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What Adults Who Use AAC Say About Their Use of Mainstream Mobile Technologies

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Abstract

Mobile technology – cell phones, smartphones and tablets – has expanded communication and social interaction, commerce, and access to information for many people with disabilities. Survey research has shown that adults with complex communication needs who rely on Augmentative and Alternative Communication (AAC) continue to face barriers in using mainstream mobile technology. In order to learn more about their experiences, eight adults who have complex communication needs and who use both AAC and mainstream mobile technology participated in a 10-week online focus group. Using the 173 unedited posts, a thematic analysis resulted in 4 themes: (1) use of mobile technologies, (2) recommendations for the AAC and mobile technology industries, (3) intelligent digital assistants, and (4) feedback and social exchanges. Fifteen subthemes also emerged from the first two themes. Detailed accounts of each of the themes and subthemes, through the voices of adults who use these technologies, provided the bases for the results. Conclusions include outcomes and benefits for the design of future specialized AAC and mainstream technologies, policy makers and people who use these technologies.

Keywords: complex communication needs, augmentative and alternative communication, mobile technology, online focus groups

Introduction

Mobile technology – cell phones, smartphones and tablets – has become ubiquitous, reaching out to the most isolated and least served communities worldwide (G3ict & ICT, 2012). These technologies enhance communication with friends, family, and co-workers. They provide access to information, entertainment, banking, and commerce at any time from almost anywhere. The world has gotten smaller and more accessible – at least for some.

According to the Pew Research Center (2015), cell phones (portable telephones that use cellular technology) are as common in low-income countries as they are in high-income countries. Smartphones – cell phones that run complete operating systems and that can access the Internet and applications ("apps") with robust features such as calendars, media players, GPS navigation, web browsing, and much more – are increasing world-wide (Bryen & Moolman, 2015).

Mobile Technology and People with Disabilities

Despite the many advantages of mobile technology, people with disabilities continue to have more limited access to these mainstream technologies with only 35% of persons with disabilities in North America having access to them compared to 75% of non-disabled people (Center for an Accessible Society, 2014; Duchastel de Montrouge, 2014). The importance of mobile technology in equalizing opportunities for people with disabilities has been reinforced by the United Nations in the Convention on the Rights of Persons with Disabilities (CRPD). Article 9 of the CRPD states that:

> *"To enable persons with disabilities to live independently and participate fully in all aspects of life, States Parties shall take appropriate measures to ensure to persons with disabilities access, on an equal basis with others, to the physical environment, to transportation, to information and communications, including information and communications technologies and systems, and to other facilities and services open or provided to the public, both in urban and in rural areas. These measures, which shall include the identification and elimination of obstacles and barriers to accessibility, shall apply, inter alia (Article 9, para. 1):*
> *…. g. To promote access for persons with disabilities to new information and communications technologies and systems, including the Internet;*
> *h. To promote the design, development, production and distribution of accessible information and communications technologies and systems at an early stage, so that these technologies and systems become accessible at minimum cost (United Nations, 2006, Article 9, State Parties para. g)."*

Internationally, the CRPD recognizes the importance of accessible mobile technology for the approximately 1 billion individuals with disabilities worldwide, including those with complex communication needs (CCN). This human rights treaty has been used as a mechanism for monitoring digital accessibility and as an instrument for change.

In the United States, Section 508 of the Rehabilitation Act of 1973, Section 255 of the Telecommunications Act of 1996, and the Twenty-First Century Communications and Video Accessibility Act of 2010 have promoted improved accessibility of mobile phones and services for individuals with hearing, vision, dexterity, and, to some extent, cognitive disabilities. However, to date, the needs of people with complex communication needs who use AAC have not been specifically addressed.

Mobile Technology and People with Complex Communication Needs Who Use AAC[1]

Mobile technology offers many potential benefits for individuals with CCN who require AAC. Benefits include improved communication and social interaction, as well as increased access to information and commerce. In addition, mobile technology has increased "awareness and social acceptance of AAC in the mainstream, greater consumer empowerment in accessing AAC solutions, increased adoption of AAC technologies, greater functionality and interconnectivity, and greater diffusion of AAC research and development" (McNaughton & Light, 2013, p. 108). Nguyen, Garrett, Downing, Walker, and Hobbs (2008) demonstrated that when mobile phones were interconnected with the individual's AAC device, they were able to effectively use the mobile phone in its many modes of operation, resulting in a greater sense of independence, safety and security. Their use of mobile phones also contributed to improving their communication skills, resulting in greater self-confidence in conversation and social interactions. Mainstream mobile technology, such as smartphones and tablets, are becoming more stylish, which has resulted in their becoming fashionable accessories compared to specialized AAC[2] devices which lack the "cool factor" and often look as if they were designed for children, or carry other markers that signify disability in some way (Foley & Ferri, 2012).

Research focused on the use of mainstream mobile technology by individuals with complex communication needs who use AAC has had a rather short history. Based on the few existing studies, survey data suggests that, in the United States, use of mainstream mobile devices by individuals who rely on AAC is growing, but a gap continues to exist between their use and that

[1] Augmentative and alternative communication (AAC) includes a variety of communication methods used to supplement or replace speech or writing for those with impairments in the production or comprehension of spoken or written language resulting in complex communication needs.

[2] Specialized AAC devices are computer-based devices with digitized or synthesized speech that have been specially developed to supplement or replace speech or writing for those with impairments in the production or comprehension of spoken or written language. Other commonly used terms are voice output communication aids (VOCA) or speech generating devices (SGD).

of other disability groups and the nondisabled population (Bryen, Carey, & Potts, 2006; Morris & Bryen, 2015). Furthermore, individuals who rely on AAC who responded to a national survey generally have multiple disabilities – spoken language and physical disabilities – that have not been fully addressed by the accessibility features currently built into mainstream mobile devices. This has resulted in an extra burden of retrofitting needed adaptations to their mainstream mobile devices that are not required by the general population and less required by other disability groups.

First-person "voices" of members of this low-incident community have been historically omitted from the wireless technology industry and from policy makers. Until their voices are included, the existing gap and extra burden of retrofitting needed adaptations will continue.

Purpose of this Study

The purpose of this study is to provide a first person account of the use of, barriers to, and recommendations for more equal access to mainstream mobile technology by adults who have complex communication needs who use specialized AAC technologies and who are also increasingly using mainstream mobile technology. This research builds on the work of Bryen and Pecunas (2004), Bryen, Carey and Potts (2006), Bryen and Moolman (2015), and Morris and Bryen (2015) in the United States along with colleagues in South Africa (Bornman, Bryen, Morris, & Moolman, 2016; Bryen, Bornman, Morris, & Moolman, 2017) that has provided a broad look at this population's use of mainstream mobile technology.

Target audiences. The participants in this study were adults who have complex communication needs and who use both specialized AAC devices and mainstream mobile technologies such as cell phones, smartphones and tablets. The target audiences for this manuscript are primarily the specialized AAC technology and the mainstream mobile technology industries. They will benefit from hearing the first-person voices of individuals with complex communication needs who rely on AAC in designing more accessible and inclusive technologies. An additional target audience is comprised of policymakers. They develop and monitor consumer technology standards to ensure that the accessibility and usability needs of people with a variety of disabilities are adequately addressed in the design and manufacture of mobile technologies. Finally, people who rely on these technologies, family members, and their supporters are important audiences given that they are the end users of these important specialized and mainstream communication technologies.

Method

Research Design

A mixed-method research design was used to extend the findings of exploratory quantitative

studies using the Survey of User Needs (SUN) on the use of mainstream mobile technology by adults with complex communication needs who use AAC. The SUN was originally launched in 2002 by the Rehabilitation Engineering Research Center on Wireless Technology (Wireless RERC) and has been updated 4 times to keep up with the rapid pace of technological change and the inclusion of questions that are relevant to people who have complex communication needs and who use specialized AAC technologies. Through participation via an online focus group, qualitative data was obtained so that their voices will provide direction to the design of more accessible and inclusive mobile devices.

According to Kitzinger (1995), focus groups are a form of group interview that capitalizes on communication among research participants in order to generate qualitative data. Kitzinger notes that:

> *"Focus groups explicitly use group interaction as part of the method. Instead of the researcher asking each person to respond to a question in turn, people are encouraged to talk to one another – asking questions, exchanging anecdotes and commenting on each other's experiences and points of view. The method is particularly useful for exploring people's knowledge and experiences and can be used to examine not only what people think but how they think and why they think that way (p. 299)."*

Participants

Recruitment. Recruitment began once approval was obtained from the Institutional Review Board (IRB), accessible consent processes developed, and funding to compensate each participant with a $50.00 Amazon gift card secured. Recruitment for this study required multiple steps. First, potential participants were initially drawn from the 33 respondents to SUN5 who have complex communication needs, who use AAC, and who stated that they were interested in being invited to participate in further research related to mobile technology. To be eligible to participate in the online focus group, potential participants had to meet all of the following inclusion criteria:

1. Completed the SUN5 (as such, they had to be 18 years or older),
2. Use an AAC device for their face-to-face communication,
3. Currently use mainstream mobile technology (e.g., cell phone, smartphone, or tablet), and
4. Provided consent.

Participant selection and description. Thirty-three (33) respondents who use AAC completed the national SUN5. Shown in Table 1 is relevant information about these potential participants. The majority were white (87.9%), had a mean age of 43.1 years, were mostly college educated (87.9%), had a household income of between 0 and $24,999 (54.9%), and worked either part-

time or full-time (54.5%). Further, almost all reported that they had difficulty speaking so others could understand them (90.9%) and also had difficulty walking (75.8%), using their arms (72.7%), and their hand and fingers (78.8%). As such, they were all adults with complex communication needs. Additionally, they all used speech-generating AAC technology for face-to-face communication. Twenty (60.6%) reported that they also used mainstream mobile technologies – cell phones, smartphones, or tablets.

From these 33 respondents, 12 (36.4%) met all the participant requirements. An invitation describing the purpose and format of the online focus group was emailed to each of the 12 individuals who met all the inclusion criteria. Nine of the 12 accepted the invitation and provided written consent to participate in the 10-week online focus group. Of the 12, two persons could not be reached and one person stated that he was interested but was too busy with work to commit to the 10-week focus group. One other person signed the consent and became a participant, but had to leave due to illness. Relevant data for the 33 people with complex communication needs who rely on a specialized AAC device and who completed SUN5 and the resultant subset of the final eight focus groups' participants are provided in Table 1.

Table 1

Summary of the 33 Adults Who use AAC/SGD and Who Completed SUN5, and the final 8 Participants Who Met All of the Inclusion Criteria to Participate in the Online Focus Group*

Charateristics of Potential and Actual Focus Group Participants	**Adults who Use AAC who Completed SUN5 *N*=33**	**Adults who Use AAC, Completed SUN5, Use Mobile Technology & Consented to Participate *N*=8***
Gender Male	20 (60.6%)	4 (50.0%)
Female	13 (39.4%)	
Age Mean	43.10	45
Range	19 – 77	31 – 76
Ethnicity African-American	1 (3.0%)	-
Latino	1 (3.0%)	-
Asian-Pacific	2 (6.1%)	-
Native American	1 (3.0%)	-
White	29 (87.9%)	7 (87.5%)
Other	1 (3.0%)	1 (12.5%)
Education Elementary school	1 (3.0%)	-

High school diploma	3 (9.1%)	1 (12.5%)
GED	13 (39.4%)	1 (12.5%)
Some college, no degree	3 (9.1%)	-
Associate's degree	8 (24.2%)	2 (25.0%)
Bachelor's degree, Master's degree, or doctoral degree	5 (15.2%)	4 (50.0%)
Household Income Less than $10,000	11 (35.0%)	1 (12.5%)
$10,000 to $14,999	6 (19.4%)	1 (12.5%)
$15,000 to $24,999	6 (19.4%)	2 (25.0%)
$25,000 to $34,999	2 (6.5%)	1 (12.5%)
$35,000 to $49,000	2 (6.5%)	-
$50,000 to $74,999	2 (6.5%)	1 (12.5%)
$75,000 or more	2 (6.5%)	2 (25.0%)
Employment Status (*N*=23) Works Full Time	8 (24.2%)	2 (25.0%)
Works Part Time	10 (30.3%)	4 (50.0%)
Not employed	10 (30.3%)	2 (25.0%)
Retired	5 (15.2%)	-
How Accesses SGD Device Direct selection – hand	13 (39.4%)	8 (100%)
Direct selection – feet	2 (6.1%)	-
Direct selection – head stick	3 (9.1%)	-
Switch/scanning	1 (3.0%)	1 (12.5%)
Light or laser technology	1 (3.0%)	1 (12.5%)
Optical indicator	5 (15.2%)	1 (12.5%)
Speech recognition	2 (4.3%)	2 (25.0%)
Other	4 (12.1%)	2 (25.0%)
Difficulties Speaking so can be understood	30 (90.9%)	8 (100%)
Concerntrating, remembering	2 (6.1%)	-
Worry, nervous	6 (18.2%)	2 (25.0%)
Seeing	2 (6.1%)	1 (12.5%)
Hearing	1 (3.0%)	2 (25.0%)
Using arms	24 (72.7%)	7 (87.5%)
Using hands & finger	26 (78.8%)	4 (50.0%)

Walking	25 (75.8%)	4 (50.0%)
Mainstream Wireless Technology Used? Yes	20 (60.6%)	8 (100%)
No	10 (30.3%)	-
Did not answer	3 (9.1%)	-

**There were originally 9 participants. However, one participant became ill during the 10-week online focus group and could not continue. Consequently, he is not included in this table.*

As is shown in the far right column of Table 1, the final sample of 8 participants shared many of the characteristics of the 33 persons who completed SUN5. The majority were male, white, were in their mid-40s, completed college, worked part-time or full-time, and had household incomes between 0 and $24,999. Both samples had complex communication needs, given that they both reported experiencing difficulty with speech and difficulties using their arms, hands, and fingers. The major relevant differences between the two samples were that (a) all the final 8 participants used direct selection to access their technology and (b) all used mainstream mobile technology. Presented in Table 2 are profiles of each of the 8 participants.

Table 2
Profile of Each of the Final Online Focus Group Participants

Participant	John	Matt	Alex	Chris	Julie	Ellen	Heather	Ashley
Gender	Male	Male	Male	Male	Female	Female	Female	Female
Age	76	38	49	41	48	31	40	37
Difficulties	V, H, HF, A, Walk	W, HF, A, Walk	W, HF, Walk	H, HF, A	HF, A, Walk	HF, A, Walk	No other difficulty	HF, A, Walk
Education	College	High School	High School	College	College	College	College	College
Employment	Employed: FT	Employed: PT	Not Employed	Not Employed	Employed: PT	Employed: PT	Employed: FT	Employed: PT
AAC Device	S2T/T2S	VOCA	VOCA	S2T	T2S	T2S	VOCA/T2S	VOCA
Access	Direct Selection: Hand	Direct Selection: Hand	Direct Selection: Hand	Direct Selection: Hand	Direct Selection: Hand	Direct Selection: Hand	Direct Selection: Hand	Direct Selection: Hand

Notes. All participants reported not being able to speak so that others could understand them. In addition, the following difficulties were reported: W=worried a lot; HF = difficulty using hands and fingers; A= difficulty using arms; H = hearing difficulty; V = Vision difficulty; Walk = difficulty walking. AAC Device used: S2T = Speech to text, T2S = Text to speech, VOCA = Voice output communication aid also called a Speech generating device.

Materials

The 10-week focus group was conducted online using Facebook Secret Groups. This platform was chosen for three reasons. First, participants lived in several different states and travel to one spot was not possible, so an asynchronous online focus group made communication among

them possible. Second, all 8 participants were already familiar with and had a presence on Facebook. Third, Facebook Secret Groups ensured privacy of any exchanges where asynchronous collaboration in sending and receiving ideas could occur anytime and from anyplace.

Each week, a different topic and set of topic-related questions were posted. The topics and questions were developed prior to the establishment of the Facebook Secret Group. All participants received the list of the 10 topics before joining the group. The topics were established based on the following sources:

- A series of questions grew out of responses to SUN5. SUN5 had been revised to include 8 items that address information uniquely relevant to adults who have complex communication needs and rely on specialized AAC technologies. Input in developing these survey items came from experts who were knowledgeable about AAC and mainstream mobile technologies. Survey items unique to SUN5 appear in Table 3.

Table 3

SUN5 Items that are Unique to Adults Who Use Voice Output Communication Aids

32. If you use a Speech Generating device or software, how do you operate it?

- Touching it directly with my finger or hand
- Touching it directly with my foot or other body part
- Touching it with a head stick or mouth stick
- Using an optical pointer, light pointer, head tracker, or eye tracker
- Using light or laser technology
- Speech recognition
- Partner-assisted scanning
- Switch-assisted scanning
- Other (please specify)

33. If you use a Speech Generating Device or Software, how do you access your CELL PHONE, SMARTPHONE or TABLET? (Check all that apply)

- Touching it directly with my finger or hand
- Touching it directly with my foot or other body part
- Touching it with a head stick or mouth stick
- Using an optical pointer, light pointer, head tracker, or eye tracker
- Using light or laser technology
- Through my AAC device
- Speech recognition using my own voice
- Speech recognition using my AAC device's digital or synthesized speech
- Partner-assisted scanning
- Switch-assisted scanning
- Intelligent Personal Assistant in the Cell or Smartphone (e.g., Cortana, Google Now, Siri, Blackberry Assistant)
- Assistance of another person
- Other (please specify)

34. If you use a Speech Generating Device or Software AND you own a cell phone or smartphone, HOW DO YOU MAKE A PHONE CALL?

- I cannot make a phone call
- I play prepared messages which my assistant speaks into the cell phone or smartphone
- My assistant interprets what I say and speaks into the phone for me
- I place the cell phone or smartphone near the speaker of my AAC device
- I plug the cell phone or smartphone into a port on my AAC device, and communicate electronically through the device
- I use Bluetooth to connect my cellphone or smartphone to my AAC device
- Other (please specify)

35. How important is it to you to be able to have a private conversation using your Speech Generating Technology and your mobile device?

- Very important
- Somewhat important
- Somewhat unimportant
- Very unimportant

36. Do you have difficulties using your Speech Generating Technology with your mobile wireless device/s?

- No
- Yes

37. If you have difficulty using your Speech Generating Technology with your mobile wireless devices, what are the specific difficulties?

38. Which of the following functions on your mobile device are you able to use? (Check all that apply)

- Make a phone call
- Receive a phone call
- Send a text message
- Receive a text message
- Send an email
- Receive an email
- Use a web browser
- Use an Intelligent personal assistant (Apple Siri, Google Now, Microsoft Cortana, BlackBerry Assistant)

39. If you cannot use any of these functions, what is the specific problem or barrier?

- A literature review was conducted to ensure that no important topics were missed (c.f., Bryen & Moolman, 2015; Caron & Light, 2015; Shane, Blackstone, Vanderheiden, Williams, & DeRuyter, 2012).

The final list of topics was emailed to each participant before they joined the Facebook Secret Group (See Appendix A).

Procedures

Data collection. Once the IRB was approved and the participants had provided consent, they were invited to join the AAC and Mobile Technology Facebook Secret Group by the first author, who acted as the moderator. The topic of Week 1 was posted to the group, which included (a) introductions, (b) schedule of weekly topics with due dates, and (c) procedures. During the first week, participants were asked to

> *"Introduce yourself to the group by posting an introductory message that includes 2 or 3 facts about you. Read other members' introductions and comment on at least one member's introduction.*
>
> *Additionally, read the Procedures/Etiquette for focus group and the Outline of the Weekly posts. Post any questions or concerns that you have. Comment by [date provided]".*

Description of the procedures and etiquette included (a) visit our Private Facebook Group 2 or 3 times each week, (b) provide your response to the current week's topic under the weekly topic, (c) comment on each week's topic by the weekly due date, (d) if you are having any questions or concerns, comment by the weekly post-date, and (e) be respectful of all other participants, even if you do not agree with their comments.

The first week served as a warm up for the participants. They introduced themselves, met each other, and became familiar with using the Facebook Secret Group. In addition, the weekly schedule was also posted with assigned due dates for each post.

The focus group continued for 10 weeks. Midway through each week, the moderator posted a "friendly reminder" focusing on the current topic and questions, where to post participant responses, and the due date for their posts. Other than the weekly post and the reminder, the only other time the moderator posted to the group was to ask for clarification regarding an unclear post made by a participant. For example, in response to one of the weekly posts, one participant provided a picture with no text-based description.

At the end of the 10 weeks, the moderator posted a thank you message. The moderator purposely did not participate substantively in the weekly discussions in order to avoid potentially influencing the participants' discussions.

Data analysis. Descriptive statistics were used to calculate the frequency of posts per topic and the frequency of words used by each participant to address each of the 10 topics. NVivo was then used to analyze the qualitative data. NVivo is a software packet used to analyze and find insights from qualitative data such as interviews, open-ended survey responses, articles, social

media, and web content (QSR, 2015).

A grounded theory coding process (Strauss & Juliet, 1994) was used to analyze the qualitative data obtained from the 173 posts. Grounded theory is a research approach which operates inductively with the collection of qualitative data. Data analysis began by examining, line-by-line, the unedited transcript of the participants' posts during the 10-week focus group. The researchers then created 9 corresponding nodes in NVivo, which matched the weekly topics, excluding the Week 1: Introduction and Procedures.

During the next stage of the coding process, NVivo was used to facilitate qualitative data management and analysis of the qualitative data and then to identify themes and subthemes. Four main themes were generated via NVivo: use of mobile technology, recommendations for the AAC and mobile technology industries, intelligent digital assistants, and feedback/social. Within the first theme, 7 subthemes emerged. Eight subthemes emerged within the second theme. No formal inter-rater reliability was calculated.

Results

Results of this mixed method study are described in this section. Quantitative results are briefly provided first followed by the more detailed qualitative results that yield their first-person voices.

Quantitative Results

During the 10 weeks of the online focus group, participants provided 173 different posts, ranging from a low of 7 posts during first week (Introductions) to a high of 28 posts during the third week (barriers). Topics generating more than 20 different posts were Topic 3 (barriers), Topic 5 (most important activities), Topic 8 (recommendations for the mobile technology industry), and Topic 9 (recommendations for the AAC device industry).

Unfortunately, during week 4, one of the participants had to leave the focus group due to illness. All other participants, posted at least once during each of the weekly topics. However, the frequency of posts varied among participants, ranging from 1 post per topic to 8 posts per topic. Of note, one participant consistently posted more often than the others. Participants had the most to say, as measured by the total number of words per topic, about Topic 2 (Uses and Advantages of Mobile Technology) and Topic 8 (Recommendations for the Mobile Technology Industry). There was a large range in the number of words provided for each of the posts and by different participants. Number of words per post ranged from 0 words – a picture was used instead of words – to a high of 1,230 words per participant per post. Once again, although each participant contributed to each topic, one participant was more verbose than the others. Refer to Table 4 for a more detailed look at this quantitative analysis.

Table 4
Topics, Number of Posts per Topic, and Number of Words Per Topic*

Week &Topic	Number of Posts (Range/Participant)	Number of Words (Range/Participant
1. Introduction	7 Posts	596 words (Range = 9 to 507 words per participant
2. Use & Advantages of Mobility Technology	17 Posts (Range =1 post to 3 posts per participant)	2,160 Words (Range = 9 words to 507 words per participant)
3. Barriers in Using Mobile Technology	28 Posts (Range =1 post to 6 posts per participant)	1,934 Words (Range = 1 word to 1,024 words per participant)
4. Support Needed to Use Mobile Technology	16 Posts (Range = 0 to 2 posts per participant)	1,161 Words (Range = 6 words to 844 words per participant)
5. Most Important Activities Used	14 Posts (Range = 1 to 8 posts per participant)	1,563 Words (Range = 1 words to 747 words per participant)
6. Existing Accessibility Features Most Relied On	10 Posts (Range = 1 to 2 posts per participant)	979 Words (Range = 9 words to 507 words per participant)
7. Accessibility Features Still Needed	14 Posts (Range = 1 to 3 posts per participant)	536 Words (Range = 5 words to 253 words per participant)
8. Recommendations for Mobile Technology Industry	24 Posts (Range = 1 to 8 posts per participant)	2,342 Words + 3 Pictures (Range = 2 words to 1,230 words per participant)
9. Recommendations for AAC Industry	26 Posts (Range = 1 to 8 posts per participant)	1,896 Words + 3 Pictures (Range = 2 words to 964 words per participant)
10. Use of Intelligent Personal Assistants on Mobile Technology	17 Posts (Range = 1 to 4 posts per participant)	1,790 Words (Range = 13 words to 1,465 words per participant)
Totals	173 Posts	14,957 words

**Topics are provided in the Appendix*

Qualitative Results

Based on the results of the qualitative analysis using NVivo, 4 themes and 15 subthemes emerged when all 173 posts were analyzed. As shown in Table 5, these themes and subthemes align quite well with the 10 weekly topics. However, some additional subthemes emerged and are detailed below.

Table 5

Summary of Coding Themes and Subthemes (with frequency) and Illustrative Posts from Participants

Theme	Subtheme	Illustrative Posts from Participants
Use of Mobile Technology	Kinds of Mobile Technology Used (f = 9)	I use a iPhone and iPad daily – through the day
	Advantages: Effectiveness (f = 22)	I use my iPad for email, games, watching TV and talking on FaceTime
	Advantages: Efficiency (f = 10)	The advantages for me is having contact through text allows me to have the ability to answer questions of my employees instantly rather than waiting on someone to interpret or wait until I have my computer in front of me.
	Advantages: Use as a VOCA (f = 4)	I use it when my ACC device breaks because I can save entire files on it, which is necessary when I give speeches.
	Barriers: Physical Challenge (f = 15)	The biggest barrier that I found is the size of the keyboard. When my spasticity is at its highest peak, I will have my assistance type out a message for me.
	Barrier: Difficulty Using as a VOCA (f = 5)	Not being able to always pair my cellphone to my AAC device. sometimes it works fine, other times it doesn't pair.
	Use of Built-in Accessibility Features (f = 17)	AssistiveTouch allows me to lock the screen or turn the device off without using the power button, although there's no accessible way to turn it on again
Recommendations for Mainstream Mobile Technology and Specialized AAC Industries	Recommendations for Mobile Industry: Accessibility (f = 19)	I live alone and need immediate access to my phone for emergencies. Voice recognition software recognizing dysarthric speech would be awesome on so many levels -- forget about typing on a computer, AAC device, iPhone, iPad, etc. It would be so much faster and easier to use everything!
	Recommendations for Mobile Industry: Collaboration among Companies (f = 2)	… I would like to see more cooperation among companies without fearing secrets may get out…
	Recommendations for Mobile Industry: Universal Design (f = 19)	As to cell providers their [there] is little from my experience as far as accomodating [accommodating] our need for reasonable accomodation

		[accommodation].
	Recommendations for Mobile Industry: User Testing (f = 4)	… involve people with disabilities as testers.
	Recommendations for AAC Manufactures: Universal Design and Interconnectivity in AAC (f = 10)	I don't want to buy expensive things to get my AAC device to work with cellphones…inter-connectivity between AAC devices and technology should be errorless.
	Recommendations for AAC Manufacturers: Collaboration between Mobile and AAC Companies (f = 10)	… I would like to see is more Bluetooth connectivity between phones and [AAC] communication devices….”
	Recommendations for AAC Manufacturers: Creative Funding (f = 4)	We need to incentivize young thinking minds to develop AT solutions
	Need for Collaboration among people who use AAC (f = 11)	Can you set a delay on your phone to slow the keys down on your phone…?
Intelligent Digital Assistants (f = 11)		If we could get an Intelligent digital assistant to recognize a communication device, it would be game on.
Feedback/Social (f = 5)		I hope you share this information with various companies.

Theme 1: Use of mobile technology. Participants shared their experiences using their mobile technology. Based on the NVivo analysis, seven subthemes emerged: (1) kinds of mobile technology used, (2) advantages: effectiveness, (3) advantages: efficiency, and (4) advantages: use as a Voice Output Communication Aid (VOCA), (5) barriers to using mobile technology: physical challenges, (6) barriers to using mobile technology: difficulty using as a VOCA, and (7) use of built-in accessibility features.

Subtheme 1. Kinds of mobile technology used. Participants used a variety of mainstream mobile technologies in their everyday lives. For example, Matt and Heather use Apple iPhones. Ellen uses a Motorola Droid Maxx and Alex uses a Samsung Note 3. John uses various mobile devices, including HTC cell, Acer Android, and Microsoft Surface. Ashley uses a Nokia brick cell phone for phone calls, but she also uses an iPad. Three other participants also use Apple iPads. Among those four who use iPads, Julie has no other mobile technology for voice calling. Chris did not specify the kind of a mobile technology he uses. He did, however, indicate his reliance on wireless service (i.e., Google Project Fi).

Subtheme 2. Advantages of using mobile technology: Effectiveness (the degree to which their mobile technology accomplishes their desired tasks). Participants reported several advantages

of using their mobile devices. The majority reported that texting capabilities are the number one advantage. Julie noted that texting is her main method of communicating with everyone in her life. Ashley echoed Julie by saying, *"Your #1 is my #1 use of mobile technology."* Ellen also commented, *"The advantage for me is having contact through text allows me to have the ability to answer questions of my employees instantly rather than waiting on someone to interpret or wait until I have my computer in front of me."* In addition, Alex noted that texting capabilities were an advantage, *"…having the phone is the ability to text message or call my pca's [personal care assistants] while I am out in the community if i need something. We also set up schedules for my staff via text messaging."* He continued, *"Texting, I feel it is important to have this as way to communicate socially as well as a emergency".* These texting capabilities result in gaining confidence for participants. Matt specifically used the word, "confidence" when he commented, *"I have a greater confidence level. I feel like someone is with me at all times. I have a better sense of security."*

Participants shared other uses of their mobile technology. These include checking email, posting on Facebook, reading news, gaming, and using it as a Voice Output Communication Aid (VOCA). Matt shared his unique experience with the group. He uses his iPhone as an Environmental Control Unit (ECU) so that he can control his television and entertainment systems with his iPhone. John added his unique experience with his mobile technology. Due to the nature of his job, he is testing out a variety of devices, including mobile devices. He commented, *"In my work I have found no notable plusses in usage for people [with] physical, hearing, sight, articulation or cognitive issues."*

Participants noted other uses of their mobile technology. For example, Julie noted how she can effectively use FaceTime using her iPad. She explained:

> *"I use my iPad for email, games, watching TV and talking on FaceTime. FaceTime has opened a lot to me because my speech is impaired but I'm very understandable once you know me, but many people who understand me have a hard time understanding me on the phone because they read my lips. FaceTime solved that problem because now they read my lips when I call them".*

Ellen also expanded on the effectiveness in using of her mobile device when she noted that she *"is able to respond to emails without being in front of [her] computer."* Matt made a similar point: *"I enjoy using my iPhone to check both my email and Facebook rather than being glued to a computer station."* Additionally, Matt shared a personal experience with the group, *"Once I fell in my basement, I could easily text both of my parents to come over to get me off the floor. I live in a big house, and it would be nearly impossible to reach a telephone in certain areas."*

Participants also described the use of their mobile technology for entertainment, such as

camera/videoing capabilities (Matt, Alex, Chris), browsing the web for local restaurant deals (Ashley), playing games (Julie), and Twitter (Chris). John also described how he uses his technology regarding his work environment when stating, *"electronic equipment of mixed sorts is helpful in keeping up to date and mentally viable. Input devices that fit my multi disabilities and note taking devices are the most helpful as are authoring software devices that bring information into a functional format for others to use."*

Subtheme 3. Advantages of using mobile technology: Efficiency. In addition to describing the effectiveness using mobile technology, participants commented on its efficiency in achieving desired tasks with minimum effort and not having to rely on others. Several participants discussed the timeliness that texting enables when using their mobile devices. For example, Ellen posted, *"having contact through text allows me to have the ability to answer questions of my employees instantly rather than waiting on someone to interpret or wait until I have my computer in front of me."* Heather shared a similar thought, *"It also is good and bad for instant access to email and texts and work - although that is common for most people now. Smile emoticon."* Heather noted, *"the biggest advantage is being able to talk to people on the spot even when I don't have pen or paper…or my laptop."*

Subtheme 4. Advantage: Use as a VOCA. Several participants noted that use of mobile technology as a VOCA was a definite advantage. Ashley uses her *"Proloquo2Go app installed on her iPad when her [specialized] AAC device dies or she gets tired of carrying her heavy AAC [device].* Julie confirmed that she also uses her iPad as a VOCA. She described in detail the two apps installed on her iPad:

> *"I have a couple AAC apps on it. One's called Assistive Express and the other is Voice 4 U Text to Speech. I have them both because Assistive Express has a very good voice and the ability to store phrases, but its word prediction is horrible. Voice 4 U uses Apple's word prediction, which is the best I've seen, but its voice isn't so great and you can't store text on the free version. Although Co:Writer isn't technically an AAC app, I bought it thinking it might have better word prediction than the IOS word prediction but it doesn't. Now I use it when my ACC [AAC] device (a Tobii C8) breaks because I can save entire files on it, which is necessary when I give speeches.*

Subtheme 5: Barriers to using their mainstream mobile technology due to their physical challenges. Although participants described the many advantages to using mainstream mobile technology, they also identified a major barrier being that manufacturers have not adequately addressed their physical challenges.

Several participants noted that a touchscreen is hard for them to operate mainstream mobile

technology using direct selection because of their physical limitations. Ashley described this saying,

> *"The biggest barrier that I found is the sensitivity of the iPad screen. You have to be so precise when hitting the buttons. You also have to be very still and not have jerky movements. Spastic cerebral palsy equals jerky movements for me."* John noted similar concerns: *"notably all handheld, vocal and digit (finger) driven devices are a challenge".*

Matt supported Ashley and John's comments. He shared that

> *"At times I do wish I had an alternative key layout with bigger buttons and perhaps more flexibility when it comes to the sensitivity. It isn't just me, but I know some guys with big hands and these key layouts are hard to navigate."*

Interestingly, Matt described how he overcame access limitations after he eventually developed the necessary motor planning, even though it was nearly impossible to do anything when he first began using his mainstream mobile technology. However, he noted that *"highlighting text on my mobile tech is still tricky."*

Two participants were especially concerned about the onscreen keyboard on their mobile phones. Ellen wrote, *"The biggest barrier that I found is the size of the keyboard. I use the Google keyboard which has word prediction. When my spasticity is at its highest peak, I will have my assistant type out a message for me."* John asserted that all smartphones have useless keyboards. He shared his unique challenges with the group, *"I have significant issues with functioning mobility and need a stabilizing unit to secure phones and IPads."* He added,

> *"As a person with hemi-paresis my leg is semi-mobile with one of my arms and one hand significantly impaired plus my stroke impairment was to my major [left] arm and hand so writing and drawing are extremely difficult. My speech disarthria has left me with a very hard to render to voice for speech engines to parse."*

<u>*Subtheme 6: Barrier to using mainstream mobile technology as a VOCA.*</u> Even though participants frequently commented that their mobile technology can be used as a VOCA and this is one of the chief advantages of using mobile technology, they also pointed out that there are also significant difficulties using their mobile device as their VOCA due to its weak built-in speaker volume. For Heather, this was the only barrier she faced. She said, "*Probably the biggest problem - and one of the only ones - is the noise factor. If I am in a noisy environment, it can be almost impossible to play my voice app and have it heard."* Julie and Matt agreed with Heather's concern. Julie stated that, "*there's no way people can hear my device [mobile technology] on*

the bus". Matt also agreed with Heather, but noted that he has been pleased with the speaker quality of the iPhone.

With regard to the weak built-in speakers in mainstream mobile technology, John suggested that, based on his experience, *"the use of blue tooth portable speakers can push up the volume".* Heather cautioned that, *"Portable speakers are great but it's not something you just pull out of your pocket at the sidelines of an indoor soccer game, or as you are walking through an airport. Smile emoticon".* In addition, Alex cautioned about using a Bluetooth speaker because the pairing (that is, connecting the mobile device to a portable speaker) doesn't always work.

Subtheme 7. Use of built-in accessibility features. Several participants shared how they effectively use some of the more recent built-in accessibility features on their mobile technology. Julie, Matt, and Ellen use Sticky Keys, which allows a user to press a combination of keys (e.g., Ctrl+Alt+Del) one by one without needing to press more than one key simultaneously. In addition to Sticky Keys, they also highlighted their use of Word Prediction. Matt added that he sometimes uses Speak, *"where you select any text and have it spoken to you."* Chris wrote that he uses Apple Mac Dictation, a speech recognition software.

Julie uses Assistive Touch on her iPad because it *"allows me to lock the screen or turn the device off without using the power button… With Assistive Touch you can also access multitasking, rotate the screen, do a triple click for the home button."* Alex uses the Assistant menu on his Note because it allows him *"quick access to important functions"*. He suggested to Ellen that she set a delay to slow the keys down on her phone when she expressed her concern about difficulty typing a message on her phone when her spasticity is high.

Theme 2: Recommendations. When the participants were asked about their recommendations for technology developers so that they can use mainstream mobile technology more effectively and efficiently, they shared their excitement about making recommendations to both the mainstream mobile industry as well as AAC manufacturers. John illustrated this excitement in his post, *"Finally, wink emoticon…."*

Four subthemes emerged that focused on recommendations for the mainstream mobile technology industry and three subthemes emerged that focused on recommendations for AAC manufacturers. In addition, participants recommended the collaboration among people who use AAC.

Subtheme 1. Recommendations for mobile technology industry regarding accessibility. The first suggestion related to accessibility issues. As noted earlier, participants pointed out that a touchscreen is hard for them to operate their mobile device because of their physical limitations. Based on their experiences, they proposed several recommendations. The first recommendation

is that mobile devices be provided with a variety of alternative access methods, including joystick/mouse, switch scanning, speech recognition, and alternative keyboard layout. Matt, Ashley and Julie noted that it would be great if they could use a joystick/mouse so that they would have more control and precision. Specifically, Matt posted that he *"dreamed one day we could use our wheelchair joystick to control various devices. Let's face it, why do we need duplicates of things, we just need to figure out how to switch functions. I feel that day is coming."* In addition, Ashley also wanted to use switch scanning as an alternative access method as did John.

Julie, Ashley, and John recommended better speech recognition software as an alternative access method. Julie posted, *"Voice recognition that understands people with speech problems would be awesome. Then I wouldnt type so much, which would relieve some of my pain which is caused by repetitive movement."* Ashley agreed with Julie's recommendation.

An alternative keyboard size or layout was also recommended. Ellen and Matt commented that they wanted to see a bigger onscreen keyboard and/or different keyboard layout. John offered the following recommendations:

> *"… an app that could resize and re sensitize the touch of keyboards the same way Windows resizes icons. Also a feature, which resizes browsers and has show hide features for controls. There is no reason why these features can't be programmed in".*

John also recommended that *"different pieces of access technologies could be connected wirelessly so that different access modes"* such as switch activation, joysticks, or different keyboards could be connected to their mobile devices. He lamented, however, that the current *"wireless technology can be problematic if the Bluetooth connection does not function well as it is supposed to work."*

There was agreement that better Bluetooth connectivity needs to be developed, recognizing that Bluetooth depends on the compatibility of various mobile devices and various AAC devices. Matt stated that, *"As a consumer, I would love to see more of these Bluetooth [enabled] phones capable of working with communication devices."*

<u>*Subtheme 2. Recommendations for mobile technology industry regarding using principles of universal design.*</u> In this subtheme, John provided several ideas about how technology can be used effectively and efficiently by anyone regardless of socioeconomic status, disability etc. His recommendations are examples of principles of Universal Design. He posted that,

> *"We should think in terms of universality …value for all or at least as many as far*

> *a devices go and become the vendors of the new and greatest things since sliced bread that everyone likes and could use to ease their lives."*

Similarly, Heather shared her own experiences and recommendations about the need for the compatibility among different mobile devices using principles of universal design. She noted,

> *"I was thinking of how certain apps are only available for iPhone vs android and so we are forced to choose app vs device in some cases (at least when I first was looking at tablets while testing the AAC apps too...I wanted a specific voice AND I liked features on a Samsung, but the best AAC apps were only for IPads at the time."*

She recommended *"having apps available across all kinds of mobile devices would be beneficial to the end user."* John also commented about the need for compatibility among mobile devices by giving a specific example:

> *"PC's and Apples should be interchangeable software wise as one has great this while the other has great that and we are left in the middle with not ready for prime time solutions that do one thing very well and the other poorly. We should be looking at software that is PC, MAC, Android and IOS/Apple compatible…*

Subtheme 3. Better collaboration among mobile technology companies. The third subtheme stresses the importance of collaboration resulting in compatibility among mobile devices. It also relates to the universal design subtheme. In order to develop universal technology that would be compatible with all of the platforms, Matt asserted that he would also like to see more cooperation among companies. He shared his experience with the group and offered recommendations specific to the mainstream mobile industry:

> *"Again, I would like to see more cooperation among companies without fearing secrets may get out. For an example, my communication device can only work with certain cell phones and not others. If you ask me, this is awfully unfair to the end consumer. By closing more of this gap wouldn't only help the end consumer it would help companies as well."*

Similarly, John recommended that various technology industries share *"open source software"* with each other.

Subtheme 4. Recommendation for mobile technology industry regarding user testing. These recommendations focused on the importance of more inclusive user testing. Alex noted, *"They* [mobile industry] *should involve people with disabilities as testers."* Ashley, Julie and Ellen voiced

agreement with this recommendation. Matt added, *"It's about time that consumers have a choice on what features to add to devices instead of always the establishment."*

Subtheme 5. Recommendations that AAC manufacturers use principles of universal design and interconnectivity. In addition to recommendations for the mainstream mobile technology industry, participants also offered recommendations targeted to the specialized AAC device industry. These recommendations focused on better interconnectivity and interoperability between their AAC and mainstream mobile technology devices.

Using principles of universal design was not just relevant for the mobile technology industry. Specific recommendations for AAC manufacturers focused more on "unlocking" specialized AAC devices so that they could be more multi-functional and universal, rather than solely maintaining a specialized AAC system that fits the funding requirements of medical insurance.

When Matt shared his hope for more compatible Bluetooth connectivity between his mobile phone and his specialized AAC device, Julie agreed with him. However, she raised the concern that medical insurance would not pay for such AAC devices because *"insurances are not even paying for dedicated AAC devices that can be unlocked now."* Matt replied to her concern,

> *"This is true, however once the communication device reaches the end consumer the device can be unlocked… Getting to the Bluetooth connectivity, I don't see why it couldn't be sold as a separate component. Let's face it, over the years, needs/wants have changed. Sure, 2 decades ago a cell phone was a want but today it's a need. Things change over time, and people need to adapt… It has gotten so bad that they can't even ship a communication device with the calculator functioning. I believe they have now lightened on that as well."*

Julie agreed with Matt's comment. Ashley further recommended that "*inter-connectivity between AAC devices and* [mainstream mobile] *technology should be errorless…. user friendly and simple-to-use."*

Matt shared his hopes that his specialized AAC device would be a universal mobile technology *("like an all-in-one device")*, with which he can do everything. He has *"been disappointed with some of the AAC companies for not fully engaging with the mobile industry."*

Subtheme 6: Collaboration between the specialized AAC and the mainstream mobile industries. In order to develop AAC devices based on principles of universal design, several participants recommended that AAC manufacturers collaborate with the mainstream mobile technology industry. Matt hopes *"to see more companies working together instead of trying to reinvent the wheel."* Similarly, John suggested that:

> *"We need to stimulate collaboration and collegial development. The key is in better components that plug and play with everything else assistive, like boards, nails, screws, glue and paint create houses. Better and more interchangeable components are what AT needs to build architecturally correct and aesthetically pleasing systems for independent living, recreation and work."*

In addition to Matt and John, Ellen suggested that AAC manufacturers need a way *"to interface the voice of the AAC devices to smartphones so people can hear better."* Alex agreed with Ellen making similar points: *"I agree. When i make the call from my AAC device, i have to go to another menu on my device to turn the mic* [microphone] *on."*

<u>*Subtheme 7. Creative funding.*</u> Matt and John discussed the need for creative funding to address some possible technology solutions. John started this conversation:

> *"We need to incentivize young thinking minds to develop AT solutions. Imagine if we could stimulate and incentivize Stanford and MIT students to take on the project of enabling people with disabilities to normalize and become enabled to work and live independently without seeking people to make this happen. Think in terms of an AT tech[nology] super bowl with fame and fortune as the prize of a status symbol for the winner say for instance a BMW... All tech gains would be up for development and the innovator would reap the reward of a royalty on sale. The total cost would be under $100K for R&D rather than $1 - 2 MM* [million] *for corporate development. Hundreds of very bright new product developers could be stimulated in the production of AT innovations and some would be moved to select development as a career."*

Matt responded to John's post noting that the Gates Foundation "*does outstanding work in all fronts of humanity."* He added that, *"We need more foundations like theirs who are dedicated to research and development, a place where they aren't overly concerned about their bottom line."* John responded that the Christopher Reeves foundation "*focused on AT solutions before and after Christopher died."* He also noted that there are *"other socially responsive foundations and big corporations, such as GE, Facebook etc."* He suggested:

> *"If the right presentation was put in place, I think a million dollar funding would go a long way to focus in on solutions to needs using great young minds to engineer solutions to the fundamental needs like seeing eye actavation, physical manipulation, speech improvement, hearing solutions to communications, stress free work for people with mental health and brain injury needs, robotic PCA devices enabled homes, cars, highly improved…chairs that make your journey fun and pleasant etc."*

Matt responded to John's post:

> *"I don't know if this happens in your community, but we have lego/robotics clubs for children. They do a couple of competitions throughout the year. The goal is to inspire kids in science, mathematics and engineering. They also have a little bit of fun as well. My point is if we want change it starts with today's youth."*

Subtheme 8. Collaboration among people who use AAC. Not only did the participants offer recommendations for mainstream and specialized technology industries, their discussions and suggestions pointed to the need for collaboration among people who rely on AAC, themselves. For example, when Heather showed her concern about the use of a portable speaker because it might not be handy by saying: *"it is not something you just pull out of your pocket at the sidelines of an indoor soccer game, or as you are walking through an airport. Smile emoticon"*, John provided a suggestion:

> *"Not unless we tend to have deep pockets ;-). There are some clip on adapters that could help but my thought that short of wearing a solar cell hat or backpack the energy would deplete rather quickly. On that thought supplemental portable keyboards with batteries can extend battery life on Ipads, android and MS mini systems."*

When Ellen posted that her biggest barrier is the size of the keyboard in her mobile device, John suggested that she can *"buy oversized vinyl keys with sticky backs."* Additionally, John provided other suggestions to other participants, such as better speech recognition feature (i.e., MS 10 Cortana), better portable keyboard from Asus, using his iPad as a mouse for his 32" monitor, etc.

In addition to John, other participants shared possible solutions with others on different issues. Similarly, when Ashley said that her biggest barrier when she uses her iPad is the sensitivity of the iPad screen, Matt replied by sharing his experience: *"When I first began using my iPad and iPhone, it was nearly impossible to do anything but eventually I developed the necessary motor planning."* Additionally, Alex suggested that it might be helpful if she set a delay on her phone *"to slow the keys down"*, when Ellen shared her difficulty using her mobile technology because of her high spasticity.

Although not explicitly recommended by participants, *"collaboration among people who use AAC"* emerged as a subtheme. Throughout the 10-week focus group, several participants suggested solutions for difficulties expressed using mainstream mobile technology. Like other online technology user groups, such as Google user groups, iPhone and iPad user groups, a user group could be established to support consumers of mobile technology who rely on AAC.

Theme 3. Intelligent digital assistants. Current smartphones include Intelligent Digital Assistant (IDA) software (e.g., Siri, Google Now, Cortana, and Alexa). Six of the 8 participants had some experience with intelligent digital assistants on their mainstream mobile devices. Heather was aware of iPhone's Siri, but she remarked that she never tried to use it. Ashley noted that she did not know anything about intelligent digital assistants.

The majority of participants who have tried this feature on their mobile device lamented that it was not effective because of their speech limitations. For example, Alex said, *"I have played with Siri and Google [Now]. However, it does not understand me well enough to use."* Julie also commented that Siri couldn't understand her. She mentioned that she used Siri with entertaining results and shared her Siri experience with the group: *"I've talked to Siri just for laughs because it can't understand me and it's fun to see what it makes up from want I said."*

Matt has tried Siri using the synthesized speech built into his AAC device, instead of his natural speech, to operate his mobile device. He reported that Siri sometimes understood the synthesized speech of his AAC device, but other times it did not. He also noted: *"I have always meant to explore different settings to see if that would make a difference… If we could get an Intelligent* [digital] *assistant to recognize a communication device, it would be game on."* Julie commented that she has heard that they *"understand the synthesized speech better than it understands people."* However, Ellen noted that Google Now could not understand her voice or the synthesized speech on her AAC device.

John posted that he has tested various Personal Digital Assistants, including Siri, Dragon, Alexa and Cortana. He reported that he is impressed with Cortana and uses it on his desktop PC. Chris reported that he uses Dragon Mobile Assistant for his Android device, and the combined use of Dragon, Swype, a 3rd party onscreen keyboard, and Google apps is "amazing!!!" He wrote, *"Everything is perfect…Anything you want, I speak about there is a lot of things and a computer listens and writes."*

Theme 4. Feedback/social. The final theme that emerged from the NVivo analysis is comprised of participant feedback or social comments to each other or about the Facebook focus group process. Although not totally relevant to the purpose of this study, it does provide some insight into the benefits of using online focus groups as potential sources for gathering important "first person" information and collaborating with each other. The first interchange focused on the purpose of the focus group. John began by expressing concerns about the goals and objectives of the focus group, by stating

> *"…in pouring out our experience and wisdom for weeks there has been little said by you as to your goals and objectives in this exercise. Hint, a little understanding about what you seek to accomplish and how we fit in would be nice as would be*

> *input into whether we are being helpful in assisting and shaping your goal and who will benefit from this. You have gleaned much information and intellectual property information in the process. So isn't it about time for us to know what we are doing this for and whether our contribution is on target, useful or needs work;-).”*

Alex responded to John’s concern by providing the following feedback, *“Diane* [first author] *has explained the purpose to us. There are no right or wrong answers.”* John then responded by noting

> *“I am sorry Alex, I must have missed that briefing. But also significant would be feedback on how we are assisting in advancing her … objectives. I agree that there are no right or wrong answers in many such processes but the stimulus of ideas and directions is in most cases critical to meaningful research!”*

Social comments were also provided during the 10-week focus group. An example is Ashley’s expression of frustration. *“Some people are clueless, even in the disability-field, persons with AAC devices also use mobile devices. ‘Oh wow! You text?’ ‘Yes, I live in the 21st century. Lol’”* and Matt’s culminating hope, *“I hope you share this information with various companies. It's about time that consumers have a voice….”*

Discussion

Summary of Findings and Recommendations

During the 10-week online focus group, the quantity and quality of the posts were not consistent and informative. Participants provided 173 different posts focusing on 10 different topics relevant to mainstream mobile technology and individuals who use AAC. This is impressive given that each of the participants has complex communication needs including physical impairments resulting in limitations in mobility and use of their hands. Every participant contributed to every weekly topic.

Qualitatively, their posts were rich in content generating 4 themes and 15 subthemes emerging from the NVivo analysis. Although, participants used a variety of mainstream mobile technologies, their experiences and recommendations were quite similar. Texting was the most frequent use of their mobile devices noting that this was their “*main method of communicating with everyone”.* This finding is consistent with how other populations with disabilities (Morris, Sweatman, & Jones, 2017) and with how adults in the general population use their mobile technology (Pew Research Center, 2015). Like many others with and without disabilities, texting was used for social, work-related, and safety purposes. Participants in this study also noted that the use of texting provided them with a sense of security and confidence.

Like other populations reported by Morris et al (2017) and the Pew Research Center (2015), participants used their mobile technology for checking email and connecting with others through social media, reading news and obtaining information, and for entertainment and gaming. Unique to this population, however, was the frequent use of their mobile devices as a VOCA. One participant noted that her mobile device was used *"when her AAC device dies or she gets tired of carrying her heavy AAC [device]."* Another participant noted "*I can save entire files on it, which is necessary when I give speeches".*

Although participants described the many advantages of using mainstream mobile devices, they also shared the barriers that they encountered when using it. Physical challenges were foremost when attempting to use the touchscreen. This barrier was best summarized by John, "*notably all handheld, vocal and digit [finger] driven devices are a challenge."* Barriers to effective and efficient use of their mobile devices included inaccessible standard keyboard layouts, touch screen sensitivity, the size of the keyboard, and the inability of Intelligent Digital Assistants to recognize their dysarthric speech or the synthesized speech of their VOCA. Weak built-in speaker volume was another barrier for those who use their mainstream mobile device as a VOCA.

Participants had a wealth of recommendations for both the mainstream mobile technology and the specialized AAC industries. For mainstream mobile technology industries, they recommended providing alternative access methods such as an inter-operable joystick or mouse, alternative keyboards, switch scanning, alternative keyboard layouts, and more robust speech recognition software. One participant recommended "*an app that could resize and resensitize the touch of keyboards the same way Windows resize icons."* Another recommendation was better Bluetooth connectivity between their specialized AAC device and their mainstream mobile technology. It should be noted that no one recommended the need for new, perhaps expensive, hardware but rather improvements in less expensive and easily downloadable apps using principles of universal design. Participants also recommended that apps be designed so that they can be used interchangeably with different mobile technology platforms (e.g., iPhone, Android). In fact, one participant proposed, *"various technology industries share open source software with each other".*

Another recommendation was for the mobile technology industry to include people who use specialized AAC technologies in user testing of new mainstream technologies. Only then will *"consumers have a choice on what features to add to devices…"*

Recommendations for the manufacturers of specialized AAC devices paralleled in many ways those made to the mainstream mobile technology industry and focused on using principles of universal design. Specifically, it was recommended that AAC manufacturers" unlock" their AAC devices so that they can be more multifunctional and robust, rather than solely provide specific

features to enable face-to-face communication. Additionally, building in better Bluetooth capabilities into AAC devices so that they are inter-connective with computers and mainstream mobile technologies would ensure better interoperability between specialized AAC devices and mainstream mobile devices. Participants summarized these recommendations by stating that "*interconnectivity between AAC devices and technology should be errorless… user-friendly and simple to use."*

In summary, participants recommended better collaboration between the mobile technology and AAC industries. In order to accomplish more fruitful collaborations, creative funding was recommended. The participants provided several examples. Of note were (1) incentivizing Stanford and MIT students to come up with more inclusive mobile technology designs and (2) reaching out to major stakeholders in information and communication technologies and who might support the development of future mobile technologies that are more accessible and useable by people who have complex communication needs and use AAC technology.

Not only did participants recommend collaboration between mainstream mobile technology and AAC manufacturers, collaboration among people who use AAC emerged as a recommendation. Throughout the focus group, participants shared their experiences and suggestions with each other, thus providing informed first-person solutions to barriers encountered by others. As knowledgeable consumers of mainstream mobile technologies, a consumer group could be established to support others who wish to use mobile devices more effectively and efficiently.

Finally, participants noted the potential of IDAs to enhance access to and more effective use of mobile technologies. Two recommendations emerged from their posts. The first is to improve the speech recognition capabilities of current and future IDAs so that they can be trained to understand the dysarthric speech of people who have complex communication needs. The second recommendation is to determine how the speech synthesizers used most commonly on AAC devices can be better understood by current and emerging speech recognition software in mainstream mobile devices. One participant noted, *"If we could get an intelligent personal assistant to recognize a communication device, it would be game on."*

Limitations

This online focus group has provided a rich source of information and recommendations. However, it must be noted that the participants do not represent the larger population of adults with complex communication needs. Participants were literate, generally well educated, had the physical capabilities to use their hands to directly access their mobile devices and to participate on a web-based online focus group. Given that this sample may not be representative of the larger population of individuals who rely on AAC, the recommendations of this study should be applied with some caution.

It is important to note here that conducting a focus group comprised of adults with complex communication needs who use AAC, while so important in providing their first-person voices, pose significant challenges. First, this population is a low-incident one. Prevalence rates range between 0.2% and 1.5% of the overall population (Beukelman & Mirenda, 2013). Furthermore, due to their accompanying motor disabilities, travel to one place where a focus group could be held is extremely difficult, if not impossible. Finally, it has been estimated that up to 90% of adults who use AAC lack functional literacy skills (Foley & Wolter, 2010). This further restricts options needed for online communication. These were major challenges to obtaining a representative sample for research to inform the mobile technology industry as well as policy makers.

Conclusions: Outcomes and Benefits

This final section describes the major outcomes and benefits of this research relevant to the four targeted audiences.

Outcomes and Benefits for the Mainstream Mobile Technology Industry

Given the first-person accounts of the uses, barriers and recommendations provided by this study, the mainstream mobile technology industry could incorporate these design features to improve accessibility and usability. Four concluding outcomes based on this study are provided.

1. All smartphones and tablets should include built-in accessibility features relevant to people with complex communication needs are not limited to, device access (e.g., switch control, assistive touch), touch accommodations for touch screen (e.g., hold duration, tap assistance), keyboard layouts (e.g. size and organization), and word prediction.
2. Bluetooth in all cell phones, smartphones and tablets should be interoperable with specialized AAC devices, external amplifiers and speakers, and external keyboards. Reliability in pairing mobile technology with Bluetooth-enabled specialized devices is necessary.
3. The volume of the speech output in mainstream mobile devices must be louder in order to be heard in noisy environments.
4. Research and development should focus on better speech recognition software. This includes speech recognition software that is compatible with speech synthesizers most frequently built into specialized AAC devices. Additionally, improved speech recognition software may also be able to parse the dysarthric speech of many individuals with CCN.
5. In order to address these recommendations, collaboration with the specialized AAC device companies is needed.

Outcomes and Benefits for the Specialized AAC Device Industry

Three outcomes of this research would benefit the specialized AAC industry in designing specialized AAC devices that would improve interoperability and interconnectivity with mainstream

mobile devices.

1. Specialized AAC devices should ensure that their Bluetooth capabilities are compatible with Bluetooth-enabled mainstream mobile devices. If they were, it would benefit the end user to know this. Manufacturers of AAC devices can mark the Bluetooth logo and registered trademark on their AAC devices and supporting material advising consumers to only purchase wireless technology that carries this logo:

2. Speech synthesizers in AAC devices should be compatible, where possible, with the speech recognition software used in mainstream mobile technology.
3. In order for these outcomes to be realized, collaboration with mainstream mobile technology companies is essential.

Outcomes and Benefits Relevant to Policy Makers

By law, all mobile technology must be accessible to and usably by people with disabilities. Section 508 of the Rehabilitative Act of 1973 applies to the accessibility of hardware and software. Section 255 of the Telecommunications Act specifies that telecommunications equipment and customer service shall be accessible to and usable by individuals with disabilities. Most recently, the Twenty-first Century Communication and Video Accessibility Act of 2010 was enacted to ensure that people with disabilities have access to the modern and innovative communications technologies of the 21st-century. Based on these three Acts, through proactive monitoring policy makers must ensure that accessibility and usability of mobile technology address the needs of people who have complex communication needs and who rely on AAC.

Outcomes and Benefits Relevant to People Who Use AAC

Individuals with complex communication needs who use AAC must become knowledgeable consumers about both their specialized AAC devices and desired mobile technology. It is hoped that the information provided by this study will arm them with information needed to be an informed consumer.

Additionally, connecting with others who have experience using both specialized and mainstream technologies can provide supports in locating accessibility features that are already built into mainstream mobile technologies. When needed, they can also be a collective voice in advocating for needed change.

The results of this study provide a powerful first-person voice needed to ensure equal access to mainstream mobile technologies by adults who use AAC. This is an important step in bringing the benefits of the digital age to all, including those with complex communication needs. Technology development and expertise exists. Research and development must now ensure that

"accessibility and usability are applied early and throughout the development and manufacturing of specialized AAC and mainstream mobile technology devices" (LaForce, 2017).

Declarations

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References

Beukelman, D.R. & Mirenda, P. (2013). *Augmentative & alternative communication: Supporting children and adults with complex communication needs, Fourth Edition,* Baltimore: Baltimore: Paul Brookes Publishing Company.

Bornman, J., Bryen, D.N., Moolman, E., & Morris, J. (2016). Use of consumer wireless devices by South Africans with severe communication disability. *African Journal of Disability.* 5(1), 1-9.

Bryen, D.N., Carey, A., & Potts, B. (2006). Technology and Job-related social networks. *Augmentative and Alternative Communication*, 22,1–9. doi:10.1080/07434610500194045 PMID:17114154

Bryen, D.N., & Moolman, E. (2015). Mobile phone technology for all: Towards reducing the digital divide. In Z. Yan (Ed.), *Encyclopedia of mobile phone behavior* (pp. 1456-1470). Hershey, Pennsylvania: IGI Global.

Bryen, D.N., & Pecunas, P. (2004). Cell phones and people who use AAC: One off-the-shelf solution and some policy considerations. *Assistive Technology*, 16(1), 11–17. doi:10.1080/10400435.2004.10132070 PMID:15357145.

Caron, J., & Light, J. (2015). Social media has opened a world of 'open communication' experiences of adults with cerebral palsy who use augmentative and alternative communication and social media. *Augmentative and Alternative Communication*, Early Online, 1-16.

Center for an Accessible Society (2014). Disability and the digital divide. Retrieved from http://www.accessiblesociety.org/topics/webaccess/digitaldivide.htm.

Duchastel de Montrouge, C. (2014). Review of disability and new media. *Canadian Journal of Disability Studies, 3,* 135-141.

Foley, A., & Ferri, A. (2012). Technology for people, not disabilities: Ensuring access and inclusion. *Journal of Research in Special Educational Needs, 12,* 192.

Foley, B.E., & Wolter, J. (2017). Literacy intervention for transition-aged youth: What is and what could be. In D.B. McNaughton & D.R. Beukelman (Eds.) Transition strategies for adolescents and young adults who use AAC (pp. 35-68). Baltimore: Paul Brookes Publishing Company.

Kitzinger, J. (1995). Qualitative Research: Introducing focus groups. *British Medical Journal*, 311, 299- 302.

LaForce, S. (2017). *Strategies to effect policy change.* Paper presented at the 32nd CSUN Assistive Technology Conference San Diego, California – February 27 - March 4, 2017.

McNaughton, D., & Light, J. (2013). Editorial: The iPad and mobile technology revolution: Benefits and challenges for individual who require augmentative and alternative communication, *Augmentative and Alternative Communication, 29*, 107-116.

Morris, J.T., & Bryen, D.N. (2015). Access to and use of wireless mobile technologies by adults who use AAC. *Journal on Technology and Persons with Disabilities, 3,* 101-115.

Morris J., Mueller, J., Jones, M.L., & Lippincott, B. (2014). Wireless technology use and disability: Results from a national survey. *Journal on Technology and Persons with Disabilities, 1,* 67-77.

Morris, J., Sweatman, M., & Jones, M. (2017). *Smartphone use and activities by People with Disabilities: User Survey 2016.* Paper presented at the 32nd CSUN Assistive Technology Conference San Diego, California – February 27 - March 4, 2017.

Nguyen, T., Garrett, R., Downing, A., Walker, L., & Hobbs D. (2008). An interfacing system that enables speech generating device users to independently access and use a mobile phone. *Technology and Disability*, 20, 225-239.

Pew Research Center (2015). *Cell phones in Africa: Communication lifeline*. Retrieved from http://www.pewglobal.org/2015/04/15/cell-phones-in-africa-communication-lifeline.

QSR International (2015). What is NVivo? Retrieved from http://www.qsrinternational.com/what-is-nvivo on March 8, 2017.

QSR International (2015). Retrieved from http://www.qsrinternational.com/about-us/history on March 8, 2017.

Rehabilitation Act of 1973, Section 508. Retrieved from http://www.section508.gov on July 16, 2017.

Shane, H., Blackstone, S., Vanderheiden, G., Williams, M., & DeRuyter, F. (2012). Using AAC technology to access the world. *Assistive Technology*, 24, 3 – 13.

Strauss, A., & Juliet, C. (1994). Grounded Theory Methodology: An Overview. In N. Denzin & Y. Lincoln *Handbook of Qualitative Research. 1st ed.* (pp. 273–284).

Telecommunications Act, Section 255. Retrieved July 16, 2017 from https://www.fcc.gov/consumers/guides/telecommunications-access-people-disabilities

Twenty-first Century Communication and Video Accessibility Act. Retrieved July 16, 2017 from https://www.fcc.gov/consumers/guides/21st-century-communications-and-video-accessibility-act-cvaa

United Nations. (2006). United Nations convention on the rights of persons with disabilities. Retrieved from https://www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities.html.

Appendix A: List of Weekly Topics

Week 1: Introductions and Procedures

Week 2: Advantages and Importance of Using Mobile Technology

Week 3: Barriers of Using Mobile Technology

Week 4: Supports You Need for Using Mobile Technology

Week 5: The 3 Most Important Activities You Use Mobile Technology

Week 6: Accessibility Features You Rely on the Most

Week 7: Accessibility Features Still Needed

Week 8: Recommendations for developers and manufacturers

Week 9: Recommendations for AAC device developers and manufacturers

Week 10: Use of Intelligent Digital Assistants *(e.g.,* Siri, Google Now, Cortana)