Technology Use Among Adults Who Are Deaf and Hard of Hearing: A National Survey

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As society becomes increasingly more dependent on technology, information regarding the use, preference, and accessibility of commonly used devices and services among individuals who are deaf and hard of hearing (DHH) is crucial. Developing technologies that are functional and appropriately accessible allows persons who are DHH to fully participate in society, education, and business while also providing opportunities for personal and professional advancement. Although a few international studies have addressed the technology use of individuals who are DHH, none exist that focus on the needs, preferences, and accessibility of current Internet- and mobile-based technologies. Consequently, a national survey was conducted in the United States to determine the preference, frequency of use, and accessibility of various technologies (hardware, software, Web sites) by adults who are DHH and living in the United States. Findings indicate frequent use of smartphones and personal computers, specifically for text-based communication and web surfing, and little use of Teletypewriter/Telecommunications Device for the Deaf. Web site feature preferences include pictures and text, and captions over signed translations. Some results varied by demographics.

As mobile- and Internet-based technologies become an ever-present and indispensable part of daily life, accessibility for all people must be examined and addressed. Technology has the potential to reduce isolation, increase independence, and provide educational, financial, and social opportunities for users; yet, barriers and inconsistencies may exist in both hardware and software, as well as on the Internet, that can limit access to information and opportunities, particularly for individuals with unique needs (Kaye, 2000) such as those who are deaf and hard of hearing (DHH; National Association of the Deaf [NAD], 2012).

Persons who are DHH have always looked to new technologies with anticipation; however, there seems to have been an historic “one step forward, two steps back” with regards to DHH persons and technology. For example, in 1876, Alexander Graham Bell’s effort to electronically transmit speech, intended to assist DHH persons, produced the telephone, a device that essentially further alienated DHH persons as more and more of the general public used the telephone instead of face-to-face conversations or letters to communicate. In the 1960s, Robert Weitbrecht, a scientist who was deaf himself, invented the acoustic coupler which allowed DHH persons to communicate over the telephone via a teletypewriter (TTY) Lang, 2000. Although the technology opened up long-distance communication to DHH persons widening their social participation, they still were limited to communicate with only those having a Teletypewriter/Telecommunications Device for the Deaf (TTY/TDD).

Today many people around the world obtain information related to education, business, news, and events via the Internet through computers and various mobile-based technologies. The number of Internet users worldwide has more than doubled since 2007, reaching 2.27 billion users worldwide in 2012 (Pingdom, 2012). According to Devan (2012), Internet-based video consumption in the United States increased 660% from February 2011 to February 2012, and it is estimated that persons in the United States spend more than 20% of their Internet time watching videos (O’Neill, 2013; 3PlayMedia,
This increase is expected to continue as consumers shift to faster Internet-enabled equipment and “instant access” providers (e.g., Netflix), which allow consumers to view online video content on their portable devices and on their televisions (Devan, 2012). Unfortunately, online informational, instructional, and entertaining videos or audios, whether recorded or streamed live, are rarely captioned, and there are no known laws that currently exist requiring captioning of all video or audio content on the Internet, unless the content was broadcast first on television with captions (O’Neill, 2013; 3PlayMedia, 2013). Thus, a great majority of information remains inaccessible to individuals who are DHH (Harkins & Bakke, 2003; NAD, 2012), which could ultimately lead to intellectual, economic, and social disparity.

Background

A review of previous investigations on the use of technology by adults who are DHH revealed an urgent need to explore this topic again and in greater depth. Despite an extensive search of various databases, including ERIC, Google Scholar, and ProQuest, just 15 studies were found. Ten out of the 15 studies focused exclusively or primarily on the use of text communication, including short message service (SMS), two-way text messaging, instant messaging (IM), and e-mail (Akamatsu, Mayer, & Farrelly, 2005; Bakken, 2005; Bowe, 2002; Henderson, Grinter, & Starner, 2005; Henderson-Summet, Grinter, Carroll, & Starner, 2007; Okuyama & Iwai, 2011; Pilling & Barrett, 2007; Power & Power, 2004; Power, Power, & Horstmannshof, 2006; Power, Power, & Rehling, 2007). Three of the 15 studies targeted the impact of the Internet- and web-based video on the user (Barak & Sadowsky, 2008; Fajardo, Parra, & Cañas, 2010; Keating & Mirus, 2003). One study (Luft, Bonello, & Zirzow, 2009) investigated the technology skills of DHH high school students, and one study (Zazove et al., 2004) focused more generally on the use of technology, including computers, with regards to health care issues among the deaf community in a small geographical area. Further, many of the studies mentioned above were conducted prior to the availability of now common hardware and programs such as touch screen tablet computers (e.g., iPad, Galaxy Note, and Kindle Fire) and online video-conferencing tools (e.g., Skype, ooVoo, and Google+ Chat). Given the rapid development, societal demand, and dependency on technology, an up-to-date understanding of the technology use among DHH persons is not only warranted but essential.

SMS, IM, and E-mail Use Among Individuals Who Are DHH

Technologies such as SMS, e-mail, and IM are commonly used among individuals regardless of their hearing status (Henderson-Summet et al., 2007; Pilling & Barrett, 2007). Bowe (2002) and Power et al. (2006) reported that SMS and other similar technologies that allow users to transmit textual information instantaneously (e.g., e-mail and IM) are a first step towards “leveling the playing field” between individuals who are hearing and individuals who are DHH. Studies investigating the use of these technologies among individuals who are DHH found that they provided greater independence both socially and academically (Akamatsu et al., 2005), while also reducing isolation (Bakken, 2005; Power & Power, 2004). DHH individuals, especially by those younger than 50, reported (Akamatsu et al., 2005; Power & Power, 2004) high satisfaction with these types of technologies (Bakken, 2005; Henderson et al., 2005; Henderson-Summet et al., 2007; Okuyama & Iwai, 2011; Pilling & Barrett, 2007).

Although most of the studies addressing SMS and similar technologies focused largely on participants in their teens and young adult years (Akamatsu et al., 2005; Bakken, 2005; Bowe, 2002; Henderson et al., 2005; Henderson-Summet et al., 2007; Okuyama & Iwai, 2011), other studies included a wider age range of participants. These studies reported that SMS and e-mail were preferred over the use of TTY/TDD or relay service because of their convenience (Akamatsu et al., 2005; Bakken, 2005; Henderson et al., 2005; Henderson-Summet et al., 2007; Okuyama & Iwai, 2011), their ability to remove a third party when communicating (Pilling & Barrett, 2007), and their ability to incorporate the use of emoticons to express emotion and sentiment within their message (Bowe, 2002; Okuyama & Iwai, 2011).
In the most comprehensive study found, Power et al. (2006) carried out a survey of the uses of different forms of text communication by 172 members of the Australian Association of the Deaf. This study not only looked at the use of electronic communication by individuals who are DHH but also explored the uses, gratifications, and implications of technology use in the deaf community. The authors found that individuals living in Australia who are DHH are partial to a variety of electronic communication methods (e.g., SMS, TTY/TDD, relay services, fax, and computer use) and that the primary use of these technologies was to enhance sociability, followed by use in business and/or work settings.

In addition to convenience and motivational factors, several studies (Akamatsu et al., 2005; Bowe, 2002; Henderson et al., 2005; Henderson-Summet et al., 2007; Okuyama & Iwai, 2011) discussed the importance of strong literacy skills in using text-based technologies. Unfortunately, none of the studies investigated the effect of these technologies on literacy development among individuals who are DHH.

Use of Internet-based Technologies Among Individuals Who Are DHH

The Internet has been a significant tool in creating a place of equity among those with unique needs and has become an “empowering agent” for adolescents who are DHH by opening more opportunities to access information and socialize (Barak & Sadowsky, 2008; Bowe, 2002; Power et al., 2006). Barak and Sadowsky (2008) reported that adolescents who are DHH spend more time on the Internet than hearing users of the same age. The authors also suggested that the Internet could be a source of improving the well-being of individuals who are DHH.

Keating and Mirus (2003) and Fajardo et al. (2010) were the only studies found that investigated technologies related to signed languages. Keating and Mirus (2003) investigated how Internet-based video communication technologies shaped the language practices of individuals who are DHH. Although a ground-breaking study at the time, these technologies were still very much in their infancy stages, and the bandwidth requirements allowing for “natural” signed communication over the Internet were not yet available to the general public. Internet-based video and video communication technologies now have faster access speeds (e.g., 4G), and devices are smaller, portable, and more personal (e.g., smartphones and tablet computers) with applications (e.g., FaceTime, ooVoo, and Skype) that are popular and widely used within the general population and perhaps similarly in the deaf community.

Another consideration in Internet-based technology use and accessibility among individuals who are DHH is Web site accessibility. Web site accessibility is discussed in Chapter 5 of Title III of the Americans with Disabilities Act (ADA; 3PlayMedia, 2013). The ADA recommends the following for Web site accessibility for individuals who are DHH: add captions to videos; create text transcripts; and add additional links to text transcripts when video and audio files are linked to a specific Web page. However, the current Web site accommodation recommendations from the ADA only apply to online content of government and federally funded entities. Because the Internet has not yet been defined as a “place of public accommodation” by the ADA (1990), compliance with the ADA is subject to interpretation among sites that do not fit into the “government or federally funded” category. Still, research that investigates other options for Web site accessibility for individuals who are DHH is warranted.

Just one study (Fajardo et al., 2010) was found that investigated Web site accessibility specifically for individuals who are DHH. Fajardo et al. (2010) investigated the use of signed videos added to text hyperlinks in web pages to improve efficiency in web searching. Their findings indicated that hyperlinked signed videos did improve web navigation somewhat for signing deaf users and reduced the need for users to have strong word categorization skills (e.g., knowing that “digital camera” would be included under the term “electronics,” or that “blouse” would be included in the category of “clothing”) often needed for web-based searches.

Overall, although technology has been widely accepted by the general public and is convenient to use, the majority of studies investigating the technology use of individuals who are DHH have focused on a singular
piece or practice, such as SMS text, or on forms of dated technologies such as TTY/TDD, fax, and videophone (Bowe, 2002; Okuyama & Iwai, 2011; Pilling & Barrett, 2007). None of the studies addressed current Internet-based and mobile device-based use, including current video conferencing (e.g., Facetime, ooVoo, and Skype) and social networking technology (e.g., Facebook, Twitter, Google+, and Pinterest), among the American DHH community. Further, no studies were found that addressed preferences in software use (e.g., presentation software such as PowerPoint, word processing software such as Microsoft Word, or spreadsheet software such as Excel), social networking sites (e.g., Facebook, Twitter, Google+, and Pinterest), or Web site design preferences among the deaf community. In response, a survey study was designed to answer the following research questions:

1. What technologies (hardware and software) do American DHH adults use? How often, and for what purpose(s)?
2. What Web sites do American DHH adults frequent the most?
3. What accessibility features do American DHH adults prefer in Internet Web sites?
4. To what extent do the findings differ by demographics such as age, communication preference, level of loss, and level of education?

Methodology

A nation-wide survey comprised of 20 questions addressing the technological use, needs, and preferences of individuals who are DHH and living in the United States and its territories was made available through a secure web link provided by SurveyMonkey.com. Each question was presented in English text (Appendix A) as well as in American Sign Language (ASL; available to the participant via embedded videos). A paper-and-pencil version of the survey was also available to participants upon request; no such request was made.

Prior to disseminating the survey, permission to conduct the study was granted by the Michigan State University’s Institutional Review Board. Requests to complete the survey were then circulated to the deaf community through schools for the deaf, national, state, and local organizations of and for the deaf, and through personal contacts across the United States and its territories via a snowball sampling method (aka, chain sampling or referral sampling; Atkinson & Flint, 2001). All surveys completed between May 14, 2012 and June 15, 2012 were accepted. Data were then coded and entered into an Statistical Package for Social Sciences (SPSS) database and were analyzed using descriptive statistics.

Instrument

The 20-question survey was comprised of seven multipart, close-ended questions, addressing the use (e.g., frequently, sometimes, rarely, never) and preference of stationary and mobile technologies, software or hardware, and the Internet. Three open-ended/free response questions addressing frequently visited Web sites, frequently used software, and suggestions to improve access to Internet-based content for DHH users were included. Ten questions addressing demographic information such as location by state, age, level of education, occupation, audiological levels, use of assistive listening devices (ALDs), communication preferences, and disability (not hearing loss) were also included.

Sample

Two hundred and seventy-eight DHH individuals from 31 states and the District of Colombia participated in the study. Table 1 shows the demographics of the sample by various background variables, including age, audiological level, use of ALD, communication preference, educational level, income, and disability (not deafness). As can be determined from the table, the sample included fewer persons under the age of 25 years (2.9%), fewer persons with a mild to moderate loss (11.9%), and fewer persons having cochlear implants only (8.3%). In addition, more than half of the sample reported a profound loss (59.0%) and nearly three-quarters reported preferring at least some signed communication (76.6%; with or without speech). Hearing aids were the most commonly reported ALD used (32.0%; an additional 4.7% made use of both cochlear implants and hearing aids). Income among the sample ranged from below $25,000 to above $75,000, with nearly 30%
of the sample earning between $25,000 and $50,000. Although results should be considered under these conditions, this distribution is similar to that of previous related studies, including Bowe (2002), Power et al. (2006), and Power et al. (2007).

More than half of the participants reported their audiological level as being profound (59.0%), followed by severe (13.3%), moderate (8.3%), and mild (3.6%). A little more than 15% (15.8%) of participants did not report their audiological level. Additionally, a large percentage of participants (41.0%) reported that they did not use an ALD. Regarding communication preferences, the majority of participants (76.6%) used some form of signed communication, with 43.2% being users of ASL. Only 10.1% of the participants reported using speech only. Few participants reported having a disability (not deafness; 13.3%).

Geographically, the sample included a majority (31.3%) of participants from the southern region of the United States (as defined by the U.S. Census Bureau, 2012), followed by the West (24.5%) and Midwest (24.1%) and the Northeast (10.4%) regions. Regional data was not reported for 9.7% of the participants in the study.

Statistical analyses in the form of chi-squares were completed to determine if the sample was skewed by particular demographic characteristics. It was determined that there was a significant difference at the .01 alpha level in communication preference by audiological level (more sign use by those with profound loss), use of ALDs ($p = .000$; less use of ALDs by those who sign), and household income by disability and degree ($p = .000$; more income earned by those with a higher degree). There was also a significant difference at the .05 alpha level in age by disability ($p = .020$; older persons reported more disabilities), disability by degree ($p = .013$; those who reported a disability tended to earn less income), and communication preference by household income ($p = .017$; those who reported using ASL as their primary mode of communication earned less than those who used other methods such as speech only, speech and sign, and signed English).

### Table 1  Sample demographics in percentage

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Percentage of sample</th>
<th>Demographic</th>
<th>Percentage of sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td></td>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>18–25</td>
<td>2.9</td>
<td>High school</td>
<td>15.8</td>
</tr>
<tr>
<td>26–35</td>
<td>15.8</td>
<td>Assoc/trade</td>
<td>19.8</td>
</tr>
<tr>
<td>36–45</td>
<td>19.4</td>
<td>BA/BS</td>
<td>22.7</td>
</tr>
<tr>
<td>46–55</td>
<td>21.9</td>
<td>Master’s</td>
<td>27.3</td>
</tr>
<tr>
<td>56+</td>
<td>28.8</td>
<td>Doctorate</td>
<td>5.0</td>
</tr>
<tr>
<td>Missing</td>
<td>11.2</td>
<td>Missing</td>
<td>9.4</td>
</tr>
<tr>
<td>Audiological level</td>
<td></td>
<td>Household income</td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>3.6</td>
<td>&lt;$25,000</td>
<td>21.9</td>
</tr>
<tr>
<td>Moderate</td>
<td>8.3</td>
<td>$25,000–$50,000</td>
<td>27.7</td>
</tr>
<tr>
<td>Severe</td>
<td>13.3</td>
<td>$51,000–$75,000</td>
<td>16.9</td>
</tr>
<tr>
<td>Profound</td>
<td>59.0</td>
<td>&gt;$75,000</td>
<td>18.7</td>
</tr>
<tr>
<td>Missing</td>
<td>15.8</td>
<td>Missing</td>
<td>14.7</td>
</tr>
<tr>
<td>Assistive listening devices</td>
<td></td>
<td>Disability</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>41.0</td>
<td>No</td>
<td>73.7</td>
</tr>
<tr>
<td>Aids only</td>
<td>32.0</td>
<td>Yes</td>
<td>13.3</td>
</tr>
<tr>
<td>CI</td>
<td>8.3</td>
<td>Missing</td>
<td>12.9</td>
</tr>
<tr>
<td>CI &amp; aid</td>
<td>4.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>14.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Sign Language</td>
<td>43.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sign English (no voice)</td>
<td>3.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sign &amp; speech</td>
<td>30.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speech only</td>
<td>10.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>13.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. CI = cochlear implant.*
Results

Data from the survey were entered into SPSS and analyzed using descriptive statistics. Frequency counts and chi-square analyses were conducted to determine how often, where, and for what purposes the deaf community used various technologies, that is, hardware, software programs, and Web sites.

Frequent Use of Hardware

The survey asked respondents to comment on their use of various hardware. Findings from the survey suggest that, overall, individuals who are DHH make frequent use of smartphones such as iPhones, Androids, and Blackberrys (71.6%), as well as personal computers (PC) (70.9%). There were significant differences by age in regards to smartphone and PC use. Results reflect that more of younger DHH persons make use of smartphones (p = .039) while less younger DHH persons make use of PC computers (p = .004). This younger group also made frequent use of iPads (p = .044) and iPods (p = .008).

TTY/TTD use, once overwhelmingly popular within the deaf community, was reportedly used rarely if ever by 70.1% of the sample, although more persons with a disability (not deafness) reported using TTY/TTD (p = .002) than did other age groups. Other demographic differences included those with more hearing using iPods and cell phones frequently (p = .000 and p = .008, respectively). Participants who reported using sign language as their preferred mode of communication reported using Mac computers more frequently (p = .013). More participants who reported not using sign as their preferred mode of communication reported using cell phones frequently (p = .008). More participants who reported earning a higher income made frequent use of iPads (p = .044).

Frequent Use of Technology for Specific Purposes

Respondents were asked where and how often they used technology for a particular purpose, such as text messaging, surfing the Internet, playing games, and tracking household budgets. A majority (62.9%) of the sample reported using technology in the home, and more than three-quarters reported frequent use of technology for the following purposes: e-mail (88.1%); text messaging (75.5%); and surfing the Internet (74.5%). Between 40% and 50% of the sample reported frequent use of technology for the purpose of video conferencing (e.g., Facetime, ooVoo, and Skype) and writing documents or papers. Demographics affecting these results include those with a disability frequently using editing software (p = .024), those with more education using software to write documents (p = .000), and those with less education (associate degrees) frequently playing games (p = .018). More of those who reported using no ALDs made frequent use of the phone (p = .002), but those with a mild audiological level reported using e-mail infrequently (p = .001). In addition, more respondents who preferred to use both speech and sign reported that they surfed the Internet frequently (p = .035). Finally, those who frequently used technology for writing documents also tended to have higher incomes (p = .036).

Frequent Use of Software for Specific Purposes

When asked about the reasons for which they use software, a majority of the sample responded that they use software for writing documents (55.0%). Frequent use for presentations and spreadsheets were next with 31.0% and 29.8%, respectively. When analyzed according to demographic statistics, results showed that there was a significant difference in the purpose for software use by age, disability, communication preference, degree, and household income. More of the younger participants in the sample made use of video editing (p = .010), presentation (p = .001), and spreadsheet programs (p = .029). In addition, those who preferred to use sign language were more apt to use video editing (p = .048) and spreadsheet (p = .043) software. Use of spreadsheet programs was more common among individuals with higher income (p = .030) and among individuals reporting not having a disability (p = .000). Additionally, results showed that as educational level (degree) increased, so did use of spreadsheet programs (p = .000), presentation software (p = .000), and software for writing documents (p = .000).

Most Frequently Visited Web Site Types and Design Preferences

The survey included several questions related to Web sites, including those most frequently visited, the purpose
for visiting, and preferences for including sign language, pictures, and/or text. More than 60% of the sample reported making frequent use of research/search engines such as Google and Wikipedia. Google-related sites were the top Web sites most often visited (39.3%), followed by social Web sites (more specifically, Facebook; 32.9%) and news/information sites such as CNN (31.3%). More than half the sample reported that their favorite Web site contained “many pictures and a lot of text” (57.2%) and no sign component (53.6%). A large number of those surveyed (41.4%) reported that they wanted captions or captioning options on Web sites. More participants with profound audiological levels reported wanting captions ($p = .035$).

There were several significant differences in Web site design preferences by age, presence of a disability (not deafness), communication preference, and educational level. Participants preferring signed communication methods ($p = .000$), participants with disabilities ($p = .043$), participants with lower levels of education ($p = .000$), and older participants ($p = .005$) reported that they preferred Web sites that incorporated a signing component. Social Web sites were used frequently by more of the younger participants ($p = .001$) and by participants who reported having a severe audiological level ($p = .036$). Association Web sites (such as those associated with the Alexander Graham Bell Association for the Deaf, the NAD, and Self Help for Hard of Hearing People) and school alumni Web sites were frequently visited by more of the older participants ($p = .016$), participants who reported using signed communication (e.g., ASL or sign and speech) as their preferred method of communication ($p = .029$), participants using no ALD or hearing aids only ($p = .014$), participants reporting having a severe or profound hearing loss ($p = .001$), and participants with associates, bachelor’s, and master’s degrees ($p = .007$). School Web sites were frequently visited by more participants with master’s and doctoral degrees ($p = .000$). Gaming Web sites were frequently visited more by those with less education ($p = .021$), those using hearing aids ($p = .019$), those using speech and sign as their primary mode of communication ($p = .010$), and those reporting having an annual income between $25 and $50,000 ($p = .024$). Participants earning between $25 and $50,000 annually reported visiting news Web sites ($p = .003$) and shopping Web sites ($p = .033$) frequently.

Where Technology Is Most Frequently Accessed

The majority of participants reported using and accessing technology from home (62.9%), followed by work (29.1%) and then by school (4.3%). Age and disability status were factors differentiating where respondents accessed technology, with those over the age of 25 years ($p = .000$) and those reporting having a disability (not deafness; $p = .001$) using technology frequently at home. Technology was frequently used in the workplace by more participants preferring both speech and sign ($p = .003$), by participants with higher incomes ($p = .000$), and by participants with advanced college degrees ($p = .001$).

Discussion

Results show a particular preference of technologies such as smartphones, PC computers, software for writing documents, and informational and social networking Web sites such as CNN, Google, and Facebook among the deaf community in the United States. Participants’ overwhelming desire for captioning may indicate a current level of limited access to video and audio content on the Internet, in effect keeping persons who are DHH from full participation in society. Further, findings suggest that technologies once exclusively used by DHH individuals (i.e., TTY/TDD and video relay service) are being replaced with those that are more universally used, personal, and convenient such as Internet-based video conferencing, mobile person-to-person video conferencing (e.g., Facetime, ooVoo, and Skype), and social networking sites (e.g., Facebook).

Differences in results by demographics do show possible variability within the population. Significant differences were found most often for the demographic category of age (11), followed by level of education (10), communication preferences (8), household income (7), disability (5) and audiological levels (5), and lastly, ALD (3). While these results may reflect biases in the data, given the distribution of respondents (for example, a greater representation of persons under age 25 or persons with cochlear implants may have produced different results), they may just as likely illustrate an accurate depiction of technology use in the United States among the deaf community. This assertion is supported, for example, by results showing prominent use of iPods.
by those with mild to moderate audiological levels—a finding that would make sense, given that this device (and other mobile digital media players such as SanDisk Sansa, and Sony USB Media Player) is primarily marketed to store and play back digital audio (music) files. A second example is the noted significant differences in Web site design preferences by age, presence of a disability (not deafness), communication preference, and educational level, which may be related to proficiency in English literacy as suggested in previous studies (Akamatsu et al., 2005; Bowe, 2002; Henderson et al., 2005; Henderson-Summet et al., 2007; Okuyama & Iwai, 2011).

In another finding, data showed that those with advanced degrees were more apt to frequently use software for document writing, presentations, and spreadsheets. Here it is presumed that persons with higher degrees tend to use these applications in their professions, which was also reflected in the results of the survey that indicated that more participants with higher degrees and higher incomes accessed technology frequently in the workplace.

Results of the survey also suggested that more participants with higher incomes were likely to frequently use state-of-the-art technologies such as tablet computers (e.g., iPad, Galaxy Note, and Kindle Fire). This may be a ramification of the cost of items and their relative benefit. A computer itself may cost more than a tablet device at the onset, however, a computer is capable of running more complex software and has more storage capability (at least right now) than do tablets. Thus, a person who is earning less in salary may make the choice of purchasing a computer over a tablet, but those with a higher, and perhaps more disposable, income may be able to purchase both, or at least keep up with the ever-changing technology.

Implications

The results of the study present several implications legally, socially, and educationally for the deaf community. First, until laws, such as the ADA in the United States, specifically identify the Internet as a “place of public accommodation,” it will be left to the deaf community to advocate for equal and fair access to content published online. Recent cases in the United States against providers of online video content are setting precedent for this work. In 2012, the NAD filed a suit against Netflix, citing ADA and requesting that streaming video services be captioned in order to provide fair and complete access to information. Netflix claimed that complying with the captioning laws did not apply to them because the law did not explicitly state that captioning was required on online and “instant access” content, and that requiring the company to caption all content was a violation of their First Amendment rights. The court ruled in favor of the NAD, citing that Netflix was a “place of public accommodation” and thereby must follow the accessibility laws outlined by the ADA (3PlayMedia, 2013). Most recently, a suit was filed against Time Warner by the Greater Los Angeles Agency on Deafness for failure to provide captioning on streaming videos on CNN’s Web site. This case is still in litigation at this time.

These cases have brought attention to the need for fair access of online content. Assistant Attorney General of the United States, General Thomas E. Perez, noted that the entertainment industry has been revolutionized by the Internet, and failure to provide access to video and audio content potentially violates the ADA (3PlayMedia, 2013). However, because the ADA does not specifically address online video and audio content, the current laws could be interpreted otherwise. It is recommended that those creating and developing online content get direct input from diverse and underrepresented groups to ensure compliance with laws and fair access for all.

Second, there are social implications in the results found here for individuals who are DHH. As discussed in Akamatsu et al. (2005) and Power & Power (2004), because many of the technologies addressed in this study as used by individuals who are DHH are also used by the general population, there are more opportunities for individuals who are DHH to make connections with a wider variety of people. Social networking sites such as Facebook, Pinterest, and Twitter could help break down social barriers that often exist between individuals who are DHH and individuals who are hearing, perhaps also bringing a mutual understanding of each other’s needs and cultures.

Finally, there are educational implications for the deaf community in these results. Technology has the potential to enhance and support education among
individuals who are DHH, especially in regards to language learning. Although none of the studies in the literature specifically address the effects that certain technologies have on improving the literacy skills of individuals who are DHH, many speculate that certain technologies provide greater access to English language models (Akamatsu et al., 2005). Scholars (e.g., Dewey, 1932/1990; Vygotsky, 1978) argue that knowledge is constructed through transactions between individuals. This idea is further expanded in the transactional theory of reading and writing to include transactions between readers and texts (Rosenblatt, 2004). Rosenblatt (1985) defines the transactional theory of reading and writing as a “reciprocal, mutually defining relationship” between a reader and a text. This theory could be applied to text-based technologies and social media sites, as studied by Stewart (2009), and may, then, hold some promise in supporting literacy development among individuals who are DHH. More research, however, is needed.

On the contrary, the lack of captioning of online audio and video content could limit DHH students’ and educators’ accessibility in regards to supplemental educational materials. For example, sites like history.com and theamericanrevolution.org contain informational videos and audio content that are not captioned. This limits the use of these high-quality materials during instruction with students who are DHH and impedes individuals who are DHH from accessing these types of materials in their own personal enrichment and learning endeavors.

Limitations
There are several limitations that must be considered when reflecting on the results found in this study. First, although the survey was made available in both electronic and paper forms, no one requested the paper form. Thus, those who responded may be considered already, at least minimally, technologically savvy. Further, because of the way in which the survey was distributed, that is, via a snowball sampling method where initial contacts forwarded the survey to others like themselves (Coleman, 1958), a misrepresentation of the population could have exposed the data to numerous biases. For example, in the sample, there was a significantly higher number of respondents who indicated a preference for sign (with or without speech) and a significantly lower number who preferred speech only. In addition, there was a significantly higher number of respondents with a profound hearing loss and a significantly low number of respondents 25 years and younger. This latter point may be most critical as this group may be the most technological. Similar investigations in the past (Bowe, 2002; Pilling & Barrett, 2007; Power et al., 2006) have also failed to capture this younger subgroup. It is suggested, therefore, that future studies make a particular effort to obtain a sample that includes a strong representation of this age group.

As with any self-reported data, there is always a chance of misrepresentation of actual behavior due to misunderstandings of one or more questions and/or ambiguity in response options. For example, the survey included a question on communication preference, with one option being “sign and speech.” It is possible that those who are bilingual (ASL and English) and those who use “sign-supported speech” or simultaneous communication were included in this count. Also, response choices of “frequently,” “sometimes,” and “rarely” are subjective and therefore are open to the interpretation of the survey-taker. One person’s understanding of “frequently,” for example, may be every day, whereas another’s may be 3 times per week (in contrast to “never,” which is objective). Consequently, it is difficult to determine the exact amount of time spent with any one piece of technology or software. It is suggested that future studies use a more sophisticated system to gather data on technology use, perhaps using management systems inherent in the technology.

Finally, although the current study is the most recent, comprehensive national (US) survey of individuals who are DHH regarding their technological use and preferences, technology innovation and development is a constant and rapidly changing domain. Since this study was conducted, newer technologies, such as the social video applet Vine and the photo-sharing applets Snapchat and Instagram, have emerged and/or become more popular. Therefore, regular updated surveys in this area are warranted.

Conclusion
The current study provides an overview of the use of technology among the DHH community in the United
States. Indications on the survey, including prominent use of smartphones instead of TTYs/TDDs and social networks such as Facebook, may indicate that the deaf community in the United States is more closely aligned to the general population than once believed, and that technology may indeed “level the playing field” as Bowe (2002) and Power et al., (2006) alluded. At the same time, indications by respondents regarding the desire for captioning, and significant differences in results by demographics such as disability and household income, may indicate that there still exists a “digital divide.” Groups with no access or unequal access to information and communication technologies are said to be “disadvantaged in the global economy” (Sey et al., 2013, p. 27). Use of technology and full access to software programs and Web sites positively affects academic success, advances professional careers, and connects persons socially (Rowland, Burgsthaler, Smith, & Coombs, 2013).

In order that this “digital divide” does not further itself to become “digital marginalization,” we urge legal, educational, and humanitarian professionals in both the hearing and deaf communities to work to create full and equal access to technology and the Internet so that DHH persons worldwide can participate fully and successfully in society. This includes requirements for captioning of all videos uploaded to the Internet. We appeal to those in business, health, and education in particular to be conscious of the needs and wishes of the deaf community when designing courses, interventions, and Web sites. We suggest, specifically giving consideration, and to bandwidth requirements as most DHH persons use the Internet at home where high-speed access may not be available. Finally, it is imperative that ongoing, updated surveys be conducted to keep pace with technology and allow the deaf community to maintain equal opportunity.

Note

1. Deaf community refers to persons who are audiologically deaf or hard of hearing and does not necessarily denote cultural identification.

Supplementary Data

Supplementary material is available at http://jdsde.oxfordjournals.org/.

Conflicts of Interest

No conflicts of interest were reported.

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