they'll figure it out that way."

In some cases, while unable to detect it themselves, the teens were aware that they needed to mute their device to avoid detection. The vibrate setting was the de facto alert mechanism for most teens, but they were aware that even that could occasionally be detected. When asked why they went to such lengths to avoid detection, one student summed up her feelings as, "I don't want everyone looking at me" (P8).

In their work on SMS, Barkhuus and Vallgård found that SMS was used to communicate mainly among friends and significant others, but IM was used for a wider range of conversational partners [2]. Like Barkhuus, we found that the primary recipients of IMs were the Deaf teens friends, and they valued this ability to communicate very highly. They mostly reported messaging people who were not co-present, as they preferred to communicate directly with collocated people. One notable exception was a student who told us she used her Sidekick with a hearing person, passing the device back and forth. "When I can't hear [people], but they don't know how to sign, it's the only way we can actually get the point across" (P4).

Students had no qualms about IMing someone not co-present even while physically with someone else. The teens didn't consider it rude if someone they were with also messaged other people. However, messaging was supposed to be conducted during breaks or lulls in the conversation. Being kept waiting to chat face-to-face by someone messaging was "wasting my time" (P2). Messaging while collocated was seen as something to fill time when their conversational partner was distracted by talking or driving. P1 noted, "You know sometimes, like with hearing people, they'll be talking to someone, and I feel left out. So I IM my sweetheart."

Siblings were frequent targets for messages, but parents were not, unless something was required of the parents such as locating them in a store or needing a pickup from a friend's house. They used IM on their Sidekick for talking to their friends about school,

plans, how they were doing, or just to find out ‘what’s happening?’. One student noted that only after he was done messaging his friends would he consider talking to his parents, clearly viewing such interaction as a last resort for socialization.

The students used the devices heavily. Most students who had a device reported using it daily with most use occurring during the free time after school or on the weekends. When questioned about the reporting in their daily journals of several hour-long blocks of IM with no interruptions, the students assured us that was correct and that they were constantly chatting. One student observed, “I [chat] a lot. Even in my sleep I do it” (P8). A few other students told us that in the past, they used their Sidekick every day, but now had grown somewhat tired of it, and “once in awhile” they didn’t use it at all. Two students in particular stressed that they liked IMing with their friends but also liked doing other things. One student said he also enjoyed such things as spending time with his family or reading. His multitasking often involved chatting with his friends via IM for a period of time and then doing something else before resuming chatting with his friends. Another student simply noted, “Sometimes I’m doing things. I’m busy” (P6). One student admitted he chatted with his friends all day, saying his practice was, “kinda lazy, I guess” (P10). Another student noted that “sometimes my thumbs get worn out” (P6). One student who did not own a Sidekick offered his incredulous take on the constant chatting of his classmates by saying, “My eyes would be falling out of my head if I did that!” (P3).

In addition to just chatting, IM was viewed as the optimal way to schedule things with friends. This mirrored findings by Nardi et al. and Grinter and Palen [10, 24] that the immediacy of IM was useful for coordination and scheduling. Scheduling things was of great importance to the teens given their lack of transportation and proximity to friends. Like Ling and Yttri’s micro-coordination [21], the teens could refine their plans on-the-fly, but the teens had to largely schedule things in advance due to geographic distances and logistics involved in meeting. Only if a friend was offline was email employed to schedule things. Even then, email was usually used to establish a time when both would be available to IM and finalize the details.

The students managed their contacts in a variety of ways, including blocking, buddy lists, and screen names. Blocking is a standard feature of most IM clients and allows users to block messages from other users. One student noted she usually only blocked advertisements and spam. Another volunteered that he never blocked anyone. Several would immediately block someone they didn’t know, but one student would try to talk with people before blocking them, explaining, “Maybe it’s a new friend. I wouldn’t mind trying to talk to them” (P6). However, that student went on to state she would block them if she did not feel comfortable with them. Students would also block people who simply annoyed them either through the content of messages or the volume of messages sent. They would block friends if they were having a fight or disagreement. Although some students reported that acquaintances they blocked were quite upset, they still utilized the feature. One student noted that she would unblock acquaintances after some time to see if they still bothered her.

The students had also developed methods for controlling and managing their contacts. Several students reported having only one screen name or email address, although they used to have more. One student reported that having more than one was “too much to keep up with” (P4). They did report that their friends sometimes had up

to 20 names, but often forgot one or two and had to abandon some. One student told us that she would simply make up a new buddy name when her current one hit the maximum number of contacts allowed, around 200 contacts by her estimation. This student's philosophy was that "I might want to contact them again, you know? You never know..." (P6). However, other students reported 20, 89, and 72 people on their buddy lists. One student noted that having many people on her buddy list led to people contacting her constantly which "gets kinda silly at times" and led to her having to put people "on hold" while chatting with others.

The students also reporting IMing from the Sidekick with groups of their friends in large, multi-user sessions. Some of the students clearly enjoyed the large conversations with "lots of chatting going on" (P5). However some students were indifferent or clearly blasé about group conversations. Several students said it depended on what was going on. Another student noted that it could be "kinda annoying" (P12). Yet another characterized group IM conversations as "Blah, blah, blah" (P2).

Somewhat surprisingly, given their difficulty with written English, most students expressed only minor worries over how other people viewed them due to their grammar or spelling mistakes. These mistakes were considered inconsequential for the most part, particularly among friends. One student said, "If I don't know how to spell it, I just make it up" (P8) while another noted, "Sometimes, if I get the grammar wrong or whatever, I'll just send [the message] anyway" (P2). When confronted with grammar or spelling mistakes, one participant said he would generally ask his mother for help, but several others relied on the Sidekick, noting that it had built in spell check and grammar help. One student gave the example of the Sidekick adding an apostrophe to her spelling of "Ive" instead of "I've."

### **6.2.6 Away messages**

While not a specific medium of communication, away messages filled an important aspect the teenager's communication spectrum, just as Baron found in her work on college students use of away messages [4]. Students had a variety of away messages which they used to communicate their activities and availability. Many students left a time estimating when they would return in their away messages before going out or being involved in other activities. They went to great lengths to maintain an accurate away message, including minute by minute updates. "When I get up in the morning, I immediately have to change [my away message] to my 'Hi, I'm at school now' message. I don't want people to think I'm sleeping then!" (P1). The teens also used others' away messages as indicators of availability and read the messages or glanced at icons before initiating contact. One student described using away messages as a social activity, maintaining a large buddy list and reading away messages because she was curious what people were doing.

Students reported they felt little or no pressure to respond immediately to incoming messages, especially if the messages were sent while they had an away message on display. They expected people to read their away messages before initiating contact. However, they did acknowledge that people expected a response more quickly if there was no away message. Two students however, felt it was more "respectful" to respond right away to messages.

Like the teens in Smith et al.'s study [31], the Deaf teenagers sometimes felt overwhelmed by the sheer numbers of contacts and the social energy expended maintaining them. Students used away messages as a means to get private time without explicitly offering explanations. One student explained that he used away messages if he was in a bad mood and wanted to be out of contact for awhile. If they didn't want to get messages they would make up an away message to allow them to maintain some distance. One student used away messages as a first line of defense, but if he was continually bothered, would turn the device off. Two students explained they would put up an away message but continually screen messages as they arrived and only respond when ready. Several noted that the only foolproof way to avoid messages was to turn the device off.

### **6.2.7 Multiple device usage**

While the sections above appear very clear-cut, the students occasionally reported using more than one platform at a time. However, students never reported communicating from more than one platform at a time. Some students reported using their Sidekick while also using a traditional (desktop or laptop) computing environment, but they would use their Sidekick for messaging their friends while playing games on the computer or working on homework. Overall, the students seemed to view the Sidekick as their main communication device with a traditional computing environment having a very secondary, limited use.

## **7 Discussion**

In this paper we have presented a detailed report about the adoption and use of a variety of communications technologies among Deaf teenagers. In so doing, we have answered questions about who, what, where, when and how. In answering these questions, we have raised many more, but two points bear further discussion here: first, the teens use-centric view of mobile computing, and secondly the social acceptability of their chosen device and the tension arising from that choice.

### **7.1 “Use-Centric” Perspective**

Our students could not always define the services they used. As described earlier, students sometimes defined the difference between services as the amount of time required to send or receive a message using that service or by who they could contact using that service. At other times, the Sidekick device itself encompassed possible uses. As P5 noted, “I use it for calling my mom and I use it for instant messaging and the relay.”

In many ways, the teenagers confusion mimics Palen's findings about new users of mobile phones [27] and the distinction of the hardware and software components of service-based technologies. Palen found that users of mobile phone had to understand many different aspects of a service, including phone hardware and software, “netware” (e.g. analog or digital service), and “bizware” (e.g. service plans offered by the

provider) before achieving mastery of their communication devices. For example, the bizware layer imposed by the service providers clashed with the users' mental models of telephony service and created confusion.

However, the teenagers did not exhibit this confusion. While they may not have understood the underlying elements of the device, they had no trouble using the device in a variety of different ways. During the course of the study, the teens cited using the Sidekick for voice telephony, email, IM, Internet search, relay, and grammar/spelling checks. In addition, many of these uses came in a mobile setting. Our study suggests that some forms of what we, as technologists who understand the distinction between SMS, IM, etc. might find confusing, are unproblematic in use for other people.

The teenagers lack of confusion is interesting because the Sidekick comes from a class of devices widely predicted to be the platform for ubiquitous computing. In many ways, the teens uses combined with their simple statement of "I use it" mimics the perception of what ubiquitous computing should be from a user-experience point of view.

Our study highlights that, while the device and underlying bizware may be complex, clarity in usage models is key for usability. In our study, the teens viewed the device as something to be used for communication, and seemed to inherently knew what service to use when.

## **7.2 Social Acceptability**

As discussed earlier, the teens drew from a wide geographical area which often limited their contact with each other. The Sidekick has succeeded in this community largely because it is something which helps reduce this distance, and it does so in a socially acceptable way. That is, this device, unlike relay or a TTY, is practical to the entire population, not just the deaf or those trying to communicate with them. The Sidekick is accepted by both hearing and Deaf teens, and allows the Deaf teens to be similar to their hearing peers and establish a communication link using that similarity.

However, this similarity comes with a price. In some venues educators and linguists have expressed reservations about instant and text messaging and have highlighted how the English used in computer-mediated communication differs from that used in more normative language [3, 7, 30]. This is a particularly interesting issue given that our population may have problems with their second language of English, particularly structure and grammar. While the students reported using some acronyms and abbreviations, they were more concerned with whether or not the recipients could understand them. However the teens admitted that others sometimes used acronyms or slang that they didn't understand, with one participant hypothesizing, "Sometimes, they make stuff up" (P12). It is worth noting that many slang terms popular in text and instant messaging are phonetically based (e.g. "c u l8r" for "see you later") which would present inherent problems to the Deaf teens. By using the informal language of the Internet and IM, the teens are practicing written English, something their teachers usually encourage. But does the use of written English, even a very informal English, outweigh the need to understand and be able to use formal, accepted English correctly?

## 8 Conclusions

We have presented an exploratory study to begin to chart the space of electronic communication use by Deaf teens in the North Georgia and Atlanta areas. We have used qualitative methods such as social mapping, diary studies, and interviews in order to spend time with the teens and learn about them, their needs, and their communication choices. We looked for communication similarities and differences with hearing teenagers and have found both. We have found similarities in the motivation and reasons that teenagers desire and want mobile communication technology. But we have also found differences, particularly in emerging technology forms and the Sidekick.

This paper and the related work are the first steps toward understanding how to design technology for Deaf teenagers. The challenge will be to design technology which simultaneously provides similarities to the mainstream in desirable ways and yet supports cultural differences.

## 9 Acknowledgments

The authors would like to thank Mary Anne Mullins, Dr. Harley Hamilton, and Dr. Lillian Blakesley at AASD for their support in undertaking this study. We would also like to thank the teenagers who participated in this study for their time, candor, and overwhelming enthusiasm.

This work is supported by the NSF, Grant # 0093291 and a Graduate Fellowship, and the RERC on Mobile Wireless Technologies for Persons with Disabilities, which is funded by the NIDRR of the US Dept. of Education (DoE), Grant # H133E010804. The opinions and conclusions of this publication are those of the grantee and do not necessarily reflect those of the NSF or US DoE.

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