Self-Conscious or Self-Confident? A Diary Study Conceptualizing the Social Accessibility of Assistive Technology

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With the recent influx of smartphones, tablets, and wearables such as watches and glasses, personal interactive device use is increasingly visible and commonplace in public and social spaces. Assistive Technologies (ATs) used by people with disabilities are observable to others and, as a result, can affect how AT users are perceived. This raises the possibility that what we call "social accessibility" may be as important as "functional accessibility" when considering ATs. But, to date, ATs have almost exclusively been regarded as *functional* aids. For example, ATs are defined by the Technical Assistance to the States Act as technologies that are "used to increase, maintain or improve functional capabilities of individuals with disabilities." To investigate perceptions and self-perceptions of AT users, we conducted a diary study of two groups of participants: people with disabilities and people without disabilities. Our goal was to explore the types of interactions and perceptions that arise around AT use in social and public spaces. During our 4-week study, participants with sensory disabilities wrote about feeling either *self-conscious* or *self-confident* when using an assistive device in a social or public situation. Meanwhile, participants without disabilities were prompted to record their reactions and feelings whenever they saw ATs used in social or public situations. We found that AT form and function does influence social interactions by impacting self-efficacy and self-confidence. When the design of form or function is poor, or when inequality between technological accessibility exists, social inclusion is negatively affected, as are perceptions of ability. We contribute a definition for the "social accessibility" of ATs and subsequently offer *Design for Social Accessibility (DSA)* as a holistic design stance focused on balancing an AT user's sociotechnical identity with functional requirements.

Categories and Subject Descriptors: K.4.2 [**Computers and Society-Social Issues**]: Assistive Technologies for Persons with Disabilities

General Terms: Design

Additional Key Words and Phrases: Accessibility, functional accessibility, social accessibility, product design, interface design, interaction design, stigma, social interactions, assistive devices, assistive technologies, AT, abandonment

ACM Reference Format:
Kristen Shinohara and Jacob O. Wobbrock. 2016. Self-conscious or self-confident? A diary study conceptualizing social accessibility of assistive technology. ACM Trans. Access. Comput. 8, 2, Article 5 (January 2016), 31 pages.
DOI: http://dx.doi.org/10.1145/2827857

1. INTRODUCTION

People with disabilities use Assistive Technologies (ATs) when access is impeded; for example, those who are blind may use an AT to help navigate a website, or those who are deaf might use video communication on cell phones. At the same time, mobile technologies are increasingly popular, resulting in the proliferation of technology use in public observable social spaces, including the use of ATs. Personal technologies such

This is supported by the National Science Foundation, under grants IIS-0952786 and IIS-1230435.
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DOI: http://dx.doi.org/10.1145/2827857

Fig. 1. Left: The VictorReader Stream (VRS), a digital music player for the visually impaired that also plays audio books. Right: A mainstream counterpart, the Apple iPad Air, allows users to play music, read books, and interact with many other kinds of digital content.

as laptops, tablets, cell phones, and wearable technologies such as glasses and smart watches permeate modern society. Small mobile devices, including those worn on the body, bring with them heightened social exposure of who is using such technologies, how such technologies are used, and for what purpose. Heightened awareness influences social expectation around technology, resulting in devices becoming a function of self-expression and identity promulgation [Carter and Grover 2016]. With the increasing popularity of wearables like smart watches and glasses, personal technology is fast becoming a vehicle for self-expression, especially for those with disabilities who may need to use technologies for functional purposes.

Owing to historical and political factors that include function-centered attitudes [Cook and Hussey 2002; Charlton 1998], niche markets with few companies that compete on features, and engineering communities originating from medical and rehabilitation backgrounds [Kondraske 1988], AT design emphasizes functional capability often at the expense of social consideration (in contrast to mass market products). Indeed, the Technical Assistance to the States Act defines ATs as those "used to increase, maintain or improve *functional* capabilities of individuals with disabilities" [Cook and Hussey 2002; emphasis added].

Of course, the needs of people with disabilities are not limited to functional capability. As personal devices become increasingly mobile, observable, and commonplace in public and social spaces, the need for accessibility stretches into the social milieu. Mainstream technologies are usually the least conspicuous, blending as they do into popular culture, but they are rarely accessible without modification and may require noticeable add-ons or adaptations to allow users with disabilities to use them. But even assistive devices specifically created to be accessible are often not as appealing as mainstream options (see Figure 1). Thus, we argue that function-centered design does not optimize for self-expression because it does not explicitly consider the social needs of people with disabilities. In fact, most function-centered designs communicate that the person using them has quite limited ability [Shinohara and Wobbrock 2011].

To understand the social dimensions of AT use, specifically the perceptions and self-perceptions of AT users, we conducted a diary study identifying and then bringing considerations of *social accessibility* to AT design. Defining social accessibility as that which serves as a vehicle conveying both *ability* and *social identity*, we discuss how

these themes contribute to the conception of a new perspective, *Design for Social Accessibility (DSA)*. Building on prior work in understanding the misperceptions of AT users [Shinohara and Wobbrock 2011] and influenced by an ability-based perspective toward technology design [Wobbrock et al. 2011], we undertook an empirical study of people *with* and *without* disabilities to understand how perceptions of AT use in public and social spaces arise.

To limit the scope of devices, we restricted study participants with disabilities to those who were blind, visually impaired, deaf, or hard of hearing. Reasons for this limitation were two-fold: First, we wanted to limit the number of devices studied and exclude devices that lacked an analog for people who are not disabled (e.g., there is not quite a wheelchair equivalent for those who are not disabled); second, with the introduction of mainstream accessibility features like Apple's VoiceOver, we sought an opportunity to understand how disabled technology users felt about devices that *could* be in the mainstream but were not.

Study participants were asked to write about their experiences using and encountering AT in public and social spaces over the course of four weeks. We prompted AT users to write diary entries when they felt either *self-conscious* or *self-confident* in social or public situations. We prompted participants without disabilities to reflect on their reactions when they saw ATs used in public to learn which aspects of AT use and social situations shaped perceptions. Diary entries captured sociotechnical interactions that contributed to feelings of self-consciousness or self-confidence.

The key findings of this work lie in contextualizing the social accessibility of AT and in understanding how AT is perceived in social situations. We provide evidence that (1) technology breakdowns are both functional *and social*, and can therefore negatively affect social interactions; (2) the opposite of a breakdown is manifested as self-efficacy and self-confidence, leading to positive social interactions; (3) feelings of self-consciousness and self-confidence are indicative of the role AT plays in "socially recursive inference" and is characterized by the social feedback loop from which individual social behavior is derived [Tomasello 2014; Mead 1962]; (4) the functional and social design of technology can affect social participation; and (5) the existence of AT is noticed and contributes to misperceptions of people with disabilities. We found that the misperceptions held by people without disabilities corroborate findings from prior work [Shinohara and Wobbrock 2011] and that form factor, along with the consequences of breakdowns and competence—feelings of self-efficacy, self-confidence, or self-consciousness—contribute to these misperceptions.

The contributions of this work include (1) an empirical investigation of the social implications and impacts of using AT in social and public spaces; and (2) a first conceptualization of social accessibility and DSA, one built on the theme that self-consciousness and self-confidence in AT use contribute to social breakdowns and self-efficacy, impacts use in social spaces and the perceptions of ability for people with disabilities. DSA is discussed as a reflective stance with key questions to prompt sensitivity to social accessibility in design.

The desired impact of this work is to make an empirical case for considering social accessibility in the design of AT and to introduce the notion of DSA as a design stance countervailing the function-centered design tradition prevalent in AT design.

2. BACKGROUND AND RELATED WORK

What does it mean for an AT to be "accepted" in social situations? Many characteristics might define what is acceptable, and these are subjective. Therefore, in addition to understanding the landscape of AT adoption and use, we also look to literature in sociology and psychology around acceptance, norms, and identity. In perusing background and related work, we ask: What motivates people to act the way they do, to approach

others the way they do, and to carry themselves the way they do in public? How might social paradigms influence people's choices to use technologies that will be observable to others? What characteristics of AT are considered acceptable—if any—and why? The literature provides a robust explanation of technology abandonment, the influence of "cool" new devices (like wearables), and the interplay of identity and social interaction but does not yet look at how identity, social interaction, and design characteristics contribute to AT acceptance. Next, we summarize related work motivating our study design and data analysis.

2.1. Social Norms, Social Interactions, Identity, and Acceptance

Sociology and social psychology are disciplines focused on understanding issues of self-concept, identity, and social norms. These perspectives are uniquely poised to help us construct a study designed to disentangle what happens in social situations around AT use. We strive to understand how self-concept and identity are co-constructed with social interactions before we can study sociotechnical relationships.

2.1.1. Self-Concept and Identity. A person's sense of self and identity motivates personal behavior and individual choice in social presentation [Giddens 1993; Giddens 1991]. An understanding of how sense of self and identity are constructed explains social protocol and why people interact with others the way they do. How does a sense of self and an understanding of identity contribute to attitudes and behavior in social situations? In an essay about aspects of self and identity for people with disabilities, Christiansen argues that our sense of self is rooted in the meaning we derive from emotion, sensation, and thoughts; identity is our shared sense of self, socially constructed (shaped by and shaping our relationships with others); therefore, identity is directly tied to both the way a person views him- or herself and the way others view a person [Christiansen 1999]. Identity is an understanding of our own life narrative, providing "coherence and meaning for everyday events" [Christiansen 1999] with the goal of attaining feelings of well-being, satisfaction, and happiness. Christiansen writes of identity "as the superordinate view of ourselves that includes both self-esteem and the self-concept, but also importantly reflects, and is influenced by, the larger social world in which we find ourselves" [Christiansen 1999]. The very human instinct to solicit inferential meaning from social interactions, the notion that "I wonder what she thinks I'm thinking. . .," contributes to the conceptual modeling of social situations [Tomasello 2014].

2.1.2. Social Norms and Identity. Where self-identity may be derived of the social situations one experiences, the collected conceptualization of the social narrative is an understanding of how the social world works. Driven also by moral, religious, legal, or political beliefs, this collected social sense contributes to our understanding of what is acceptable [Giddens 1993; Goffman 1963a; Christiansen 1999; Mead 1962]. The understanding of what is acceptable in society drives how we frame our existence alongside everyone else, choosing to align ourselves within the acceptable, outside of it, or on the margins of it. People are driven by a conception of right and wrong guided by individual moral compasses of expectations in society and by a willingness to contribute to and participate in that expectation. In many cases, an individual may choose to rebel against the norm, convey expressions of individuality, or, in extreme circumstances, engage in immoral or illegal action [Potts and Scannell 2013].

Who we are is driven by how we situate ourselves socially, guiding our understanding of identity and sense of self. This symbiosis between self-identity and social norms is influenced strongly by experience and individual character and guides how we present ourselves to the world [Goffman 1959; Christiansen 1999]. How are these views reflected in demonstrating ability, identity, and the self we present to others? Our work seeks to understand how social participation influences how individuals perceive AT.

2.1.3. Context and Personal Space. Context frames social order and helps us define proper conduct; it has much to do with defining norms governing social behavior [Goffman 1959; Goffman 1963a; Hall 1963]. Edward T. Hall defined four types of personal space based on physical distance between individuals: intimate, personal, social, and public [Hall 1963; Hall 1966]. Each type of personal space involves different approaches to social behavior. Goffman offers an analysis on interactions within social spaces (or "events"). One such interaction he defines is *civil inattention*, a co-present, mutual understanding of accepted behavior: strangers in public spaces approach and regard each other with nonverbal cues communicating a shared social recognition of one another although they do not directly interact [Goffman 1963a]. Civil inattention is a type of unfocused interaction that occurs when more than one person occupies a social space (typically delineated by social event boundaries or timelines) but do not directly interact with one another. In contrast, *focused encounters* include direct interactions, where attention is given to participating individuals in a social event [Goffman 1963a]. As we will show, these frameworks on social space and different types of social interactions help us categorize and understand the data in our study.

2.2. Meaningful Artifacts and Acceptance of Wearable Technologies

We consider that an assistive device is viewed as a personal artifact that holds personal meaning, contributes to self-identity, and thus carries strong social implications. AT originated out of rehabilitation engineering, where the embodied perspective of the medical model presumed a goal of solving a person's functional "problem" [Cook and Hussey 2002]. Artifacts resulting from this perspective are focused on function over form, typically for good reason. Providing assistance to a person with a disability requires a sensitivity to physical, cognitive, or sensory needs. Traditional designs thus rarely incorporate consideration for personal, social, and self-presentational needs. When processing power was at a premium, sacrificing personal and social consideration may have been a fair use of resources, but today's handheld mobile devices alone supersede mainframe computing power from decades ago. This study is motivated by the notion that current processing power and design skill ought to produce high-functioning, high-quality, socially accessible technologies.

2.2.1. Meaning in Artifacts. Constructing identity through expression includes the use of daily artifacts and items of dress toward a polished appearance [Csikszentmihalyi and Rochberg-Halton 1981; Goffman 1959]. Personal digital technologies are adopted as expressions of identity, as fashion items and indicators of technical prowess. Increasingly, it matters what "tech" one uses. The proliferation of items like the iPhone and the personal laptop are not just because they are considered "cool," but also because such devices promote social stature and personal identity, encourage self-expression, demonstrate competence, and, in many cases, facilitate inclusion.

This study is motivated by a desire to understand how sociotechnical interactions influence what *is* acceptable in social situations. By gathering data on what people think of AT use in social and professional situations and why, we further our understanding of how design may facilitate positive outcomes for AT use in social, public, and professional situations.

2.2.2. Wearables and Technology Acceptance. The current personal technology market is flooded with powerful, ubiquitous technologies available in a wide range of platforms and formats, affordable for use in everyday personal life. In addition to providing functionality for everyday tasks, personal technologies can be selected on the basis of factors that reflect identity. Research applying the Technology Acceptance Model (TAM) [Venkatesh et al. 2003] on wearable technologies suggests that perceived usefulness and ease of use are significant factors in whether an individual will choose to

incorporate a wearable device in his or her daily life [Lee 2009]. Work investigating "smart clothing" similarly arrives at conclusions indicating that functional need as well as aesthetic qualities contribute to a user's acceptance of wearable technologies [Ariyatum et al. 2005]. The social acceptance of everyday wearable devices is still to be determined [Edwards 2003], yet the increase in wearable technologies (i.e., Fitbit, Google Glass, Nike Fuel, etc.) blurs function and fashion. Clearly, some mix of form and function together make such technologies "cool."

2.3. Acceptance and Adoption of Assistive Technology

We contrast prior work about technology acceptance with research investigating the acceptance or adoption of technologies for people with disabilities. ATs, arguably the first "personal technologies," have historically been stigmatizing by marking users as social deviants [Goffman 1963b; Elliott et al. 1982; Parette and Scherer 2004; Bichard et al. 2007]. Prior work investigating the use of ATs found that people with disabilities felt devices either did not serve their function or were too embarrassing to use, resulting in abandonment [Parette and Scherer 2004; Pape et al. 2002; Hocking 1999; Phillips and Zhao 1993]. Parette remarks that "public behavior (such as AT usage) activates cognitive, social, and motivational forces that align a person's self-views with those of others" [Parette and Scherer 2004]. Using an assistive device could complicate an individual's desire to identify as disabled or not in social settings or influence an individual to feel self-conscious or socially excluded [Scherer 1993a; Scherer 1993b; Hocking 1999]. Research has focused on improving the success of assistive device use by creating and evaluating frameworks to assist care providers in matching technologies with people [Scherer and Craddock 2002] or through identifying factors affecting adoption, including that AT design "must be aesthetically pleasing, age appropriate, fashionable, and culturally and socially acceptable" [Kintsch and DePaula 2002]. Thus, there is strong motivation for better sociotechnical coupling between people with disabilities and the AT they use so that users feel comfortable, supported, and aligned socially and culturally.

Research addressing abandonment has identified factors affecting adoption, proposed matching procedures, and adequate training of caregivers. Still, social stigmas associated with ATs pervade. There persists the notion that "you are who you are perceived to be" and that perception can be influenced by what you use [Shinohara and Wobbrock 2011]. Despite efforts to better match ATs to those who would use them, it is apparent that the crux of the issue may be how well technology designs are suited to the person who uses them [Christiansen 1999; Pape et al. 2002]. Yet previous research does not address *how* design might facilitate social inclusion. Furthermore, rather than appealing to ability as a binary situation (disability vs. ability), approaching disability as a multifaceted range of abilities allows us to focus on and give value to characteristics of specific experiences of disability. We entertained a different view: What if we took a step back and looked at how technology was designed and for whom? Rather than concede to the limited choice available, how can we create more acceptable choices for those who would use it? Inspired by the social model of disability, we view current technology design as insufficient to meet the needs of the person–technology relationship (not as the relationship being incorrectly formed). Instead of engaging in a one-size-fits-all view of disability, focusing our efforts on those with sensory disabilities allows us to constrain research to a class of technologies (highly mobile and bridging mainstream personal devices) that increasingly blurs the line between proprietary and popular. This limitation on disability (and, subsequently, technology) provided opportunities to investigate perceptions of devices that often were not meant to be assistive but *could* be accessible.

Finally, in recent years, the low-cost availability of 3D printers has made do-it-yourself (DIY) accessibility a real possibility [Hurst and Kane 2013]. The "maker" and

fashion communities have converged on design with an emphasis on individual expression [Lyden 2015]. We look forward to the future of these burgeoning communities, but highlight that few people have regular access to 3D printers and that adaptations may still incur a high cost to design and produce. Some knowledge of design may be required, and these printers are not designed for mass production, sometimes taking days to print a single item. 3D printers are well-suited for individual DIY projects but do not necessarily address design issues. Indeed, the concept of design for social consideration deserves more attention from the design and disability communities at large and not only from proponents of DIY and maker culture.

We have presented a brief discussion on the social and technological landscape surrounding AT acceptance and use. At the intersection of social identity and AT use, we find it useful to look at technologies not as immutable choices. We see that social as well as functional factors impact feelings of use and, as a result, in use overall [Phillips and Zhao 1993; Hocking 1999; Shinohara and Wobbrock 2011]. We consider the recent introduction of wearable technologies and the rise in 3D printing and maker culture as new indicators of what may be considered acceptable when using technologies in public. Is the "cool" factor of wearable technologies transferrable to technologies used by people with disabilities? Addressing the gaps in the research literature thus far, we seek to understand how—more than just by accepting and adopting a new device—the design of technology can influence feelings of use. To learn how this might be possible, we conducted the following diary study.

3. STUDY METHOD

We conducted a diary study with two groups of participants to investigate feelings and perceptions of AT use in social, public, and work situations. The first group comprised individuals with sensory disabilities: Those who were blind, had low vision, or were deaf or hard of hearing. The second group comprised those who had no disabilities. Participants were recruited through local mailing lists for community organizations such as the Washington State Department of Services for the Blind and the Bellevue Hearing Loss Association. Additional recruitment was completed by word of mouth through social media and individual contacts. Each group wrote diary entries about experiences with ATs in social, public, and work situations over the course of four weeks. Following the diary study, participants were interviewed about their experiences. Interviews were 30 minutes to an hour, depending on the number of diary entries collected, and were conducted over the phone or in person.

We collected 147 diary entries and conducted 22 interviews with 25 total participants. From Group 1 (sensory disabilities), we collected 97 diary entries from 14 participants (8 female), averaging 6.9 entries per person (Table I). We conducted 12 interviews. Diary entries were parsed for completeness, relevance, and response to the study prompts. For example, entries that focused on usability but excluded social and technical descriptions were omitted. Most interviews sufficiently addressed omissions, but there were a few that did not (particularly for participants who could not be interviewed due to scheduling or other constraints). A total of 69 entries from Group 1 were analyzed after parsing. From Group 2 (no disabilities), we collected 50 total diary entries from 11 participants (5 female), averaging 4.5 entries per person and conducted 10 interviews (Table II). After vetting entries for relevance to the diary prompts, three were omitted, and 47 entries from Group 2 were analyzed.

3.1. Diary Entries, Group 1: People with Sensory Disabilities

We focused on sensory disabilities to limit the scope of technologies included and the potential for ambiguity in social interaction, particularly for those with "invisible" disabilities. Group 1 participants were prompted to write diary entries when they felt

Table I. Group 1, Participants with Sensory Disabilities

Participant	Sex	(Self-Described) Disability	Age	Occupation	Entries
G1P1	M	blind, onset at 25	28	student	10
G1P2	F	low vision, onset at 7	28	student	12
G1P4	M	deaf	50	software engineer	6
G1P5	M	blind	59	retired	6
G1P6	M	hard of hearing	58	unemployed	1
G1P7	M	born blind with some vision	60	retired teacher	8
G1P8	M	blind	26	student	5
G1P9	F	hard of hearing	23	student	5
G1P10	F	deaf	19	student	5
G1P11	F	hearing loss	65	database programmer	4
G1P12	F	deaf	21	student	6
G1P13	F	blind	22	research assistant	12
G1P14	F	total blindness	19	student	12
G1P16	F	blind, deaf	23	unemployed	5

Table II. Group 2, Participants without Disabilities

Participant	Sex	Age	Occupation	Entries
G2P1	M	32	multimedia specialist	5
G2P2	M	31	case manager	4
G2P3	F	29	engineer	1
G2P4	F	29	engineer	5
G2P5	F	29	engineer	3
G2P6	M	24	unemployed	5
G2P7	F	32	nanny	8
G2P8	M	26	tea shop supervisor	2
G2P9	M	32	web developer	5
G2P10	F	33	graduate student	7
G2P11	M	35	merchandising manager	5

self-conscious or *self-confident* using their technologies in public or social situations or at work. Participants were asked to write about events that occurred around others because we wanted to get a sense of the sociotechnical interactions that impacted users' feelings. They were prompted for self-conscious or self-confident feelings to elicit moments and contexts that supported or challenged their sense of self. Capturing social circumstances personally affecting participants provided us with a sense of what they valued in social situations. Therefore, not only did the data show how participants felt, what technologies they were using, and who they were with, it also gave a sense of what parts of interactions were key to participants' comfort or discomfort.

3.2. Diary Entries, Group 2: People without Disabilities

Participants without disabilities (Group 2) were asked to write diary entries any time they saw, or thought they saw, a person with a disability using an assistive device or technology as a personal aid. Participants were asked to describe the general context (location, time of day, any people who were around), the technology observed (in their own words), and their feelings and reactions about the scenario witnessed. The prompt for Group 2's diary entries was intentionally ambiguous to allow participants to determine for themselves, guided by their own perceptions, what constituted a disability and an assistive device. Participants in this group were largely unfamiliar with common items used by people with disabilities, such as a BrailleNote or cochlear implants (common items used by participants in Group 1). However, familiarity with AT

was unimportant because participants' reactions to any situation involving a device would be legitimate provided they merely perceived the device to be assistive and the observed person to have a disability. Additionally, the prompt was not restricted to perceived sensory disabilities because of the limited interactions non-disabled individuals usually have with people with disabilities.

We note that participants without disabilities (Group 2) were generally young professionals in urban and technology-forward cities and characteristically were generally well-educated and technically savvy with respect to the "latest and greatest" gadgets. This limited our sample to a relatively young cohort, so we gauged our participants' observations and perceptions as perhaps more accepting of different or new technologies compared to others who might be older or in less technology-oriented settings. Although we were unable to verify whether Group 2 participants saw actual AT in use, we could be fairly confident in their technical acumen to adequately judge a device being used as a personal assistive aid.

Finally, although the final counts of diary entries received represented the different groups' perspectives proportionally (there were more participants with more entries in Group 1), we note that there may be many reasons for the seemingly low numbers overall. The study design was meant to be flexible, encouraging participants to include entries as often as they experienced these issues, and our goal was to capture meaningful descriptions. We asked participants to write about every time they felt self-conscious or self-confident, but, of course, it would be impossible to know if they were successful at capturing every situation. At the same time, some participants may have felt more comfortable than others in a given setting with a specific device, thus affecting diary counts, and that is a matter of personal preference.

3.3. Interviews

At the conclusion of the four-week diary portion of the study, interviews were conducted with participants for follow-up and clarification. Interviews allowed participants to verify thoughts, feelings, and reactions and to offer further insight as to why they may have felt a certain way. Questions for interviews were developed based on individual participant diary entries: for example, "In your first entry, you describe a man using an 'old' cane. Why did you think the cane was old?"

3.4. Analysis

Both inductive and deductive qualitative analyses were conducted on the diary entries and interview transcripts. Interviews were incorporated as part of the diary data since the purpose of interviews was to clarify and expand on thoughts and ideas already expressed. An inductive analysis was conducted to allow themes and categories to emerge from the data themselves. Applying practices from grounded theory, codes derived from the data were categorized thematically [Glaser and Strauss 1967]. In deductive analysis, we applied a sociological lens based on Hall's theory of proxemics and Goffman's categorization of social encounters to understand the kinds of interactions that occurred around technology use [Hall 1966; Goffman 1963a].

Initial inductive analysis was conducted by the first author. As interviews concluded, synopses were captured with contact summary sheets, as defined by Miles and Huberman [1994], to highlight concepts that arose in conversation. Common themes that persisted across diary entries, interview notes, and transcripts were coded into a list of initial codes. Themes were identified by key words or phrases that repeatedly surfaced (e.g., if a participant actively used "self-conscious") or descriptions of concepts that relayed such ideas (e.g., if a participant described feeling worried that others would think less of him due to technological failure). High-level categories and themes

Table III. High-Level Categories and Themes from Initial Inductive Analysis

Group 1 Categories and Themes	
Reactions and perceptions	
	others have of technology, of one's own technology
Influence on social interaction	
	technological requirements in use affect social interaction, context aids easy interaction
	form factor and functionality influence on social interaction contributes to social breakdown
Influence on feeling and use	
	functionality (affects feelings of use in public, about oneself such as feeling confident or not)
	social context (influences use and feelings of use, when approached out of curiosity regarding technology, when in certain locations)
Expectations	
	others have (of technology, of disabled, of disability due to technology)
	of self (when technology does not work, when exceeding expectations of others)
Group 2 Categories and Themes	
Help	
	feelings (approving, good, self-conscious) about helping; preconceived ideas of whether people with disabilities want help
Assumptions, expectations	
	making assumptions about disabilities
Feeling self-conscious	
	(outside of helping) about offending, about not discriminating, of how to act around people with disabilities
Perception, feelings	
	form factor (as main contributing factor to perception of person, in feeling self-conscious or self-confident, and toward expectations of technology)
	functionality (as main contributing factor to perception of person, in feeling self-conscious or self-confident, and toward expectations of technology)
	person (action and attitude of person with disability as main contributing factor to perception of person)

were vetted through discussion with the second author. As the data were compiled and coded, categories emerged and recurring themes were noted (see Table III).

The wide range of different contexts, people and relationships, and locations meant we needed categories to describe the social structures within which each recorded experience took place. We constructed categories based on Goffman's encounters and Hall's theory of proxemics in a deductive analysis to frame the different types of interactions. Goffman defined *focused encounters* as direct interactions where attention is given to participating individuals in a social event and *unfocused encounters* as interactions where several individuals occupy a social space (delineated by social event boundaries or timelines) and do not directly interact with one another [Goffman 1963a]. Hall's theory of proxemics allowed us to characterize social interactions described in diary entries according to his social distance spectrum: intimate, personal, social, and public [Hall 1963]. We interpreted Hall's social distance as reflective of social expectations, and employing proxemics was a powerful way to separate out context-dependent interactions by framing diary entries across seemingly different interactions but with similar contextual overtones and social cues. For example, with proxemics, we could compare a conversation on a bus between strangers with a conversation at an office party among coworkers. These situations differ contextually in location and public exposure, but proxemics comparison allowed us to classify the social spaces similarly as participants engaged in similar social decorum.

Applying Goffman's and Hall's categories allowed us to separate out focused and unfocused interactions and to examine the markers around encounters that brought interactions to the fore (e.g., the difference between being just another passenger on the bus and conversing with a stranger about the iPhone's accessibility options). Meanwhile, inductive analysis allowed us to get a sense of the influence of technology, context, and people on social interactions and personal feelings of use. Put together, we were able to see how different social situations contributed to different feelings of use (e.g., when participants were more likely to feel self-conscious about technology use) if at all. In combining themes, we could identify the types of feelings participants had (self-conscious, self-confident, etc.) and determine what kind of situation may have contributed to those feelings (e.g., a technical or social breakdown facilitated by the function or form factor of a particular device). Detailed categorizing and labeling of data is shown in the online-only supplementary material on the ACM Digital Library.

4. RESULTS

4.1. Group 1 Data (from Participants with Sensory Disabilities)

Participants in Group 1 had disabilities ranging from blind to low vision and from deaf to some hearing loss. Technology use varied across users; blind and low-vision participants used BrailleNote and BrailleSense, PC computers with Job Access With Speech (JAWS) text-to-speech software, Apple Macbooks with VoiceOver, smartphones including iPhones, smartphone technology including Sendero GPS, monocles and glasses, canes, seeing-eye dogs, and a variety of software apps, including VizWiz [Bigham et al. 2010] and OneBusAway [Ferris et al. 2010; Azenkot et al. 2011]. Deaf and hard of hearing participants used cochlear implants, hearing aids, cell phones with loop technology, captioning technology such as in-person transcribers, pocket talkers, and FM systems. Two hearing-impaired participants were fluent in ASL.

Utilizing Hall's theory of proxemics and Goffman's characterization of focused and unfocused encounters, we identified 9 intimate space interactions, 7 personal space interactions, 40 social space interactions, and 13 public space interactions (see online-only supplementary material on the ACM Digital Library for tabulated data). We found all intimate and personal space interactions were focused encounters, and almost all public space interactions were unfocused encounters. Social space interactions included both focused and unfocused encounters. Contextual themes emerged for both positive and negative feelings across all spaces: (1) situations where participants were able to accomplish a task or could explain or show off their devices, were related with positive feelings; (2) conversely, interactions attracting unwanted attention or that involved breakdowns resulted in negative feelings. Further analysis revealed themes in breakdowns: (2a) functional breakdowns (and sometimes the mere presence) of ATs elicited breakdowns in social interactions by attracting unwanted attention, and (2b) social breakdowns occurred when social interactions highlighted embarrassing features and inequalities of ATs, even if AT worked functionally. Both scenarios (2a and 2b) highlighted disability through systematic functional and social breakdowns and drawing unwanted attention to participants.

4.2. Group 1: Competence and Self-Efficacy

Successful use of AT resulted in feeling competent and having a sense of self-efficacy. Not only did having access and the ability to accomplish tasks boost self-confidence, but having the chance to tell others about AT and what one was capable of doing increased feelings of technical and social inclusion.

4.2.1. Access and Ability. The primary purpose for any AT is to provide a desired function. Participants reported self-confidence when their technologies worked as expected

and helped them accomplish a task. Participant G1P4 lost his hearing at 13 years of age and did not get a cochlear implant until he was 38. Although his implant helped him capture sounds, he admitted a lot of work was required on his part to understand everyday conversation. When his implant worked well, it provided him useful access to conversation without other aids. He described such a conversation with his mother during his son's birthday party, noting the conversation was well supported by his cochlear implant:

> Much more comfortable and enjoyable to have the conversation with the implant rather than having her write or someone else interpret. It is a lot more of an actual conversation when you are looking at the person's face rather than their writing or typing, or at another person who is interpreting—it is direct communication. [G1P4]

Whereas G1P4 used other AT when necessary, including written notes back and forth or an ASL interpreter, he appreciated the ability to have an unmediated face-to-face conversation. In another example, G1P5, who was blind and did not read Braille, relied on his technology to access restaurant menus. Unable to use the Braille menu at a restaurant, he pulled up the menu online using his iPod Touch:

> I thought it was awesome that I could have the menu to a restaurant accessible to me since I cannot read Braille, and I did not have to have my friend take their time to read the entire menu to me. [G1P5]

4.2.2. Demonstrating Technical Savviness. In G1P5's example, we see that more than just an aid, AT is the primary personal or functional device with which many people with disabilities conduct day-to-day tasks around others. In situations like G1P4's cochlear implant example, an AT may be a supporting device when directly interfacing with others; having the implant work well was crucial to a successful conversation. Successful operation allowed participants to feel technologically savvy and professionally polished. Participants wrote about using their technologies at work and the implications of being technically savvy. G1P8 led an online Skype presentation using his laptop with JAWS software. He further explained why he felt productive and confident:

> I was giving a presentation about accessibility, and the act of using my AT fluently, professionally, and in a way in which I explained what I was doing grabbed everyone's attention enough to then get them to really listen to what I was teaching.
>
> Because I was able to get something done, and contribute to improving the situation very quickly and effectively. In addition, because my audience was actively engaged, even enthused, about my topic, but only as a result of first fishing them in with the AT usage. [G1P8]

G1P8 attributed his successful presentation to his technical savviness with his AT and felt good that he met his presentation goals professionally.

4.2.3. Ability to Participate Just Like Everyone Else. AT was most socially viable for participants who felt "just like everyone else" when they used it. G1P5 sold his Seahawks tickets and verified the cash with an app on his iPod Touch.

> I felt great being able to have the capability to check my own currency and be so independent and not having to depend on and or find a 3rd party person who which [sic] would of been a stranger also... because having the feeling of doing it myself and felt that realism of ... I am just like a sighted person counting currency and making a transaction without having someone coming with me... the iTouch/iPhone

> devices with the free speech that Apple puts in all their devices is making my life so much more like a sighted person and makes me feel so much more able to be independent. [G1P5]

Not only did having the ability to verify the transaction help G1P5 be independent, but the device's form factor also contributed to his feeling "more like a sighted person." Function was key in G1P5's interaction, but just as he also took pride in using a mainstream device common for sighted users, form factor could also influence perceptions and interactions. G1P7 was approached by another coffee shop patron about his MacBook:

> I'd guess it's not uncommon to feel a little uneasy when entering any establishment with a guide dog because one never knows what to expect. This, however, was a familiar place to me where I knew some of the people. Actually, in this case, it was refreshing to not have the focus of the conversation on blindness or access technology. The conversation centered on the mainstream computer, nothing more, nothing less, and that's what's important. Stuff like this levels the playing field. [G1P7]

Describing why he felt this way, he wrote:

> I'm so used to being asked about my guide dog or, "What's that?" when I'm using my Braille PDA. It naturally is pleasant when conversations focus on mainstream technology that one can use right along with one's peers. [G1P7]

He reflected on the role of the MacBook's mix of function and form:

> Mainstream technology such as a MacBook with VoiceOver built in is, in my mind, a huge step forward. Many people use this same technology for work and entertainment. Anyone can anywhere at any time use the same technology without having to install 3rd party expensive screen reading software that may or may not work. In situations like this, there is a common interest that has nothing to do with blindness. People are truly able to connect with one another. [G1P7]

In this way, G1P7 highlighted the significance of appearing to use the same technology as nondisabled people.

4.2.4. Influencing Social Perception. Perceived social implications dictated expectations even when participants were not co-present with others. At work, G1P9 was given a week to learn a new system, design a new database, and set up accounts. She was provided a private workspace that enabled her to complete the task in a matter of hours rather than days. G1P9 wanted to make a good impression and, like her supervisor, had implicit expectations of how long it would take to complete her tasks. Appropriate accommodations helped her exceed expectations, and her confidence grew.

> I felt very confident in my abilities with this experience. With the other frustrations I had been experiencing, this was one of the positive realizations I had. It made me realize that I can do well when given the accommodations I need and that it is fair for me to ask for them. I felt as though . . . I could be just as good an employee as a non-disabled one when given the accommodations I need to do well. [G1P9]

Although G1P9 was not present with others as she completed her task, her ability to meet the task goals on time had implications for her confidence and success.

4.2.5. Supporting the Ability to Help Others. Not only was function and form important for increasing self-confidence and impressions of professionalism, having the ability to

help boosted self-efficacy and self-confidence. It contributed positively to what others thought of the participant. When traveling in a car with a friend, G1P1 used his phone to help find the way. He wrote:

> I wouldn't have been able to do that without the accessibility features of the iPhone. But more than that, my friend was really impressed with me and my phone. I felt like he felt like I wasn't going to be able to help him get to where we needed to go. So I really felt like I was helpful. It was nice to feel that way. I don't always feel like I can help, and sometimes when I could help, people don't always let me help because of my disability. [G1P1]

G1P1 felt good that he could be helpful, and he realized the social implications of the incident: His friend witnessed his helpfulness by way of his technological expertise with a common mainstream device. We point out here that the significance of showing he could use a typically mainstream device even with his disability was not lost on G1P1. As noted in prior work [Shinohara and Wobbrock 2011], the implications for demonstrating ability through these socially nuanced contexts lends great meaning to the "mainstream" aspect of G1P1's device. G1P1 recognized that not only was it common for others not to expect much from him, they also may not have "let [him] help because of [his] disability," regardless of his technical ability.

4.2.6. Educating and Sharing with Others. Participants were wary of being patronized about using AT, but they appreciated opportunities to share how AT worked, to show what technology allowed them to do, and to educate others about technology and disability. In many cases, AT provided a vehicle for conversations about access and disability. G1P1 met with his college math instructor to discuss how AT could help G1P1 understand the course material. Understanding that most people are not familiar with AT and therefore make assumptions about disability, G1P1 was grateful for the opportunity to show his instructor what worked best for a blind person.

> It was really neat to be working with my teacher and teaching him about the programs that are out there and the one I use. It really helped him to understand what it might be like to not be able to see and only be able to listen to the material. He also had a better understanding for what challenges there was [sic] for formats that worked with the AT and the ones that don't work well with it. [G1P1]

In another similar interaction, G1P1 indulged inquirers about his technology. He recognized he had an opportunity to educate others and change perceptions about accessibility and disability by answering questions about his laptop.

> It felt pretty good to know that I can tell other people about this and educate them at the same time. To be honest, I also felt like I was "cool" I have a laptop that I can use and it talks. How "cool" is that. It seems like a lot of people out there that can see or have vision are really in the dark about the things that visually impaired people can do and the things that are out there for visually impaired people. [G1P1]

4.3. Group 1: Breakdowns

Participants reported feeling frustrated, embarrassed, or awkward when experiencing breakdowns. In addition to malfunctioning technology, breakdowns included technology that worked but interrupted social discourse by drawing unwanted attention to a person's disability. Such occurrences highlight the need for design considerations that go beyond achieving only functional-restorative goals.

4.3.1. Social Implications of Breakdowns. Whether alone or with others, the breakdowns experienced by participants were heightened by social implications of a given situation.

In Section 4.2, we discussed how adequate support allowed G1P9 to complete work tasks early and gave her confidence about her ability to get things done, something she felt was crucial in setting a good impression. In contrast, participants were aware that inadequate support or malfunctioning technology had potentially adverse social and professional implications. For example, G1P13 experienced a breakdown when her JAWS program froze while preparing for a work meeting. The breakdown increased her anxiety because she wished to be professionally prepared. She was annoyed because although technological issues were not uncommon, there were significant implications when it came to AT:

> I didn't want to try to explain to someone who I was supposed to meet professionally with for work why my technology wasn't working properly when they probably are not familiar with AT and wouldn't really understand. I feel like although things like this are out of my control, they are still my fault, because I use technology differently from most people and that it is my responsibility to compensate. [G1P13]

When prompted about the influence of context and people on her annoyance, she wrote:

> I was about to have a meeting and wanted to look good. This meeting was professional, so my expectations for their performance were higher than just interacting with someone in public, as theirs were for me. [G1P13]

G1P13 shared in the typical anxieties and appropriate professional conduct, yet her concerns were skewed because she understood that most people were not familiar with AT. Indeed, she remarked in her interview that although she liked the advantages of having a portable Braille display, she switched from a BrailleNote to a laptop because "I would try to keep it low profile because I didn't—I just got sick of answering people's questions about it... It just kind of got annoying after awhile." G1P13 did not express feeling self-conscious, but she was hyper aware of being perceived at least as competent as her peers. She carried an expectation for her AT to function properly and invisibly (without obvious functional or social breakdown, as evidenced by her choice to switch from BrailleNote to laptop) so that it would not draw attention to her *dis*ability.

Other participants similarly discussed the implications of AT breakdowns on social interactions. G1P1 wrote about social consequences even if the technology worked as expected. While hanging out with friends, he felt it was "bothersome" to try to socialize and "use something that assists you, like I have been trying to use my iPhone." He concedes "I can't hear my phone talk to me or read me what's on the screen. To me that means I would have to use it outside or leave." Aware that his friends were using their phones as they socialized to play games, text with others, or browse the web, he became frustrated. He explained:

> I know that my friends around me can see and don't have vision problems. So I know that they are freely using their phones to text and do things on their phones. I don't want to be rude and just get up to use my phone. I would if it was an emergency. *But* I am trying to hang out with my friends and it gets hard to do that and be able to use my phone the same way that my friends are using their phones at the same time. Also I feel like I might be annoying to others that are doing things if I use my phone around them. So today and like many other times I just choose not to use my phone. [G1P1]

His blindness dictated he could not use the phone as his friends did because he could not hear phone commands in the noisy setting, just as similarly, he felt that using the accessibility features on his phone might also be awkward around his friends, and he chose not to use it. So, although G1P1 enjoyed time with friends and enjoyed the use

of a mainstream iPhone, he still encountered usage breakdowns because of the social implications of using a talking phone in such a setting.

4.3.2. Technological Breakdowns. Since participants would not use an AT unless they needed aid, technological failure was particularly frustrating. It was also embarrassing because participants felt a need to participate in the social discourse around them without drawing unwanted attention and without being the source of delay that technological breakdowns created. For example, G1P10's FM system (a device with a microphone that transmits sounds via radio waves to a receiver generally worn behind the ear) stopped working during a panel of women professionals. Jumping up to fix it drew full attention to her from panelists and the audience. She wrote how she felt:

> Embarrassed! And nervous or anxious, when the FM system stopped working midway when the professional holding it was still speaking. I felt fine after the panel though, because the FM system was really crucial to understanding the panel, and my transcriber was slow to transcribe the panel's Q & A. [G1P10]

G1P10 weighed drawing attention to herself in this forum versus being unable to understand what the panel was saying:

> It was off-putting to be on the spot, but since I was sitting up front, I had to quickly run to the panel table to check the condition of the FM system (and take it back with me when I verified that it just wouldn't turn on) when they looked at me. I just think it's embarrassing when something stops working midway and I don't want to interrupt the flow of the conversation just for my benefit... I did not want the attention to be focused on me; I wanted the attention to be focused on the female professionals on the panel. I was going to check on the FM system when the FM system was later passed to the professional who was the closest to me and had finished speaking, so that it wouldn't seem as dramatic, but then a new question popped up and they kept the discussion going so it was hard to interrupt. I think my inner frustration with my inability to hear their voices loudly built up... [G1P10]

In addition, the context of the location and the people around her added to her anxiety:

> I think that the location... played a partial role in how I felt, because I was representing myself and the University... with my behavior, and I wanted to be respectful of people, and I didn't want to be rude by suddenly asking them to check the FM system in the middle of their answers. [G1P10]

Although participants experienced breakdowns when technology failed, they also reported social breakdowns when technology worked. These occurrences indicate that functional correctness is not enough; a sensitivity for social implications—that is, acceptance in social situations—is also a must for successful AT design. On the first day at a new class, G1P6 was called out by his professor because his new hearing aids made a whining sound. He described the situation:

> It was my first full day with hearing aids, ... I had taken the hearing aids out before class started because all the people coming in the door were making very loud noises with the door that hurt my ears with the devices in. (Hearing aids pick up and amplify sounds that are sharp more so than talking.)
>
> When the class was starting, I was putting in the hearing aids, and they make a whine when you do this and it bothered the instructor. He demanded to know who was making the noise. I went to put in the second hearing aid, and he got pissed with the whine. He stopped class and demanded to know who was making

> the noise. I told him and the class: "I just got new hearing aids today, first day with hearing aids. The sharp noises and everybody talking was overwhelming so I had to take them out. When class started I was putting them back in, and they apparently whine when I do this, for that I apologize, but I really want to thank you for embarrassing me in front of everyone." [G1P6]

G1P6 reported that this made him feel, "Like crap, I wanted to crawl out of the room." He further contextualized his frustration with the history of his hearing aids:

> These were my first hearing aids, I intentionally got the ones that go inside your ear so no one would know that I had to use hearing aids. And on day one everyone was flatly told I had hearing aids. [G1P6]

G1P6 intended to fit in with the rest of the class by selecting smaller hearing aids, but although they functioned generally as he expected, they had a noisy side effect that drew unwanted attention, culminating in a dissatisfying social outcome.

Breakdowns were frustrating for all participants. Whether around close family or in public spaces, participants experienced a range of social situations where technologies failed to meet functional and social expectations and brought unwanted attention. For example, G1P4's cochlear implant fell off when his young son gave him a hug as they sat down for a movie in a theater. He described how he felt and why:

> Awkward, embarrassed, angry. Because it emphasizes how fragile and in-the-way the device is, as well as bringing my disability front-and-center and ruining the moment. [G1P4]

He was aware of the effect of the incident, "My son felt bad about knocking it off, which in turn made me more irritated with the situation." A happy and cherished moment faded into embarrassment and awkwardness when the cochlear implant was knocked off, G1P4's son began to feel bad, and G1P4 himself resented the fragility of his technology. In another example, G1P9 was on a work call in shared office. Given the small space and presence of familiar coworkers, G1P9's experience differed from G1P4's interaction in a public movie theater. Still, similar issues were at stake as she wrote about using her phone with hearing aids while within earshot of her coworkers:

> It was awkward to know that I was being watched because it made it harder to continue with the conversation on the phone normally.
>
> I felt as though I was a distraction for others because I had to use the phone in a non-conventional way (using the loop). I also simply felt like even with that technology to assist me, I was still at a disadvantage compared to my other co-workers who could use the phone without being concerned about understanding the other person. [G1P9]

She qualified the significance of the form factor of the loop she used for the phone call:

> It attracted attention to me by its distinctiveness—using the loop, using the remote that it was connected to. It is not as attention-catching as the old FM systems used to be and was modeled to look more like an mp3 player, but it was still obvious to my co-workers what it was. [G1P9]

G1P9's experience was frustrating because she had a hard time understanding the person on the other end of the line and was aware that her coworkers could overhear her technical difficulties. Add to this the distinct loop technology she used with hearing aids, and she was self-conscious about attention drawn to the phone call. Although we

cannot be sure what her coworkers actually thought, her perception of awkwardness around the situation compelled her to end the call early.

4.3.3. Transitional Encounters. Unfocused encounters occurred when participants did not directly interface with others present. Transitional encounters began as unfocused and drew focus to a participant, noted as unfocused to focused in our analysis. Most of these interactions were initiated by strangers, and most resulted in negative feelings. For example, G1P12 already had several interactions with the staff at a restaurant by the time a waiter noticed her cochlear implants. She described the waiter's changed behavior:

> A waiter started talking to me very slowly and loudly when he recognized my implants. Prior to recognizing my implants, he talked to me as if I was a hearing person. [G1P12]

G1P12 felt, "Discriminated, signaled out, annoyed, frustrated," and explained:

> My implants automatically signal to other people that I have a hearing loss or that I am deaf. The busy restaurant made me feel like the waiters had no patience with my hearing loss, that the restaurant felt as if I was slowing them down. [G1P12]

Although her cochlear implants worked just fine, just noticing them caused a behavioral and attitudinal change in the waiter. G1P12 did not report feeling self-conscious before the waiter's behavior change, but the transition of bringing attention to the previously unnoticed device facilitated a self-conscious experience for her.

4.4. Group 2 Data (From People without Disabilities)

Whereas many entries from Group 1 participants centered around circumstances of technology use, Group 2 participants (without disabilities) described seeing technologies used by people with disabilities. Group 2 participants comprised mostly professional men and women reporting on a variety of ATs they saw in public spaces, including manual and electric wheelchairs, scooters, canes, walkers, hearing aids and other hearing technologies, prosthetics, and screen magnifiers.

Group 2 participants were unlikely to directly interact with people with disabilities on a regular basis. Most diary entries from Group 2 described interactions that took place across public or social spaces and could not be appropriately categorized according to Hall's personal spaces. An analysis revealed themes around "perception of disability": (1) participants formed perceptions around technology appearance and use, including (1a) judgments about technology users and (1b) feelings of self-consciousness; (2) participants formed perceptions from context of use; and (3) sometimes participants had neutral perceptions and were less biased toward AT and disability. Participant perceptions were guided by preconceived expectations of AT and disability and by individual interpretation of accepted social decorum around people with disabilities.

4.5. Group 2: Perceptions Rooted in Technology

Most frequently, Group 2 participants described feelings and reactions based on perceptions of technology appearance and use. Participants reacted to AT in two ways: (1) When observing technology users, Group 2 participants applied judgment on the situation or person; and (2) when directly engaging with technology users, participants described feeling self-conscious. Many participants applied a judgment on challenges and abilities based on perceptions of the technology they saw. Appraisals ranged from pity and sympathy to approval or to feeling glad or inspired that the person with a disability had the help or assistance needed. For example, Participant G2P6 felt "approving" when he saw family members help an older woman with a cane:

> The cane indicated that she had difficulty walking and needed assistance. The role of people (family members) assisting by bringing the car around had the most effect on the way I felt. [G2P6]

In his interview, G2P6 qualified, "If there was no one assisting her actively, that would be what would make me disapprove of the situation." He explained why:

> I guess so like when you're a little kid like your parents take care of you and when you grow up then you have to take care of whatever kids you have—you're parents. When you're at that age, like for me my expectation for people that age is for their children, if they have children, to assist them and I guess that could just be cultural. [G2P6]

G2P6 felt that his upbringing and cultural background dictated a responsibility to help an elderly family member in need and since this woman had a cane, she needed help. In contrast, form factor could also result in positive perceptions. On seeing a man in a wheelchair with "hand rims for users who race/exercise in their chairs," G2P6 described the man as "very independent and athletic," and he explained why:

> Well, he had like gloves on; he seemed like he was very active and very independent and didn't need anyone to help him and just like any other day for him. So if you have rails on your wheelchair that means like you want to go fast around, he also had gloves on; that means you want to get somewhere fast very often so you wouldn't get like blisters on your hands. [G2P6]

Perceptions also characterized whether or not a participant approached an AT user. Group 2 participants felt self-conscious when they engaged in, or felt they were about to engage in, direct interaction with technology users because they were concerned about offending users. Participants wrestled to understand ambiguous social cues and debated appropriate decorum around people with disabilities. G2P4 encountered a man in a wheelchair at the theater and wrote:

> I was confused, but also ashamed to ask if he was in line . . . because I generally don't talk to strangers, and am probably generally less comfortable around people in wheelchairs because I don't want to offend them by cutting in line, or getting in the way.
>
> It was a busy theater, so he could have been in line, but I wasn't sure and his being in a wheelchair was more confusing to me than if he wasn't because I wasn't sure if he was sitting in that exact location by choice or if he was waiting for someone to move him. [G2P4]

G2P4 admits her apprehension was because she did not want to offend the man, and she debated approaching him because she was unsure of the situation. Should she have known whether the man was waiting to be pushed? Would asking him if he was in line be offensive? G2P4 did not know how to read the social cues from the man in the wheelchair; in her case, this ambiguity made her feel less comfortable about how to act. Ultimately, she chose not to interact with the man.

Similarly, G2P5's experience of seeing a man with a cane entering a building and her decision not to help exemplified her inner debate of what might be offensive:

> I didn't offer to help open the door because I remember someone saying that disabled people like to do things on their own. He could've possibly taken offense to me offering to help him. [G2P5]

In her interview, G2P5 later added more context behind her decision:

> Well I heard that . . . People say that if they have disabilities then they don't necessarily want any help. They prefer to do it themselves, but at the same time I don't want to offend anyone too. So . . . I'm torn a little in between those thoughts because sometimes I want to help, but then I don't want to offend them. I don't think that they can't do it on their own—that's not my intention of offering to help—but I always have to second-guess myself whether or not I actually want to offer . . . I mean, in that situation, I had to think about whether I would have offered someone else without a disability to hold the door open. [G2P5]

G2P4 and G2P5 articulate a common theme among Group 2 participants. Many were *self-conscious* about initiating interactions with people with disabilities because they did not want to offend. Participants were sensitive about whether or not to offer help even if they would have offered it to a nondisabled person, and they avoided direct interaction because they were unsure how to avoid appearing offensive.

4.6. Group 2: Perceptions Rooted in Context

Some Group 2 entries described feelings strongly tied to context of use. While we acknowledge that simply seeing an AT in use may generally have tipped off any reaction, we identified 10 diary entries where context seemed to strongly influence the way participants felt. In one, G2P3 was surprised to see a woman with a white cane walking in a busy parking lot while talking on the phone.

> I felt a little surprised that she was able to walk so "normally" with her walking stick and talking on her cellphone at the same time. I guess I would have thought that if you cannot see, it would be even more difficult to multi-task while walking. Especially in a busy, crowded, and potentially dangerous area (cars around).
>
> The fact that she was talking on a cellphone like any "normal" person would be while walking made her stand out as not being inhibited by her blindness. [G2P3]

While G2P3 noticed the blind person walking in the parking lot "normally," she attributes her surprise to the context in which it occurred:

> The fact that she was in a busy area with cars definitely made me notice the girl and find it unusual that she was able to navigate without sight, and talk on the phone at the same time. If it were in a safer environment, it would not have been so surprising. [G2P3]

G2P3's expectation of white canes was such that one would need to be able to hear without distraction what was going on in the surrounding environment. Add to that the reasonable safety concerns when in a parking lot, and G2P3's expectations of how a blind person would act in such a situation were upended. Her expectation was that the blind person she saw was indeed blind; however, we have no way of knowing whether the person may instead have had low vision.

Similarly, G2P6 expressed sympathy and concern for a person he saw in a darkened city street at night, struggling with two canes. G2P6 explained in his interview:

> I guess the location itself . . . There's always some random person that comes up to you, like asks you for money or "can I get a cigarette?" The surroundings . . . I don't feel it's very safe and then add in the fact that you can't see anything and you can get mugged at any moment . . . and you can't do anything about it. That's what made me feel sympathetic towards them. Because they're pretty much helpless if like something happens to you. Then it gets compounded by the time [of night] that there are less people out and about.

> If there was another person there helping them, maybe just have the walking stick in his left-hand and like another person holding his hand or grabbing his arm and guiding him. Like help him walk the street to traverse from point A to point B and that would be a lot better than being by himself at night . . . [G2P6]

Although G2P6 recognized the situation of having to navigate city streets with two canes could be precarious, his impression of the unsafe street added to his sympathy.

Some perceptions rooted in context were influenced by perceived attitudes about technology users. G2P7 described her feelings on seeing a man in a wheelchair while shopping, "I was disturbed and felt pity for him." She explained:

> [He] was sitting, facing the wall near the front of the store. As if he was waiting for someone or had just been left there.
>
> I was there waiting for five minutes. In that time, the gentleman [was] mostly looking at his hands, or glancing around. People stared as they passed by, but no one engaged him or came for him. [G2P7]

She wrote that location and context influenced how she felt, particularly that, "the gentleman being in the chair and facing the wall played a large part." Similarly, G2P11 had a perception of a customer to his shop based on the attitude with which she carried herself. Wanting to accommodate customers with disabilities, G2P11 initially tried to be helpful. However, this customer's attitude toward him and his employees made him question that she had a disability at all:

> She is there almost every night. She does not need the wheelchair. She walks around just fine; she even pushes herself around backwards. On top of that, she wants special treatment because she is in a wheelchair.
>
> My employees get upset that she uses the wheelchair when she doesn't need it. This lady angers me. There are people that actually need it, and here's someone that is trying to acquire pity and special treatment. Yuck! [G2P11]

G2P11 felt angry about what he perceived as her exploitation of exceptional service for customers with disabilities. While we could not verify if this woman did have a disability, we know that G2P11's feelings about her were strongly guided not just because she had a wheelchair, but by how she used it and her attitude toward others.

4.7. Group 2: Neutral Perceptions

Three entries described little judgment or self-consciousness based on technology or context, as if technology and disability had no bearing on how they felt. We understand there may be no truly neutral perspective; however, we identify these entries as neutral because participants did not explicitly indicate bias rooted in AT or disability (particularly in contrast with other entries). For example, G2P1 felt annoyed as he waited for a slow pedestrian with a cane to cross the street:

> [The people] getting off the bus just assume they can walk where ever they wish and cars will yield to them. She is no exception. None of them use a cross walk or walk in groups or anything to help keep traffic moving through the area. So I was annoyed as usual. [G2P1]

When prompted about the role of the technology in influencing how he felt, he responded, "None really, while she is slow crossing the street, I didn't feel any different towards her than anyone else." G2P1 felt equally annoyed toward the woman with the

cane as he did with the other patrons because they all walked slowly and blocked his path.

G2P2 offered a similar description of his experience riding a bus with newly installed accessible automated announcement systems. He liked the system because, "I can close my eyes to 'nap' and hear the announcement and know where we are." Prompted about the role in technology in how he felt, he responded:

> This is an excellent upgrade in their system. Previously, bus drivers were required to announce the stops, if they did not do so, they would be penalized by their employer. This removes this responsibility and allows the driver to focus on driving. [G2P2]

G2P2 recognized the implementation of the announcement system as an accessible feature but did not offer any other qualifications for it.

Still, neutral perceptions highlighted that even unbiased participants carried social sensitivities about interacting with AT users. G2P10 submitted several entries describing interactions between her young children and AT users. In one, her family waited to be seated at a restaurant, and her four-year-old daughter struck up a conversation with an elderly woman with a cane:

> The woman was very nice, but I felt a little worried that my daughter would draw too much attention to her cane and make her feel embarrassed. My daughter kept staring at her cane and even pointed to it a couple of times during the conversation, but the woman either didn't notice or didn't mind. [G2P10]

G2P10 explained her own reaction to the situation:

> Young children are very observant of anything that's unusual to them, and they often find accessible technology quite fascinating. This is fine, as long as the person using the technology doesn't feel self-conscious about it. [G2P10]

In another entry, G2P10 described how her nine-year-old son and young daughter made outbursts when they saw a man on a scooter. She noted that she felt self-conscious of the man being uncomfortable at the attention of her children, adding:

> I don't want my children's innocent interest in and tendency to verbally point out the way that people are different to offend or embarrass anyone. My husband and I work hard to teach our kids manners, and they honestly don't mean to be rude (there's never any negative judgment in their exclamations, which mostly consist of them saying "Wow, that's cool!") but I don't want them to be interpreted as such. [G2P10]

G2P10's self-consciousness was related to her children's uninhibited reaction to AT and affirmed norms embedded in our adult knowledge of appropriate social interactions. G2P10 sought to instill open-mindedness in her children, but she was aware that social expectations might have made technology users feel uncomfortable. Toward the end of the study, G2P10 offered insight to her experiences:

> I've realized, in the course of this project, that a lot of the weirdness that people might feel about accessible technology has to do with not wanting to make the person using the technology feel uncomfortable.

We find these viewpoints illuminating, indicative of judgment passed on the situation at large, but not on any one aspect of a disabled individual, their technology, or their ability.

The *in situ* descriptions of Group 2 participants provide an in-the-moment perspective of inner debates that nondisabled participants engage in when encountering AT

in the social milieu. It is safe to assume that most observations reflected on a person with a disability using an AT, but we cannot be sure about the level of severity of the disability itself. (Maybe a person had low vision, but still used a white cane and was not completely blind?) Either way, participants made assumptions about levels of disability to help themselves explain technologies they saw and to draw inferences from the situations they witnessed.

5. DISCUSSION

Our data show there is a kind of "social negotiation" on either side of AT use in which participants attempt to align their behavior when they encounter each other. We note that our findings are limited by the scope of technologies observed by the two different groups: Group 1 participants primarily wrote about experiences with software and hardware technologies popular among people with sensory disabilities, whereas Group 2 participants wrote mostly about larger, visible technologies common for people with physical disabilities. We temper our discussion with the concession that both groups were unable to provide observations on the same set or type of technologies, and we recognize this as a tradeoff of the study design (it would be impossible to control how two groups "in the wild" might comment on the exact same observations). Given this caveat, both groups were concerned with social presentation: Group 1 participants with presenting an able self and Group 2 participants with appearing understanding, nonjudgmental, helpful, or sympathetic. We found that both groups presented complementary evidence of *socially recursive inference* [Tomasello 2014]: Group 1's perceptions were influenced by what they thought people without disabilities thought, whereas Group 2 perceptions and behavior were guided by what they thought people with disabilities thought. Following our discussion, we offer a definition for socially accessible technology: That which serves as a vehicle conveying both *ability* and *social identity*. We discuss our findings in detail here.

5.1. Interactions in the Public Sphere: Negotiating Social Norms

Feelings of self-consciousness for both groups of participants were most prevalent when on the boundaries of social interactions. Implications for functional failure not only affected productivity, but also significantly impacted social and professional relationships for Group 1 (disabled) participants. Where functionality was not an issue, social breakdowns occurred when unwanted attention was drawn to a device. Transitional encounters (noted as "unfocused to focused" encounters) that brought attention to AT use were examples of Group 1 participants being "*outed*" as deviating from expected norms. Although Group 1 participants did not mind being approached out of curiosity, they were sensitive to patronizing and sympathetic remarks and unwanted reactions from others, and they were typically concerned with presenting an able self, particularly when the social consensus was to be "one of the crowd" and especially when working. As a result, participants wanted to draw the right kind of attention to themselves: portraying identities of ability, professionalism, being technically savvy, and socially adjusted.

In comparison, Group 2 (nondisabled) participants were sensitive to expected behavior when directly engaging AT users and when proximal distance elicited potential interaction. Not knowing the most appropriate response to seeing a person use AT in public, most Group 2 participants experienced apprehension over how to react: They were concerned that bumping into wheelchair users or offering help might be considered offensive. Participants in Group 2 worried that calling out a disability or need would be offensive, while at the same time they harbored perceptions that an AT indicated a need or limitation of ability. Direct interaction with people with disabilities was

not required for Group 2 participants to feel self-conscious about potential interactions or to experience concern about offending people with disabilities.

5.1.1. Expectations. When it came to negotiating interactions, both groups constantly tested expectations of appropriate social behavior around AT. Group 1 participants were aware of what others might expect of them, as demonstrated when they showed off what they could do and enthusiastically shared how their technologies worked. At work, Group 1 participants held themselves to the same level of expectation as other, nondisabled employees. Witnessing scenarios that challenged expectations compelled Group 2 participants to reflect on what they thought of AT and disability. Such reflections implied that (1) Group 2 participants had a vague sense of what disabilities might entail, and (2) their expectations were influenced by technology form factor and the attitude and ability of the user. For example, recall that G2P3's expectations about blindness was challenged by seeing a person with a cane on the phone while walking in a busy parking lot. Although G2P3 at first assumed the presence of a cane (represented by its form in the shape and color of the canes that people with visual impairments use), indicated a visually impaired user who would not be able to walk and talk on the phone at the same time, further observation of the encounter allowed her to see how it was used and to adjust her expectations.

5.1.2. Social Encounters and Disability. As with expectations, Group 1 participants (with disabilities) were cognizant of how using AT contributed to an ever-changing social knowledge base of what it means to have a disability in today's society. Although participants were quick to share what their technologies do and portray disabilities in a positive light, they were also apprehensive and self-conscious about situations in which they had little control—where their disability was highlighted in a less appealing way. Aware that social perception of disability is not always positive and is often incorrect, some Group 1 participants were sensitive to situations where outing their disability conflicted with the identities they wished to portray. This was evident in G1P12's experience with the restaurant waiter whose reaction to her cochlear implants was not an accurate reflection of her ability or identity.

Group 2 participants (without disabilities) struggled to understand expectations around disabilities and to know how to react, behave, or even *feel*. Encountering AT in use highlighted ambiguous social rules involving people with disabilities. G2P4 felt self-conscious about potentially bumping into people with wheelchairs because she perceived wheelchairs as less mobile than walking. Whether or not her comparison of walking versus wheelchairs was viable, she felt apprehensive when approaching potential interactions. She stated, "I consciously thought about not bumping into them because of their wheelchairs." Her perception and reaction to wheelchairs precedes any interaction she had with them, ultimately preventing interactions (as it did when she encountered the man in the wheelchair at the theater).

5.2. Function and Self-Efficacy

Function fulfills a sense of purpose, boosts self-efficacy and control, and promotes a positive sense of self. The main focus of AT is to provide functional capability where there might be a physical, sensory, or cognitive impairment [Cook and Hussey 2002]. This unique characteristic is what most separates ATs from mainstream devices. Yet the effectiveness of such technologies may also depend on characteristics that may vary depending on context, user, and type of technology. A proprietary assistive device and a mainstream accessible technology may both contribute to low feelings of self-efficacy or feelings of self-consciousness if an individual is unable to participate in a social situation as desired. When a device successfully supports a user's identity functionally and socially, the device "disappears" into the task-at-hand [Winograd 1996; Suchman

2007], supporting the flow of social discourse. Although our data are limited in scope, our findings offer a brief window into themes that influence how function, social context, self-efficacy, and identity intersect in AT use. ATs that supported a positive sense of self-efficacy in participants (e.g., G1P1 feeling good about using his iPhone to find directions, and G1P8 feeling productive and confident in his use of JAWS and Skype in a successful business presentation), arguably contributed to their sense of identity and ability.

5.3. Form Factor and Self-Confidence

Group 1 participants (with disabilities) cared about how they might appear to others, as manifested in the desire to appear professional when fretting over functional breakdowns or when experiencing social breakdowns. G1P13 related this experience when VoiceOver on her iPhone began relaying text messages to her while she was conducting a work interview: "Typically, I appreciate this information. However, I was trying to have a professional phone call." She explained why this particular scenario caused her stress: "The interviewee was getting an impression of the university and our research team from me, and I wanted to make this the best impression possible." Also compelling was G1P12's account of the restaurant waiter's reaction to her cochlear implants. It was not until he saw her implants that he began to treat her differently, even though nothing about either the implants' functioning or her ability to interact with him had changed. Thus, despite her ability to interact with him and others without issue just moments before, his perception that the form of the device was a hearing aid of some sort contributed to the waiter's overall (incorrect) perception that she could not hear or communicate at all. G1P12's frustration with the situation is indicative of her desire *not* to be identified as "disabled" by her device.

Group 2 participants (without disabilities) developed misperceptions about disabilities when encountering AT in use. For example, engaging with the notion that a person in a wheelchair would only use it if they could not walk, participants in Group 2 justified wheelchair use with a significant physical need (and made adjustments when the form of the wheelchair dictated otherwise, such as in G2P6's description of the "athletic" wheelchair). Yet, disability runs a spectrum of needs (e.g., not all people who use white canes are completely blind). And the whole of a person's ability is not matched by the perceived use or needs of the technology that a person uses. The reactions of our participants lead us to understand that the mere presence of AT may not communicate or promote the abilities of users.

Group 2 participants notably commented on positive and self-confident attitudes when technology users exceeded expectations of disability. In comparison, Group 1 participants expressed feelings of self-confidence when technology use demonstrated ability and polished professionalism. A personal technology, as much as any personal artifact, arguably has a potential for form factor (whether desired or not) to enhance an individual's sense of self [Csikszentmihalyi and Rochberg-Halton 1981]. Therefore, we believe that just as design may have the potential to positively influence self-efficacy, there is a potential for form factor to be designed to better communicate self-identity. If we, as technology users, consider that we are all actors in a social presentation [Goffman 1959], then all artifacts at our disposal on a daily basis are props we select and use toward supporting, in some way or another, our roles among family, friends, and strangers. Presenting a role in social and public situations is equally important for those with and without disabilities.

5.4. Appearance and Attitude: Creating Perceptions of Ability

Human actions and thoughts are influenced by social relationships, experiences, and an understanding of social norms [Mead 1962]. Insufficient function and incongruous form factors are reflected in our appearance and attitude, contributing to the perceptions

that others develop of us. Technology becomes a part of the awareness of self that is presented to others, as manifested in the ardent "image debates" people have over PCs versus Macs or Android phones versus iPhones. Through function and form then, technology has the potential to help people construct the image they wish others to see. Our data highlight situations of use where function and form may have influenced functional and social breakdowns, respectively.

Participants on both sides of disability tried to avoid potentially uncomfortable situations. Both groups were hypersensitive to socially recursive inferences: Group 1 participants considered whether their actions might be thought of as "disabled," much the same way that Group 2 participants did not want to offend. Regardless of the type or severity of disability or of the accessibility provided by technology, participants without disabilities drew on expectations based on ambiguous social norms. They also drew on how they hoped to be perceived according to social norms (appearing "accepting" of people with disabilities) and how they believed they should behave when entering into a focused encounter with a person with a disability. Therefore, we cannot understate the forces of social expectation and influence on perception.

5.5. Motivating Design for Social Accessibility

Design has the potential to promote an identity congruous with one's self-narrative through function and form. When functional breakdowns contributed to uncomfortable situations, Group 1 participants were not only conscious of the technological failure, but also of the implications of their ability to successfully use their devices (e.g., G1P13's concern that failing devices might reflect on her inability to get work done or her inability to conduct herself professionally). The literature on how people with disabilities might co-construct identity through technology use [Christiansen 1999] further supports the notion that such functional breakdowns may influence identity as much as design for form [Goffman 1959; Csikszentmihalyi and Rochberg-Halton 1981]. We identify these relationships among function, form factor, and identity as *sociotechnical identity*, constructed by the ways personal technologies define our sense of self within the communities of which we are a part. Defining this relationship strengthens the view that personal preference and meaning are key factors of AT adoption and use [Phillips and Zhao 1993; Hocking 1999; Scherer 1993b; Kintsch and DePaula 2002], but we contrast the findings in our study with related work advocating for better matching between technology users and their assistive devices [Scherer and Craddock 2002]. While sensitivity is indeed required when selecting appropriate technologies for users with disabilities, a matching framework is appropriate only for existing technologies and assumes designs as somewhat immutable—a given. Placed within the context of prior work, our findings indicate that technology matching may miss an important aspect of technology use: its inception and design. We argue that, as designers, we ought to emphasize the way AT design fits in with the social unfolding of users' daily lives. If technology as it is fails to meet user needs, then we may need to step back and re-think how we construct assistive artifacts in the first place. In addition, merely providing alternatives or adaptations may not result in functional or social access because we saw similar responses to both mainstream and assistive technology in many diary entries. Thus, our study guides us toward a new vision on accessible technology design: The implications for design to foster sociotechnical access equality are more than post-hoc principles or frameworks, but are instead a change in philosophical foundation, a development of a *designer's stance* positioning accessible design solidly under identity, function, and personal meaning. We argue that this vision must be clear, not just for creating AT and not just for the accessibility-minded designer, but for any designer to understand how to make technologies accessible overall.

Two themes emerged from our data that conceptualize acceptable design of accessible artifacts. The first is that functional and social breakdowns due to AT use result in negative feelings and awkward or embarrassing encounters. The second theme is that having the ability to accomplish goals through the successful use of AT, or having the chance to "show off," result in positive feelings and a confident sense of self. Furthermore, this competence is served both by function and by form, as shown in G1P1's desire to be viewed as another competent iPhone user, by G1P13's desire to appear professional to others through effective use of her technologies, and by G1P12's desire not to be treated as being unable to communicate merely because she uses cochlear implants, to name a few examples. Owing to the concerns expressed by both participants with and without disabilities, we posit that a useful conceptualization of socially accessible design is one in which design serves as a vehicle conveying both *ability* and *social identity*. Achieving socially accessible AT designs motivates the need for a unified holistic view on both functional *and* social aspects of design not as mutually exclusive, but as complementary dimensions. As we discuss in future work, we propose to investigate how function and form factor propagate functional and social breakdowns.

5.6. Limitations and Generalizability

We accompanied diary entries with follow-up interviews to clarify and confirm participant ideas and thoughts. In addition, we situated the motivation for and results of this study within existing literature on the acceptance, adoption, and abandonment of AT and its influence on personal and social identity. Our findings confirm similar research on why people with disabilities are likely to avoid or abandon AT and corroborates that the self-consciousness around what others might think about AT is founded. We would be careful, however, to generalize our Group 1 findings to the wider community of individuals with other kinds of disabilities (e.g., physical or cognitive) because they may have a host of different types of social expectations around AT use. And although Group 2 participants contribute a rich set of data across a range of different kinds of assistive devices, the sample is limited to mostly professional young adults. Additional investigations would have to be done with other populations of people with a variety of other disabilities and ages to generalize.

Finally, in attempting a more ecologically valid approach, we structured the study design to encourage Group 2 participants to record what they experienced "in the wild." Unfortunately, most people are generally unfamiliar with AT for people with sensory disabilities (including software adaptations or mobile accessories like hearing loops). Thus we acknowledge that our Group 2 data are mostly limited to observations of devices that are more obvious in public spaces, such as for those with physical disabilities. A replication of this study to strengthen and verify these results should ask nondisabled participants to focus on participant observations of either mobility impairments or on sensory impairments, but perhaps not both.

6. FUTURE WORK: TOWARD DESIGNING FOR SOCIAL ACCESSIBILITY

Our data suggest that current AT designs may influence perceptions of disability when functional or social breakdowns bring disability to the forefront, particularly when design influences *self-consciousness* or *self-confidence*. Reflecting on the *social accessibility* of AT design frames the need for further investigation. Although we agree that designing functional accessibility is crucial [Wobbrock et al. 2011; Newell et al. 2011; Newell and Gregor 2000; Connell et al. 1997; Danford 2003], we argue that post-hoc or disability-specific mindsets may perpetuate misperceptions about disability (as we saw in Group 2 participants) because participants were already anticipating social ambiguity when confronted with AT use in public. Perhaps misperceptions of AT and disability are so ingrained in society and people's thinking that such perceptions are

almost unwittingly designed into our technologies. Rather than unintentionally isolating accessibility from overall designs by giving accessibility the burden of an added approach or post-hoc constraint, we propose a change in attitude toward designing for disability. The results from this study and from prior work [Shinohara and Wobbrock 2011] inform key themes and reflective questions about design that may be appropriately addressed by the DSA design approach. The aim of such a design approach would be to shift focus from already produced ATs toward the inception of ideas before device creation. For example, before a given technology is made and pushed to market, how can designers prioritize accessibility, acceptance, competence, positive perception, and the social dimensions and impacts of design? How can AT designs reinforce notions of ability, capability, inclusion, professionalism, self-efficacy, and self-confidence? These are personal and social considerations that go beyond mere functional concerns. Perhaps AT design should be sensitive to influences on identity by embodying sociotechnical approaches. AT users in Group 1 were aware of perceptions others may have of them, and those in Group 2 did, in fact, make judgments about people with disabilities based on perceptions of AT. A sociotechnical-centered stance supports self-expression and identity. An approach such as DSA might posit reflective questions for designers.

DSA must incorporate diversity in users as well as strong functionality. What design principles and design process can support the reliable achievement of positive social outcomes when using accessible technologies? How can design reflect ability through accessibility? What are the design implications when adding constraints for disability early in the design cycle? What resources and techniques must be altered, included, or excluded to support disability constraints? Key for any technology used by people with disabilities is the requirement for robust functionality (true for technology adoption by people without disabilities as well [Lee 2009; Venkatesh et al. 2003]). How does functionality accommodate impairment and boost self-efficacy? How can function and form factor translate into a confident sense of self?

Finally, accessible design must be reflective of sociotechnical considerations such as perception, social expectation, and personal meaning. Personal devices such as tablets, cellphones, and wearables are rising in popularity and contributing to the growing social awareness of what a given technology says about identity (e.g., the Android vs. iOS debates). What are the implications of technology design on social identity? In what ways might a design elicit feelings of self-consciousness or self-confidence?

Reflection on design encourages sensitivity to disability in design when emphasizing sociotechnical identity. Thus, future work will involve engaging designers to understand how existing philosophies and practices influence design work and to uncover ways to incorporate functional and social disability-specific sensitivities into design practices [Cross 2011]. As a next step, we infused DSA's reflective themes within the context of a design course investigating how student design perspectives were influenced by this nascent design concept.

7. CONCLUSION

The self-identity we co-construct with our social interactions also affects how we feel about ourselves. In turn, how we feel feeds our social interactions and our self-identity [Goffman 1959; Sommer et al. 1998]. A person's sociotechnical identity influences attitudes and perceptions about that person, as is evident in the choices people make about their personal technology [Carter and Grover 2016]. Much of the appeal behind Apple's iPod digital music player (and subsequent Apple "i"-products) has been directed at cultivating one's presentation of self, perhaps as "cool" and "tech-savvy." But despite such advances for mainstream audiences, technology choice for those with disabilities remains limited, especially when it comes to ATs promoting a capable and effective personal identity. Existing options are frequently abandoned or slow to gain adoption, often

because of the mismatch between an assisted versus a tech-savvy identity [Phillips and Zhao 1993; Hocking 1999; Scherer 1993b]. Few mainstream devices are accessible out of the box, and even fewer ATs are designed with self-presentation in mind.

Our study participants' experiences largely centered around the notion of how technology may or may not be an extension of the identity we want others to see. Group 1 participants (with disabilities) demonstrated that as players in a social world, using AT elicits not just functional challenges, but significant social challenges as well. Feelings and perceptions around AT use often identified people by their disability, not by their ability, and certainly not by their non-AT identity. Similarly, Group 2 (nondisabled) participants perceived that technology users needed help or were unable to do things because of the presence of AT and by the attitudes and appearances exuded by the users themselves.

This work provided an empirical investigation of the social implications of using AT in social and public spaces and provided evidence that (1) technology breakdowns are both functional and social and negatively affect social interactions; (2) the opposite of a breakdown manifests as self-efficacy and self-confidence, leading to positive social interactions; (3) feelings of self-consciousness and self-confidence when using ATs are evidence of socially recursive inference, the feedback loop of "I think I know what she is thinking"; (4) functional and social design considerations can affect social participation; and (5) our work corroborates prior work [Shinohara and Wobbrock 2011] and found further evidence that AT *is* noticed and *does* contribute to misperceptions of people with disabilities.

We are increasingly in a world where personal technology is used to express individuality, yet people with disabilities have limited opportunities to do so. The themes presented in this work provide insight into the ways that current ATs are perceived by both users and passers-by. In particular, we highlighted that such perceptions appear to contribute to feelings of self-consciousness or self-confidence in assistive device use. We offer the possibility for a new way of looking at how design may be one way to address self-consciousness and self-confidence in AT use through DSA, a nascent design stance with potential to reframe how we think of the term "accessible design."

ACKNOWLEDGMENTS

We thank Josh Tenenberg and Jessica Tran for their thoughtful feedback.

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Received September 2014; revised April 2015; accepted March 2015