

Article

Who Needs to Fit in? Who Gets to Stand out? Communication Technologies Including Brain-Machine Interfaces Revealed from the Perspectives of Special Education School Teachers Through an Ableism Lens

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Abstract: Some new and envisioned technologies such as brain machine interfaces (BMI) that are being developed initially for people with disabilities, but whose use can also be expanded to the general public have the potential to change body ability expectations of disabled and non-disabled people beyond the species-typical. The ways in which this dynamic will impact students with disabilities in the domain of special education is explored. Data was drawn from six special education school teachers from one school in Calgary, Alberta. Five sub-themes (social acceptance, not adding to the impairment, fear of judgement by society, pursuing “normality” and meeting the demands of society) were identified that fit under the main identified theme of “fitting in by not standing out”. Findings demonstrate a dichotomy in participant views of non- or socially acceptable communication devices. The perception of BMI technology was also explored among special education school teachers, revealing benefits and challenges with the uptake of this technology for students with disabilities. Perceptions of people with disabilities and ableism are presented as conceptual frameworks to interpret the influence and impact of the findings.

Keywords: ability expectation; ableism; communication technology; special education; teachers; students; disabilities; brain machine interface

1. Introduction

Advancements in communication technologies have transformed the way we communicate and interact with one another. Smartphone devices, tablets, video conferencing and social media are just some forms of existing communication technologies and mediums that have redefined expectations of how we connect, what we connect with and how often we connect to our devices to communicate with each other. The ability to communicate translates to personal autonomy; having the ability to interact with our environment and build social connections and relationships. Considered “vital to everyday life” [1], to be without the ability to communicate is regarded as “debilitating” by some [2]. For individuals with limited speech and motor abilities, technologies are seen as fundamental to provide external aid, support and functionality to meet the challenges and demands of the environment [3].

Communication technologies developed over time have introduced new modes of communications which have created paradigm shifts to the way we communicate with both positive and negative implications for people with disabilities (e.g., deaf people who relied on face-to-face communication were disabled by the introduction of the phone). The more recent development of the brain-machine interface (BMI) technology is introducing another paradigm shift to how humans may communicate in the near future. BMI technologies are developed with the intention of enabling people with disabilities to interact with external devices [4,5], for example, robotic limbs [6–12], wheelchairs [13–17], and other communication devices [2] through the use of thought. As such, BMI technology is perceived to provide people with disabilities with increased autonomy and a higher quality of life [18–20] and essentially restoring certain abilities such as control and mobility [10,11]. As BMI technology continues to develop and advance, its application is expanding beyond its initial target audience of disabled people, toward general and public use, providing opportunities for non-disabled people to enhance their abilities and gain more control of their environment [10,11,21]. The fusion of human and machine for the voluntary control of external devices is gaining momentum in research development [22]. It is opening up new possibilities for entertainment applications, like the gaming industry [4,5,23]. This ability to control our environment using thought, we argue, is changing our communication expectations yet again.

The emergence of BMI technology and its potential impact is highlighted in the ongoing debates of the technology’s use as a form of therapy to restore lost abilities or as a human enhancement [24,25]. While the technology is encouraged to continue its advancement, it has been cautioned that the technology should not be used as a “policy for normalizing” [24] or a solution to deficiencies [24]. Concerns are also raised in regards to research risks which include surgical procedures, unknown long term stability of the technology and receiving informed consent from vulnerable participants [25]. The effects on an individual’s personal identity (with implanted electrodes in the human brain) [25] and the question of responsibility of activity (human *versus* machine) [26] are also encapsulated within the discussion of BMI technology.

In the domain of education, communication technologies play an important role in promoting active learning and participation in the classroom for students with disabilities [27–29], contributing to their students gaining academic skills necessary for a successful transition into adulthood [30,31]. It functions to support students in developing cognitive skills, particularly with learning cause-effect relationships (learning to control the environment through a device using switch access), developing problem solving skills, and participating in play through the manipulation of objects [32–36]. Overall, the use of technology in special education school settings have increased and technology goals are being incorporated into student individualized education plans [33] however discussion continue as to which might be useful [37]. The potential role of BMI technology in the domain of education has yet to be established with its impact on students with disabilities remaining unclear, particularly beyond the clinical and medical narrative (e.g., safety of application, quality of life, and informed consent). As further advancements of BMI technology set sail, an emphasis on how its development will impact students with disabilities beyond the notion that it will “restore function” is important to consider [16,17].

We present here the results of a research study that explored the perceptions of special education school teachers of current communication technologies and what they envision is necessary for developments of new and envisioned communication technologies. Secondly, we explored their perceptions of BMI technologies, particularly the benefits and challenges they saw for future implementation of these devices for their students. The research was conducted using semi-structured, face-to-face interviews. Given the results, we present what the teachers perceived to be important to incorporate in new technologies. We also explored their perception on the potential use of BMI technologies for their students. We analyzed the results through the key concepts of perceptions of people with disabilities, and ability expectations in order to understand the influence and impact of the new and emerging communication devices.

2. Conceptual Approach

2.1. Ability Expectations and Ableism

Everyone, whether individuals or social structures such as societies have ability expectations (want stage); ability expectations often morph into forms of ableism where one not only desires or expects certain abilities but also perceives a given ability as essential (need stage) [38,39]. Ableism as a cultural concept was coined by the disability rights movement in the United States and Britain [40]. Within the disability discourse it “reflects the sentiment that a given individual, social group or social structure values species-typical-abilities of the body and promote these abilities”. The concept of ableism is used routinely by disability studies scholars [41–44]. Handicapism is a term with parallel meaning to ableism but is a term not widely used [45,46]. In disability studies, the term ableism is used to highlight the preference for certain body abilities over others [41–44]. This leads to those with preferred abilities to label those with “real or perceived deviations” from the “essential” abilities as being less able than they should be [42–44]. Loja *et al.* (2012) states, “Disabled people have struggled with a corporeal identity that is predominantly defined by a medical model that reduces it to abnormality, stressing the need for correction or normalization” [47].

Although more commonly associated with disability studies, the concept of ableism has made its mark among various social groups throughout history, providing justification for the establishment of hierarchy in accordance to one's status and rights (e.g., devaluation of women) [48].

When used as a conceptual tool, ableism provides us with means to understanding how advancements in communication technologies will impact people with disabilities and others. Ability expectations and ableism are pivotal in shaping perceptions with regards to the future of a given technology and its user or non-user.

2.2. Perception of People with Disabilities

Reaction, responses and outcomes can differ depending on how matters are defined according to our set of beliefs [49–52]. Beliefs around the concepts of health, disease, ability, impairment and defect are influential in shaping the perception of so called disabled people [49–52]. Within the medical framework, disability has been framed as a “physical, moral, emotional, mental and spiritual deficit” [47,50]. The perception of disability within this framework is identified as “a defect, a problem inherent in the person, directly caused by disease, trauma or other health condition and a deviation from certain norms” [50]. That is, finding a cure, issuing prevention, or developing adaptations to meet the demands of society (e.g., assistive technology and equipment) are attempts at managing the deficits of disability [50,53].

On the other hand, the social model of disability does not view disablement as originating from the state of the body—it is a result of environmental, social and cultural demands that accumulate into a complex condition [50,53]. As noted by Loja *et al.* (2012) the focus is on, “the elimination of prejudice and discrimination and [a defense of] self-determination, social integration, and the civil rights of disabled people” [47]. Therefore, the perception of disability and people with disabilities is a matter of human rights, requiring social changes in attitudes, ideologies and policies [50].

In the field of scientific and technological development, perceptions of disabilities are profoundly influenced by the medical framework [49,54]. That is, people with disabilities become “defined and confined” within this framework [53,54]. Consequently, the beliefs that encompass the medical framework influence the perception of disabilities and people with disabilities among other discourses as well – reducing their identity and scope of social participation [53,54]. An illustration of this is reflected in the report of Birbaumer and Cohen (2007) on the quality of life issues in BMI research and application for patients with amyotrophic lateral sclerosis [55]. Birbaumer and Cohen (2007, p. 629) noted the perception of the patients by family members and doctors:

The vast majority of family members and doctors believe that the quality of life in total paralysis is poor, that continuation of life constitutes a burden for the patient and that it is unethical to use emergency measures such as tracheostomy to continue life. The pressure on the patient to discontinue life is high [55].

However, when the patients were asked to rate their quality of life according to a depression measurement scale with questions modified appropriately to reflect their environment, the results demonstrated that they were not clinically depressed [55]. In fact, their quality of life was rated much better than their caretaker and family members [55]. This example highlights that while those around a

person with disability may perceive that person's life to be of poor quality, people with disabilities do not necessarily share the same feelings.

In examining perceptions of people with disabilities, in conjunction with an ableism lens, we analyzed how these factors can be influential for future technological developments in how they are used and distributed for students with disabilities.

3. Method

3.1. Participants

Special education school teachers were recruited from one school specific for students with multiple and complex needs in the Calgary Board of Education. A total of six teachers out of 12 teaching staff at the school agreed to be interviewed about new and envisioned communication technologies and their impact to students.

3.2. Data Collection

Semi-structured interviews were implemented to offer flexibility in allowing for topical trajectories that may come about through conversation with each respondent [56]. Additionally, this method allowed the interviewer to probe or seek for further clarification from participants, where necessary [57]. Interviews were conducted from June 18, 2012 to July 6, 2012.

Prior to conducting the interviews, consent forms were provided to each participant that outlined the purpose of the study, the method of data collection and the process of ensuring the safe-keeping of their identity. All six teachers provided their consent. The interview sessions were tape-recorded to allow for the assurance that all accounts of the conversation would be captured accurately. The length of the interviews ranged from 45 min to 1.5 h. Interviews were transcribed verbatim by the author. Participants were identified as TA, TB, TC, TD, TE and TF in the transcripts for the protection of their identity.

In addition to asking participants about their views of new and envisioned communication technologies including the BMI, participants were provided a list of ten desirable features for new and envisioned communication technologies and asked to rank from 1 to 10 (1 = highest priority; 10 = lowest priority) technological features they considered most desirable for future development. After ranking, participants were asked to explain their reasoning and whether a feature was missing. The list of desirable features for new and envisioned communication technologies presented to the participants is listed in Table 1.

The ranking system was utilized to gain further understandings of participant views. It also allowed for comparison of similarities and differences among the sample of participants.

Table 1. Desirable features for new and envisioned communication technologies.

Desirable features for new and envisioned communication technologies
Make the technologies smaller
Make the technologies invisible (incorporate nanotechnology)
Make the technologies faster
Make the technologies lighter
Make the technologies appear more flashy; allow it to stand out
Make a more 'wearable' technology to improve portability
Incorporate technologies into our bodies (transhumanism)
Make the technologies more affordable
Make the technologies simpler so that we can learn how to use and teach them faster
Not much change is required

3.3. Data Analysis

The transcribed documents were imported into the qualitative data analysis and research software, ATLAS.ti[®] version 7.0.75 to code for prevailing themes. Themes were identified using the techniques of repetition and finding similarities and differences as outlined by Ryan and Bernard (2003) [58]. The identified theme and sub-themes along with their corresponding statements were also mapped in FreeMind version 0.9.0 for the purpose of organization and visual aid.

3.4. Study Rigor

Transcripts were e-mailed to the participants in this research as an opportunity to review and provide further comments. The validity of this research was conducted through peer debriefing to ensure that the themes presented in this paper are reflected appropriately [59,60]. Credibility was also established through members checking with the participants involved in the research to validate that the interpretations were accurately presented [59–61].

3.5. Limitations

The scope of the study was limited to the perception of six special education school teachers at one school in the Calgary Board of Education. This research group is small and is not representative of the perception of new and envisioned communication technology developments among all special education school teachers, nor of other educators within the board or elsewhere. It is acknowledged that the recruitment of more special education school teachers from within the school and throughout the city may have contributed further depth to the data. However, this group provided rich data for expanding our understanding of this topic further.

It is also acknowledged that the data presented is limited to the perceptions of what special education teachers believe is suitable and desirable for their students. Our data is not truly representative of the students' beliefs as no data was obtained from students themselves.

4. Results

Participants were asked to provide their perceptions of what they thought were most desirable features for the development of future communication technologies through a ranking system followed by an explanation of their ranking order. Additionally, participants were also asked to provide their perception of the development of BMI technology and its impact to their students with disabilities. Our analysis through the lens of ableism and perceptions of people with disabilities on the ranking activity identified the main theme of “fitting in by not standing out” with five sub-themes: social acceptance, not adding to the impairment, fear of judgment by society, pursuing “normality” and meeting the demands of society. From the discussions around BMI technology and its impact to students with disabilities, benefits and challenges were revealed from the perception of special education school teachers.

The classroom demographics for each teacher are shown in Table 2.

Table 2. Portrait of participant class demographics and teaching experience.

Classroom demographics	
TA	Communication focus
TB	Pre-communication—preparing students to transition to TA's class
TC	Visually impaired
TD	High medical and physical needs
TE	Higher functioning, behavioral, varied communication abilities
TF	Heterogeneous - autism, non-verbal, verbal, ambulatory, physical needs

A list of ten desirable features was provided to participants (Table 3). All six special education school teachers in this research provided their views of what they considered to be desirable technological features for the future development of communication technologies. The average rankings taken from the six responses are:

Table 3. Average rankings of desirable features for development of future communication technologies (n = 6).

Average	Ranking *	Desirability
2.17	1	Make a more 'wearable' technology to improve portability
3.17	2	Make the technologies more affordable
3.83	3	Make the technologies faster
4.67	4	Make the technologies simpler so that we can learn how to use and teach them faster
4.83	5	Make the technologies smaller
6.17	6	Make the technologies lighter
6.33	7	Incorporate technologies into our bodies (transhumanism)
6.50	8	Make the technologies invisible (incorporate nanotechnology)

Table 3. Cont.

Average	Ranking *	Desirability
9.17	9	Make the technologies appear more flashy; allow it to stand out
9.83	10	Not much change is required
0.17**	11**	Accessibility

* 1 = High priority; 10 = Low priority. ** Accessibility, as a desirable feature, was added to the list by participant TF. The participant defined ‘accessibility’ as allowing students with diverse abilities to utilize a device. The iPad was used as an example: “TF: (...) Because to me a touch screen, while it can be extremely effective, there’s a large population that may not be able to use it.”

4.1. Fitting in by Not Standing out

When the teachers were asked to rank the desirable features for the development of new and envisioned communication technologies, they consistently based their rankings accordingly to their classroom demographic and the experiences they and their students have had with the tools used for the purpose of communication that school year. Results from ranking the technological desirability and accompanying discussion revealed the importance of the pursuit of “normality”. This was described in the theme, “fitting in by not standing out”. This main theme was expressed in the following five sub-themes: social acceptance, not adding to the impairment, fear of judgement by society, pursuing “normality”, and meeting the demands of society.

4.1.1. Social Acceptance

Social acceptance based on the type of communication technology used by the students became apparent in the perception of what society deemed as a socially acceptable tool. For example, participant TA, who teaches in a classroom of students focused on communication using speech generated devices, noted the attractiveness of a popular technological device and a shift in the student’s social interaction in the use of that device:

TA: (...) I just love it because of its size, its portability, and a huge one is its acceptance with the world at large (...) There’s a little story about one of our students (...) just really extended family, lots of interaction with cousins and everything. The parents had said, “You know, when we go out to family functions, all the other kids come and say hi, you know, and stuff like that and then go off to play”. They got her an iPad, not a communication device, or nothing, just an iPad. And now all the kids were coming and (...) hanging around with her (...) Now they’re not going to stand out as much as with a big, huge Dynavox, but (...) maybe be right in with the crowd and accepted just like anybody else. So that’s the neat thing.

Consumer appeal to keep up with technological trends were seen as influential to how certain communication technologies within the school were perceived as more acceptable in society than others, even though the device may be providing satisfactory results in functionality for the students:

L: (...) when you say that iPads don’t really facilitate that communication need (...) what do you mean? Do you mean the interaction?

TA: Right now, mostly the challenges (...) of it working consistently. Let's say you have a communication page on there and the student wants to access it but he swipes his hand a little bit and, it's like uh oh, this menu has come down. Now he can't use the communication page that's on there because this drop down menu has come down. So those kind of challenges. That's what I see.

Device aesthetics were perceived as an important feature. Socially acceptable devices were recognized as more attractive, drawing positive attention, an encouraging result:

TA: (...) make [communication devices] more flashy, allow it to stand out (...) I think I was going the other way around, not to have it stand out. Unless it's the iPad which brought people to it, you know (...).

Furthermore, teachers reflected on the application of future technologies, such as the BMI through invasive or non-invasive procedures. Interestingly, some participants noted that the ability to hide an element of one's adaptive needs may trump the risks associated with invasive procedures:

TA: (...) two ways I look at it is...non-invasive is definitely very, very good because you don't have to have surgery and whatever and all that kind of stuff (...) But then, you could stand out with other people and not fit in as well and that kind of stuff (...) it just depending on, on what (...) what it looks like.

TB: (...) It's always, 'oh faster, lighter, smaller, invisible', you know (...) I get that, and certainly in terms of portability and if I want to present as a typical kid or a typical person, I would want it to be as invisible as possible whether or not that meant, intrusive. Surgically, that wouldn't bother me (...) but that's my personal feeling. It might bother someone else and certainly, if (...) there are medical implications, obviously, then you wouldn't want that either.

4.1.2. Not Adding to the Impairment

Adding flashy aesthetics to a student's communication device was revealed to be an unfavourable option among the teachers. By placing themselves in the shoes of their student, they perceived that making the technology stand out was an added element to the student's impairment, setting them further apart:

TB: (...) "make the technologies appear more flashy, allow it to stand out" (...) I (...) don't see any um (...) I can't think of any reason why (...) certainly (...) if I was the one with the technology, that's the last thing I would want is, you know, a beacon on my head saying I have a hearing aid, or I have a disability, or I have a challenge or whatever, unless it was necessary for me to communicate to that to somebody and then I would communicate it. I don't need it to be flashing to, you know (...) to stand out for that.

4.1.3. Fear of Judgment by Society

As an extension of not wanting to add to the disability, the fear of how society will perceive disabilities and the individual with the disability is an influential factor in the desire to make communication technologies as unnoticeable as possible. Participant TF highlights this:

TF: (...) I think a lot of times when we look at people that are using different devices to assist them in whatever way they need (...) it's easy to look at what they have with them and what's there and it's easy for general society to make judgements and (...) having certain perceptions based on what they're seeing and so, in a way I think if it's smaller, it's just more so as though they don't have anything different than you and I for what they need to communicate.

4.1.4. Pursuing "Normality"

Among participants, the development of smaller communication devices for students with disabilities was viewed as the most desirable feature. Its portability would mean that students were no longer tied to the constraints of carrying around a large device for the purpose of communication. Furthermore, students would have the opportunity to interact in their environments as "normal" as possible:

TE: (...) Four, "incorporate technologies into our bodies", well wouldn't that be the dream (...) realistic? I don't know if that's possible for everything?

L: Why would that be so great?

TE: Well (...) then they wouldn't have to port anything around (...) you know, really (...) it could be a function of them and then they could function, you know, as close to (...) typical as possible. Especially as far as communication goes, you know, and (...) wouldn't that be nice?

4.1.5. Meeting the Demands of Society

Communication expectations within our society are occurring at a rapid rate as we become more connected through the use of technology. For students with disabilities, the ability to keep up is highlighted as an important function to acquire and have in order to actively participate within their community. Participant TB reflected on the realities this reality:

TB: (...) The sales assistance in Zellers is not gonna stand there and wait 5 min for you to tell her that you want a red t-shirt and not a blue one. So, and (...) for you, personally, you know, if that's (...) it wouldn't happen 'cuz you would have given up on Zellers a long time ago.

So far, the use of technology has made communication easier and faster for many students but much improvement is yet to be made in order for the students to meet the demands of society. Participant TA describes the impact of this:

TA: So they do not have (...) a very efficient way to access [communication], so then message production (...) it takes a long time. So I think that's one of the biggest hindrances in communicating, with others. Even us, who are dedicated to this, sometimes we just can't give them the time that they need, let alone out in the community with regular kids and others. In a regular classroom, topics change and go and everything and (...) there's (...) it's really, really hard for them to keep up (...) they'd be doing a, a message with one (...) about one thing that was happening and the whole class would be 5 or more steps down the road. Even individuals that access (...) well and all that kind of stuff, it's still incredibly (...) what's that (...) 120 words per minute is what (...) I've heard that we speak. Whereas, I think, an accomplished user of a speech generated communication device, 10–15 words per minute.

Data from these interviews provided insight to the perceptions of special education school teachers on the current realities of students' experience with current communication technologies according to their order of ranking. The next section focuses on the teachers' perception of BMI technology an emerging new communication technology that might soon be available to their students.

4.2. BMI Technology

BMI technology is rapidly advancing as a means to providing people with disabilities the ability to communicate and control their environment [2]. However, its potential role in the domain of education has yet to be established. In this study, we explored the benefits and challenges of BMI technology for students with disabilities from the perception of special education school teachers.

4.2.1. Benefits of BMI Technology

Of the six teachers interviewed, half had prior knowledge about BMI technology and only one of the three had done further research into the technology as part of personal interest.

When teachers were asked about the perceived potential benefits of BMI technology for their students, the following points were addressed:

- The elimination of the operational challenges experienced by students with physical impairments.

TA: (...) I'm looking at some students that are physically very, very challenged and (...) operational is one of the biggest needs of accessing a communication device, so then the physical ability is not necessary with a brain machine interface.

- The ability to receive feedback from students would allow teachers to better meet the needs of the student.

TF: (...) getting feedback from students is just (...) I guess, the biggest way that you can see if you're having an effect and if learning is happening and (...) things are being internalized so, it would certainly provide more (...) an increased opportunity for feedback for us to maybe (...) change our practice if need be and (...) to differentiate our teaching more so to meet the needs of the student. So that would probably be the number

one thing for me as a teacher would be for me to get a better grasp of how I can do my job the best I can from what they're kind of gaining from it or not getting what I can change to help that.

- Students will experience an overall increased quality of life with increased independence, participation and social interaction. Participant TD noted the changes in student's life when they are able to communicate their likes and dislikes for the first time. Participant TC envisioned students having the ability to create new relationships beyond their family circle with BMI technology.

TD: (...) benefits communicating [student's] needs, communicating likes, dislikes (...) even interaction with their peers, interaction with staff (...) all of those. So it's just a whole new world for them, really.

TC: (...) [BMI] can make [students] more independent, it can have them communicate clearly for the first time with their families and other people, not just their families. Their families understand their language (...) their gestures and everything. But to then now open that up to talk to a friend or (...) someone on the street or, whatever (...) yes, I think that is amazing and yeah, could be very beneficial.

4.2.2. Challenges of BMI Technology

The teachers also expressed the following challenges with implementing BMI technology:

- Ease of use and reliability of the technology for students. Some teachers expressed concern whether the technology will be difficult for students to learn and grasp the intention of its function. Participant TD notes the challenges a student may face transitioning to the use of BMI technology to express their needs:

TD: (...) maybe just being able to understand [BMI technology] as well. Here we are taking time to understand and if we get confused and then just think how challenging it is for [the students] to understand and know how to use [the technology]. And time could be a big factor in that as well and (...) even for them to understand, "oh if I can (...) one, I can communicate my needs and (...) what do I know, what do I like and don't like? You know, how do I say that?" So I think just wrapping their heads around what it's all about (...) and what they can now do would be different for them (...) or biggest challenge, I guess.

While learning and understanding new technology has its challenges, participant TE expresses concerns with its reliability and the frustrations that arise from this:

TE: (...) well I think as with any technology, it's great when it works, not so great when it doesn't work. So, you're looking at some frustration maybe (...).

- Ensuring that this technology will be appropriate for the student therefore accurate assessments will be required.

As technologies are emerging to support individual needs, implementing the most appropriate technology is important for students with disabilities. Participant TD expresses the challenges of ensuring that students are paired with technologies best suited to their needs and with that requires thorough and accurate assessments:

TD: (...) finding out which device is right because there are such a wide range and there's always a new latest and greatest thing so finding the right device for that students' needs and even best assessing the students' needs as well, what they can and cannot do and (...) being accurate with those assessments (...) and then finding the right piece of equipment and then after that, just being able to use it effectively and (...) being comfortable to teach others that as well (...).

- Students learning appropriate communication skills.

By providing a student with a device that will express their thoughts and intentions it does not imply that what is being communicated will be appropriate or deemed socially acceptable. Participant TE emphasizes this challenge as their experience teaching in a primarily behavior focused classroom:

TE: (...) it might open them up to some (...) possibilities that maybe they were sheltered from a little bit as far as communication goes and who they communicate with and (...) an appropriate communication, having to learn that appropriate communication (...) those might be some of the challenges.

- The medical risks involved with invasive procedures.

Participant TC expressed this concern of surgical risks from experience of a student in the class who had undergone surgery to implant a shunt in their brain. The rejection of the shunt in addition to the student's inability to communicate resulted in further impairments for the student:

TC: Yeah, for students, for our kids (...) our bodies reject things sometimes when they're foreign and our kids lots of times can't tell us that that's happening. I had a young fellow who had a shunt in his head and (...) it got infected but there was no way for him to tell us and his behaviour was different and we watched it for a week and reported it home to parents, finally went to the hospital, ends up its infected, he's got meningitis, hearing loss. So I mean, you know what, that's major devastation and all of that because of foreign something is in his body and he wasn't able to tell us. Now that foreign plate in his head was helping him (...) but then there was no way for him to tell us right out that this was going on and so it took too long, didn't catch it in time and now he's suffering repercussions. So, in that aspect with our kids, and as well, just sometimes a simple surgery for our kids can set them back and not only (...) like in physical as well as mental skills and, some kids have lost their language after a surgery, so surgery for these guys can be very devastating so it would have to be very, very life changing (...).

Furthermore, participant TF brought forward concerns of stability of the technology over time:

TF: (...) definitely safety in terms of surgery or risks that are taken but then also not knowing any sort of long-term risks that could be repercussions down the road because, you know, until you try it and do it and have, I guess a population to follow and monitor and study, you don't know that sort of thing (...) that could be a challenge for sure.

- Privacy of thought.

Among the six participants, one expressed concerns of how BMI technology will ensure the protection of one's private thoughts:

TF: (...) just in terms of, like, people not having the freedom to decipher what they want shared and what they don't, like that seems really like an invasion on kind of privacy and personal space and thoughts and what not. That seems like a big issue to me.

The perceived benefits and challenges for students with disabilities voiced by the teachers provided insight to some key ethical questions required to address as the technology emerges.

5. Discussion

5.1. "Fitting in by Not Standing out"

Our findings from the ranking order of desirable features for new and envisioned communication technologies provided us with insight to the limitations the participants experience with current technologies used in classrooms for students with disabilities. Portability, affordability and speed were the top three features our participants revealed as most important to implement for new and envisioned communication technologies from the list of features they were provided. The participants used the realities they have been experiencing with the technologies their students were using to rank the features. When participants were asked to explain the reasoning for the order of their ranking, our findings identified the overarching theme of "fitting in by not standing out".

The application of ableism and the perception of people with disabilities as conceptual frameworks were used for understanding the perception of new and developing communication technologies for students with disabilities. The findings suggest a dichotomy in the views that participants have toward the degree of visibility of communication technologies; while some technologies are considered more acceptable and even desirable, other technologies remain a marker of difference. For students with disabilities, the preference is to make the technologies as invisible as possible to not add to the disability, which may transfer to a higher quality of life. When reflecting on the use of communication technologies and devices by non-disabled people, such as the cell phone, there is less emphasis on hiding or making the technologies less visible. Rather, the opposite effect is experienced—technologies are made more visible with added covers and trinkets that range in colors and textures. This begs the question of, who needs to fit in and who gets to stand out? From the findings, the preference is for students with disabilities to fit in or "normalize" as much as possible. As our ability expectations continue to be entrenched within the medical model, it consequently frames the perceptions of students with disabilities. That is, presenting students with disabilities as "normal" as possible, which may translate to a higher quality of life as a result of social acceptance. On another level, this raises the question of whether the intention of developing new and envisioned

communication technologies for people with disabilities is more for the benefit of non-disabled people by contributing to economic efficiency, social acceptability, and allowing non-disabled people to feel more comfortable interacting with people with disabilities. That is, having people with disabilities function as “normal” as possible meets the demands of society.

The dichotomy of non- or socially accepted communication technologies suggests that perceptions towards people with disabilities within the framework of the medical model continue to be influential. This dominating lens sets the tone for how people with disabilities are viewed by society by identifying disabilities as below species typical and deficient [62]. Furthermore, if a medical framework continues to be as dominant and influential as it presently is among other discourses (e.g., technology research and development) [54], people with disabilities will continue to be regarded as impaired, requiring the aid and support to become as typical as possible, rather than as part of our diverse culture) [50,51,54]. As social expectations for how we communicate and interact with each other and our environment begin to change, the maintenance of the medically framed perception of people with disabilities and ability expectations may continue to support views of disabilities as below species typical and deficient. As advances in therapeutic devices such as communication technologies allow so called disabled and non-disabled people to obtain abilities beyond the “normal”, the species-typical [50,52,63], the intention to “normalize” people with disabilities to the species-typical through the development of new technologies will be outdated. Indeed one can expect that disabled people who have access to therapeutic communication devices will gain beyond species-typical abilities. As many of these therapeutic assistive devices can also be used by so called non-disabled people to move from the species-typical to the beyond-species-typical we submit that we can predict an appearing gap between the ones who have access to the interventions that lead to beyond species-typical abilities and the ones who do not have access (techno-poor impaired) [64]. We further predict that the move toward beyond species-typical abilities will play itself out within the health discourse where the meaning of health is linked to have obtained beyond species-typical abilities [51,52]. This dynamic will impact how, which and by whom therapeutic communication devices will be used in school settings impacting both special education and integrative settings.

5.2. BMI Technology

From our participants’ perspective, BMI technology brought forth many exciting opportunities envisioned for their students with disabilities—elimination of operational challenges, receiving feedback from students and providing students with an overall increased quality of life. Some of the concerns noted of BMI technology included risks involved with the application of more invasive surgical procedures and its potential repercussions. At this particular school, teachers have first-hand experience of the difficulty and sometimes negative outcomes of surgical procedures undergone by their students. Teachers also noted that careful assessments were required for the proper application of these technologies for students; if at all the application of the technology is appropriate for the student. Part of the reality of tools utilized for children and youth with disabilities is that there are varieties of tools to try along with a variety of opinions on what will be most beneficial for the individual. Another interesting point of challenge raised from the interviews was the consideration that some students may have only been exposed to communicate verbally or non-verbally in a certain manner accepted by their

home or school environments. The addition of a tool like the BMI which will allow for more people to understand their needs does not address the fact that students may not have necessarily learned the interpersonal skills to communicate in a way deemed socially acceptable or appropriate. Among the concerns raised, the filter of information to the public and protection of privacy of thought were highlighted by our participants as uncertainty of how these would be controlled or protected. These are key ethical issues that need to be addressed further as the technology continues to advance. The BMI is one set of products used for therapeutic interventions for people with disabilities but also as non-therapeutic interventions (military, gaming) giving beyond species-typical abilities to people with and without disabilities. It is not clear yet which devices will be used by whom, when and what the social consequences will be. We believe more research is needed that involves the education, especially the special education setting, in the advancements of BMI technology.

6. Conclusions

In this research study we looked at the perceptions of new and envisioned communication technologies including BMI technology among special education school teachers. Our findings suggest that the perceptions of communication technologies are framed by the lens of ableism and perceptions of people with disabilities, dominated by the medical framework. As advanced technologies emerge, such as BMI technology, the possibility of eliminating operational barriers and providing opportunities of increased quality of life to students were perceived by the teachers in this study as a positive and exciting opportunity for their students. However this is not met without concerns of the degree of invasive procedures, appropriate technological application, transformation of communication methods for some students and filter and protection of privacy. We believe that this study has shed light on advancing communication technologies and its purpose for students with disabilities.

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