IMPORTANT FACTORS IN THE DESIGN OF ASSISTIVE TECHNOLOGY TO AVOID THE STIGMATIZATION OF USERS

by

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ABSTRACT

Some disabled users of assistive technologies (AT) have expressed concerns that their use of those AT devices brings particular attention to their disability and, in doing so, stigmatizes them in the eyes of their peers. This research studies how a wide range of design factors, influence how positively or negatively users of wearable technologies are perceived, by others. These factors are studied by asking survey respondents to estimate the degree to which they perceive disabilities in users of various products. The survey was given to 34 undergraduate Product Design students, and employed 40 pictures, each of which showed one person using a product. Some of these products were assistive technology devices, and some were not. Respondents used a five-bubble Likert scale to indicate the level of disability that they perceived in this person. Data analysis was done using SPSS software.

The results showed that the gender of the respondent was not a significant factor in the respondent's estimation of the level of disability. However, the cultural background of the respondent was found to be significant in the respondent's estimates of disability for seven of the 40 pictures. The results also indicated that the size of AT, its familiarity to the mainstream population, its wearable location on the user's body, the perceived power of the user, the degree to which the AT device seemed to empower the user, the degree to which the AT device was seen as a vehicle for assertion of the user's individuality, and the successfulness of attempts to disguise the AT as some mainstream product reduced the perceived disability of the user. In contrast, symbols or stereotypes of disability, obstructing visibility of the face, an awkward complex design, a mismatch between the product's design and its context of use, and covering of the head were factors that focused attention on, and increased the perception of, the user's disability. These factors are summarized in a set of guidelines to help AT designers develop products that minimize the perceived disability and the resulting stigmatization of the user.

DEDICATION

To my parents, Abbas and Minoo, for their endless love and support.

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CHAPTER 1

INTRODUCTION

Section 1. The General Problem Area

People have been aware of their physical limitations for many centuries, as evidenced by their attempts to design and create tools to overcome their limitations. With the progress of societal and economical development over those centuries, humans have designed increasingly elaborate tools to satisfy the increasingly complex demands of society. Today, technology is used not only to fulfill the needs of the general community, but also to enhance the life of people with particular disabilities. However, while these assistive technologies have improved the independence and social interaction of disabled people within society, their use has sometimes also stigmatized their users. In recent years, computer aided design, new types of materials, and new manufacturing processes, have given product designers a wider range of innovative options. The result has been a widening range of augmentation technologies and wearable technologies that extend the sensory and/or motor abilities of disabled users. However, unless these new assistive technologies are properly designed, they can attract the attention of other people to the user's disability, possibly stigmatizing the user in the eyes of the community. Unfortunately, not enough study has been done in the design field to understand what design factors cause stigmatization of the user.

This research is aimed at finding ways to better use leading-edge technologies to design products that will help people with disabilities assimilate into the mainstream population, by pursuing the following three objectives: (1) to develop and demonstrate a new methodology for discovering product design factors that cause others to perceive a user as being disabled, (2) to estimate the degree to which each of those factors contribute to an overall perception of

disability, and (3) to provide a list of guidelines for designers of assistive technology products who want to minimize stigmatization of their users.

Section 2. The Research Approach That Will Be Employed

To allow for a broad investigation of the product design factors that stigmatize users, this research uses a wide selection of 40 photos of people using various technologies – some of which are assistive technologies, and some of which are not.

These 40 pictures were shown to respondents in a sequence, along with a corresponding survey, which asked them about the degree to which they perceived each depicted person as disabled. The design factors of the technology depicted in each picture were then evaluated, based on the degree to which its user was perceived to be disabled. The ultimate goal in doing this was to find approaches to the design of assistive technology that do not suggest a disability, and to use the results to formulate a set of guidelines for product designers.

Section 3. Limitation And Contributions Made By This Research

The limited time available for this research has imposed certain constraints on the development and execution of the proposed approach. For instance, the study could have benefited from a subsequent face-to-face interview of the survey respondents, after the survey was completed. Also, having more participants in the survey would have provided more data. However, this study has produced results that are sufficient to provide specific design guidelines that, if followed, should reduce stigmatization of the users of assistive technologies. Both the proposed methodology and the results derived from its implementation are new contributions to the design field, and the methodology provides a good basis for scaled up future work.

CHAPTER 2

LITERATURE REVIEW

Section 1. Disability And Stigma

Any individual might experience some sort of disability at some time in his/her life. Whether it is for a brief period of time, or for a prolonged period. It is possible that the general population might perceive the person as different from a socially defined norm, and the person might eventually feel discriminated against. Thus people with disabilities sometimes feel stigmatized by the general population.

The World Health organization (WHO) "Report on Disability" (2011) claims that more than one billion people in the world live with some type of disability, which accounts for about 15% of the world's population. The report predicts that, in the future, "disability will be an even greater concern because its prevalence is on the rise". The report asserts that this is due to factors such as the worldwide increase in aging (with a higher risk of disability in the elderly), an increase in chronic diseases, and an increase in mental health disorders.

This growing number of people with disabilities around the world face obstacles in accessing public services such as transportation. They also "have poorer health outcomes, lower education achievements, less economic participation and higher rates of poverty than people without disabilities" (WHO, 2011).

In addition to the aforementioned disadvantages, people with disabilities also face negative attitudes of society. Bagenstos (2000) stated that the Americans with Disabilities Act (ADA)'s statutory findings affirm that individuals with disabilities represent "an identifiable group of people who experience similar, systematic obstacles to participation in a range of activities in

public and private life". These barriers "result from society's prejudices, stereotyping, and neglect" (Bagenstos, 2000). Thus, individuals who are different from the socially defined norm, due to their disability, are likely to experience any of three types of attitudes toward their impairments. The "normal" population might develop prejudices or do stereotyping, they might neglect the person with the disability, or they might feel empathy with the person who has the disability and decide to "help" that person without asking, which can sometimes be unpleasant for the person being helped. All of these attitudes cause discrimination and attach labels to a person with a disability that eventually stigmatize the person.

Along with the growth of the population with disabilities, scholars have expressed the following concerns: their social relationships might be disrupted (Goffman, 1963); they might suffer anxiety and depression (Crandall & Coleman, 1992; Hebl & Kleck, 2000); they might conceal their impairment from others to avoid stigma (de Torres, 2002; Liu, 2001; Lopez-De Fede & Haeussler-Fior, 2002; Miller, 2002; Napier-Tibere, 2002; Pinto & Sahu, 2001); they might feel stigmatized, resulting in a distorted self-image that brings about poor self-confidence and a lowered feeling of affiliation (Wright, 1983; Scherer, 2003; Scherer, 2000; Major & Obrien, 2005); and they might even abandon the use of Assistive Technologies (AT) because its use causes stigmatization (Brickfield, 1984; Luborsky, 1993; Zimmer & Chappell, 1999; Hocking,1999).

Section 2. The Definition Of Stigma

The notion of stigma has been studied within a variety of different disciplines, such as psychology, sociology, law, political science, and anthropology. Goffman (1963) a pioneer sociologist in the study of stigma, referred the origin of term stigma to the tool that Greeks used to tattoo their slaves.

Karst (1995) in 'Myths of Identity', said that "The harm of stigma is that a single perceived characteristic is seen as disqualifying the whole person, excluding him or her from membership in the community that calls itself the 'normals'". Lennard Davis (1995) stated that the concept of 'norms' dates back to the early nineteenth century. He argues that 'norm' replaced the notion of 'ideal', which might be unreachable by any individual human. However, use of the concept of a "norm", "unlike that of an ideal, implies that the majority of the population must or should somehow be part of the norm."

Goffman (1963) declared that stigma indicates an attribute that is discrediting, and a mark of disapproval in the eyes of other people. Other scholars (Parette & Scherer, 2004; Crocker, 1998; Scambler, 2009) agree with him. However, Goffman (1963) states that all people seem to categorize others as "The Stigmatized" and "The Normal". Whether or not a particular attribute is stigmatizing depends on its perception as normal or abnormal by individual or societal norms.

Oliver (1996) does not see disability as a result of impairment, but as evidence of social boundaries or limitations imposed upon people with disabilities. Those boundaries and limitations "range from individual prejudice to institutional discrimination, from inaccessible public buildings to unusable transport systems, from segregated education to excluding work arrangements".

Scambler (2006) claims that Goffman's debate ignores social structures such as class, command, gender, and ethnicity. Link and Phelan (2001) claim that power must be added to Goffman's definition of stigma associated with disability. They argue that "Stigma is entirely dependent on social, economic, and political power… it takes power to stigmatize". This suggests that people with disabilities are perceived to be weak by social groups who call themselves normal. They are vulnerable to be stigmatized because they are not powerful in society.

Section 3. Signals Of Disability

Goffman, suggests that "The Stigmatized" can play roles and hide their true self to cope with being in the out-group. This suggests that visibility of the disability plays an important role in stigmatizing the individual with the impairment. Hebl and Kleck (2000) agree with Goffman's assertion that people with invisible or hidden impairments have less problematic social interactions than those with visible disabilities. This suggests that any AT that a person uses that draws attention to him/her, or to his/her disability, has the potential to stigmatize a person.

While using an assistive technology (AT) might boost one's autonomy and independence, it has disadvantages along with advantages: it might draw attention to the user's disability (Brown and Webster, 2004). For example, Brookes (1998) says "Assistive devices become a signal because the sight of a person using assistive technology sends a message that this is not an ordinary person and that one needs to behave differently around this person". On the other hand, Crocker and Quinn (2002) state that AT usage is a public behavior that triggers cognitive, social, and motivational force that adjusts a person's self-perception (such as self-esteem and self-image) with social norms. Consequently, people with disabilities might abandon the use of AT if they feel that its use causes stigmatization (Brickfield, 1984; Luborsky, 1993; Zimmer & Chappell, 1999; Hocking,1999).

Section 4. Disability And The Design Of Assistive Technology

According to Crilly et al. (2004), during the process of designing a product, when usability needs have been satisfied, emphasis may shift towards aesthetic, emotional and symbolic traits of the product. They say that "consumers don't just buy a product, they buy value in the form of entertainment, experience and identity". Thus there is a need to take into account the identities and personalities of persons with disabilities, and design assistive technologies in

such a way that they will not provoke stigma. However, literature on avoiding stigma in designing a product is limited and scarce. Specifically, there is a lack of empirical studies on factors that make products stigmatizing.

To avoid the design of stigmatizing AT, Bispo and Branco (2008; 2010) suggest that the designer "look for the divergences between the social expectations of what the so-called normal characteristics should be in a specific object and the real characteristics of the given object". They state that medical devices are perceived as stigmatizing when they are used in environments other than hospitals. As strategies to de-stigmatize assistive technology they suggest designing AT according to the context of its use, "covering" assistive technology, and using symbols to alter stereotypical indicators of disability, such as the flames on Dr House's cane (Figure 1). Hiding hearing aids in "normal" eyewear (Figure 2) is an example of "covering", although these authors mention that it can lead to permanent tension as the person has to open up about his/her disability to a close person, and that might obstruct close relationships.

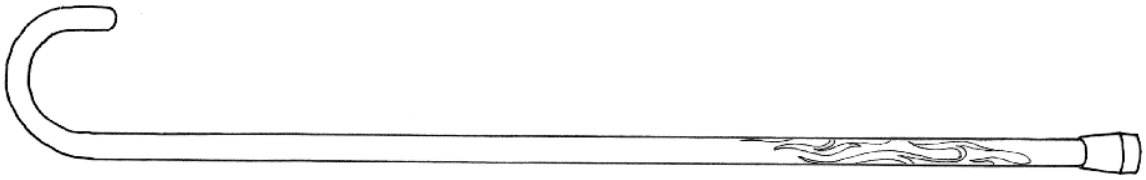

Figure 1. Bispo & Branco (2008) assert that the flames on Dr House`s cane are an example of symbols that can alter a stereotyped indicator of his disability.

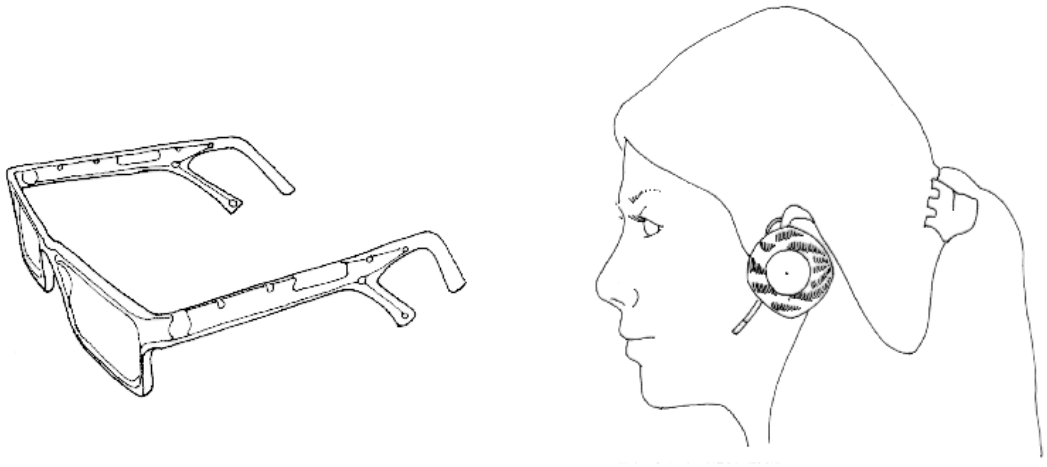

Figure 2. Bispo & Branco (2008) state that "the 'Surrond Sound Eyewear' designed by Industrial Facility (left) allows the stigmatized person to cover her disability, while the 'Universal Hear-ring' designed by Pearson Lloyd (right) calls the attention to the hearing aid and, thus, to the disability".

Vaes, Stappers, Standaert, and Coppieters, (2012a) conducted a study of "Mask Aversion" in which a confederate wears a dust mask. The study showed that the majority of passer-bys "will maintain a greater (safer) walking distance" when they pass the confederate. The walking distance demonstrates the stigma that is perceived by a passer-by who sees a person wearing a dust mask. Wearing a product like a dust mask, which might be worn by people without disabilities, shows the stigma that people attach to any abnormality. Perhaps the stigma arises from the idea that the person wearing the mask either is prone to, or has, some sort of disease.

In a "contending stigma in product design" study, Vaes, Stappers, Standaert, and Desager, (2012b) argue that "the Universal Dimensions of Social Cognition: Warmth and Competence" theory proposed by Fiske et al. (2007) is useful to designers for product assessment. A product enhances or diminishes the social image of the user through the product semantic. The two dimensions of that semantic are determined by the answers to two basic questions: 1. "Does the other person (group) intend to harm or help me (us)"? The answer to this question reflects 'warmth'. 2. "Does the other have the ability to enact those intentions"? The

answer to this question reflects 'competence'. Vaes et al. (2012b) also cite the work of Crocker et al., 1998; Jones et al., 1984; Major and Obrien (2005), which emphasize the importance of social identity in defining stigma, through "Identity Threat" model. Major and Obrien (2005) assume that "possessing a consensually devalued social identity (a stigma) increases one's exposure to potentially stressful (identity-threatening) situations". Identity threat appraises through three factors: 'collective representations', that means a person develops a shared understanding of stigma in society; 'Immediate situational cues', which means that "situations differ in their social identity threat potential, i.e., in the extent to which they signal that one is at risk of being devalued"; 'Personal characteristics' that means how a negative situation is evaluated through a person's point of view. Through these factors, a person evaluates an identity threat situation and reacts accordingly.

Vaes et al. (2012b) also cite the Wilber (2000) AQAL (All Quadrants All Levels) theory. Combining these three theories, Vaes et al. suggest three main strategies for contending with stigma, which are: A) "Re-shaping the socio-societal context" which relies on influencing the shared understandings of social structures and social groups. B) "Re-shaping the meaning of the product"; which relies on: 1. Disguising stigmatizing elements with camouflage or attracting attention toward appealing traits. 2. Product identification or personalization in a way that the user can choose or alter a product so that it matches the user's identity in the way he/she wants to express him/herself. 3. "Reshaping product meaning through meaningful interaction with other products" such as a bike helmet that can be complemented with a socially accepted fashionable hat. 4. Transforming product meaning through material and technology improvements. 5. "Reshaping meaning of products in use"; by interacting with products, "users gradually learn more about their products and they progressively understand them better. During this process their understanding changes continually. By making a bike-helmet foldable, we eliminate the

cumbersome issue of storage". C) "Empowering the product user against stigma"; which relies on boosting the user's ability, highlighting their goals, and/or improving their social skills.

Stockton (2009) suggests the following strategies to avoid stigma association in product design: A) Education of the general population, which can be done using three approaches. 1. Design as a tool to redefine the boundaries of "normality". Stockton cites "TeddyBearBand" of Phillippe Starck with this notion that this toy might teach children that there is not a defined format for people to expect them to be like that (see figure 3). 2. A purposefully designed instrument for forcing a non-disabled person to experience a position that a disabled person experiences as stigmatizing. 3. Having a non-stigmatized person use a negatively associated product such as wheelchairs and white canes, to experience the position of a stigmatized person. B) Technology; which can minimize the size of an assistive technology, or conceal it in another product. C) De-stigmatisation by the employment of mainstream user's taste, in order to turn a product with a stigmatizing function (such as an insulin needle) into an artifact (such as a modern pen) that better suits a mainstream user's taste. D) De-stigmatisation of a product feature through its application of Stigmatizing features in a mainstream product design. The example of this is the application of the stigmatizing rubber feet of crutches to a "Do Add" series of furniture (see figure 4). E) Functional Desire, which aims to make the AT device so useful and easy to use that it is adopted by the general population. F) Alteration of Ritual, which aims to avoid stigma by making the device (and its use) less obvious, such as the design of insulin needles that look like pens, and can be used through clothes, instead of directly on skin and flesh. G) Disassociation; which aims to disassociate a device with a negative stigmatizing meaning, through advertisement or other methods. H) Association; which aims to enhance a product status through association of positive brand values.

The aforementioned strategies of Stockton lack both theoretical support and empirical study, to confirm feasibility and effectiveness of these approaches. The Vaes et al. study (2012b) is based on three intertwined theories, but is also unsupported by any empirical studies.

Figure 3. Philippe Starck's "TeddyBearBand

Figure 4. "Do Add" series of furniture by Jurgen Bey(Stockton, 2009)

Wearable technologies are the future of assistive technologies. Wearable technology products are not necessarily assistive technologies, although their use might incur some social stigma similar to that incurred by the use of assistive technologies. According to Boxal (2013) Google glass is an example of a wearable technology that has been banned in several locations, and has received negative reactions from members of the general population who are not technology geeks. Thus, this wearable technology is facing social stigma, in spite the fact that it is not associated with any particular disability, and is merely designed to augment user experience. Gownder (2014) believes that the Google glass social stigma emerges from: 1. A device that invades the privacy of others, since the user can take photos or record video of them whenever she/he feels inclined to do so. 2. Use of the device (which uploads the moment-by-moment experience of the user to the cloud) sacrifices the user's privacy in exchange for the advantages offered by the device. 3. "Conspicuous consumption" because the device lacks mainstream usage "Glass suffers from an elitist perception – a $1,500 toy for the 1% of tech". 4. "Lack of élan" i.e. similar to other wearable devices, "Glass suffers from a certain fashion awkwardness". Lately, it has been reported that Google is participating with Oakley, Ray-Ban, and Luxottica to try to solve the problem of style, and to develop a new design for the glass (See Mack's report on Cnet, 2014).

Section 5. Summary

Designers of assistive technologies need to go beyond evaluation of the usability of their designs to a consideration of the stigma that might be associated with it when it is used, with the aim of avoiding stigmatizing labels that might arise from using it. Individuals with disability are concerned about designs that bring attention to their disability. In Black et al. (2012) one user is quoted as saying "Don't make me look like a Martian". Toward this aim, more study is needed to turn this concern into workable strategies that allow users to blend into the population, avoiding

the stigma often associated with the use of assistive technologies. This brings us to the Research Question that forms the basis for the research described in this Thesis:

What factors and features of wearable technologies cause a person to look disabled, to a greater or lesser degree, by their peers?

CHAPTER 3

METHODOLOGY

Section 1. Introduction

The methodology described in this chapter was used to explore the question of what design factors are most important for reducing the stigmatization of users, where stigmatization is measured in terms of how much a particular design makes the user appear to be disabled.

Section 2. Objective

The objective of this study is to collect data that will allow the formulation of a set of guidelines for designers, to help them avoid the design of assistive technology products that stigmatize the users.

Research question:

What factors and features of wearable technologies cause a person to look disabled, to a greater or lesser degree, by their peers?

Hypotheses to be tested:

Hypothesis 1: There are multiple design factors that influence how positively or negatively users of wearable technologies are perceived by others.

Hypothesis 2: In the case of assistive technologies, these factors can be discovered by asking observers how they perceive the disability level of users of various products.

Section 3. Research Design

A mixture of quantitative and qualitative methods was employed to provide answer to the research question. A set of 40 pictures was prepared, along with a survey questionnaire (see Appendix A) for use in collecting quantitative data about the entire set of 40 pictures. The

research was conducted on the Arizona State University Tempe campus, and the participants were junior undergraduate Industrial Design students. The survey was conducted as an in-class activity, without course credit given for participation in the survey. All of the survey data was collected during one class session. A total of 34 students participated in the survey.

Each of the 40 pictures showed a person using a wearable product – some of which are assistive technology (AT) devices, and some of which are not. Pictures of people wearing the product were used (instead of pictures of just the product) because the purpose of the survey was to determine to what degree that product made a person look *disabled*. All 40 pictures were collected using the Google Image search engine. These images were collected based on suggested strategies offered by the literature, which includes products that are used in fashion, using the AT as a piece of jewelry (identification), reshaping product through technological improvements, using graphical elements to moderate the disability image, disguise the AT, and potential approaches to de-stigmatize wearable AT. As examples of the latter, pictures showing people wearing conventional hats, jewelry, and headphones were chosen, to evaluate the possible use of those familiar wearable products to disguise or camouflage an AT device; and pictures showing people wearing punk tech and high fashion accessories were also chosen to evaluate any stigma evoked by the wearing of these unusual products.

These 40 pictures were then shown in sequence to the 34 survey respondents in their classroom, in the form of a PowerPoint presentation. The pictures showing people wearing conventional wearable products were interspersed randomly with pictures showing people using/wearing various AT devices, as well as pictures of people wearing unusual products.

The Respondents were first given a brief description about the study, saying that the survey was intended to get their personal impressions of people using AT devices, and that the

results were to be applied to the design of wearable AT products for people with disabilities. The focus of the survey was to document their first impressions – not about the product alone, and not about the person alone, but about the person's perceived level of disability, based on their use of the product. The survey respondents were asked to answer as quickly as possible with their first impression. They were told that a picture of a person using a particular wearable product would be put up, and then they would have 30 seconds to fill in one of five bubbles, to indicate their first impression about how disabled the person shown in the picture looked to them.

The questionnaire employed a 5-bubble Likert scale. This allowed the respondents to quickly provide the 40 answers, as they viewed the 40 pictures. Prior to beginning with the 40-response survey, the respondents were asked to indicate their gender, age, and the country in which they attended high school – the latter question being asked to provide some information about their cultural background. Then they filled in one bubble on the following five-bubble Likert scale: "Severly Disabled; Somewhat Disabled; Normally Abled; Above Average; Way Above Average", for each picture, as an answer to the following question "This person is:".

The entire process of filling out the questionnaire for all of the pictures took about 20 minutes. (Some additional class time was used to provide the instructions before running the survey, to explain the goals and intentions of the survey, and to answer questions from the respondents. Taken together with the 20 minutes for the survey, the entire process took about 30 minutes.

At the end of the survey, respondents were given a more detailed explanation for the purpose of the survey. Specifically, they were informed that "As designers of consumer products there is a realization that, when people see a person using a particular product, they might form

a positive or negative opinion of that person, based on his/her use of that product. In particular, the use of an AT product might be stigmatizing for the person using it. The purpose of this survey was to evaluate various wearable products, to determine how their use affects the perceived disability level of the user, with the goal of designing AT products that do not stigmatize users."

Excel and SPSS programs were used as quantitative data analysis tools. Two *t*-tests were run to better understand the relationship between the survey responses and the gender and cultural backgrounds of the responders. To reduce the individual biases of the 34 responders, the average (Mean) response, and the spread (Standard Deviation) of their responses was computed for each of the 40 pictures. A structured but subjective method was then employed to explore possible explanations for those statistics derived from each picture.

Section 4. Scope, Justification And Limitations

The author recognizes that generation plays an important role in perceiving stigma, as the definitions of stigma and disability changes over time, and with generations. Students in their junior level of undergraduate education represent a rather narrow population within the range from about 20 to 30 years old. Given the limited time frame available for the study, and the availability of only 34 students for 30 minutes in one session, conducting a survey seemed to be the most expedient tool for answering the research question. In order to take best advantage of the available time, and the number of participants during a single session, showing as many pictures as possible, and asking a single question about all of those pictures, was deemed to be the best way to collect the quantitative information the author was seeking. The goal of the survey was narrowed to determining the degree to which each person, depicted using each product, was perceived as being disabled, and consequently stigmatized. The pictures were chosen so that one (or a few) wearable products were salient on each person, to simplify the job

of interpreting the quantitative results, using the literature of prior work to help guide the subjective interpretation of those results.

Obviously, the study would benefit from obtaining more information from more respondents. This could be done by asking more questions about each picture, and/or by having more respondents participate. It might also be beneficial to spend more time on the selection of the pictures. This might include an initial presentation of a larger number of pictures to individual responders, followed by a subsequent "weeding out" of some of the pictures, based on those results. Having people other than design students responding to the survey could be helpful as well. Unfortunately, given the limited time available for this survey, these methods were not practical. However, any or all of them could be employed in future follow-up work.

CHAPTER 4

RESULTS AND DISCUSSION

Section 1. Demographic Information

The Genders of the study respondents: 26 out of the 34 participants were male; 8 participants were female (see Figure 1).

26 out of the 34 participants were male; 8 participants were female (see Figure 5).

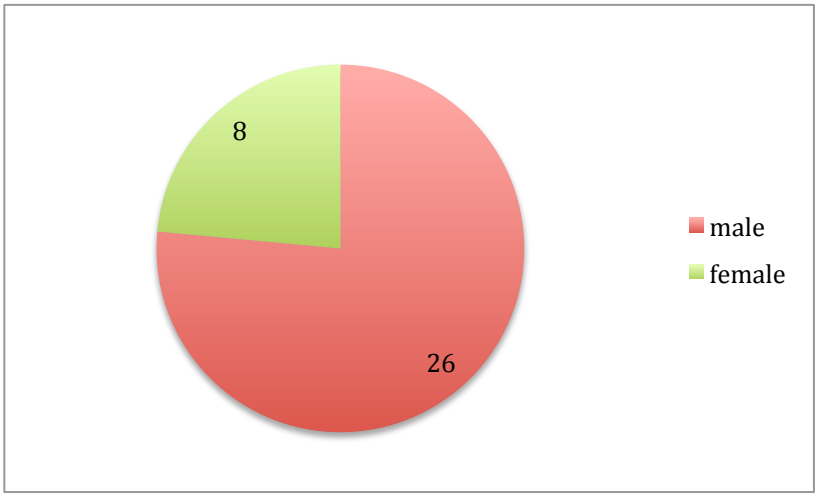

Figure 5. Participation according to Gender.

The Cultural background of the study respondents: Each participant's cultural background was judged by the location of the high school that they attended. 29 out of the 34 respondents went to high school in America, while 4 participants went to high school in Asia (3 in China and 1 in Singapore). One participant did not indicate where he/she attended high school. (see Figure 6).

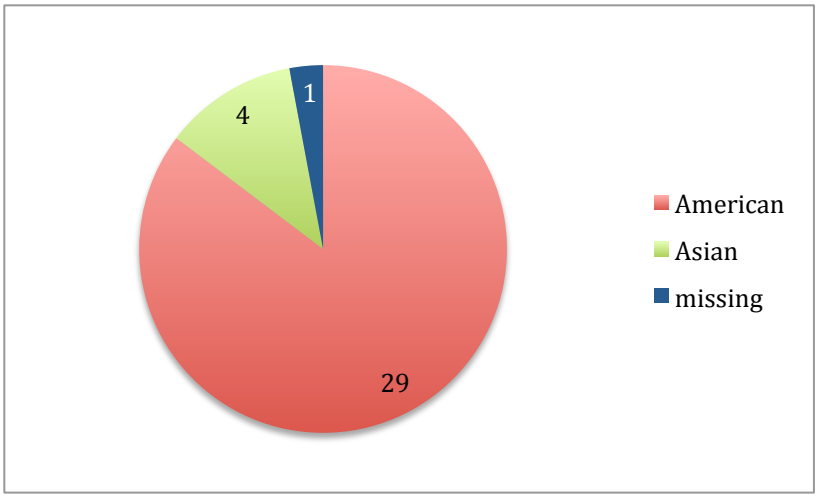

Figure 6. Cultural Backgrounds.

The Age spread of the study respondents The age spread of the study respondents was rather limited. All respondents except for one were in their 20s. (See Figure 7)

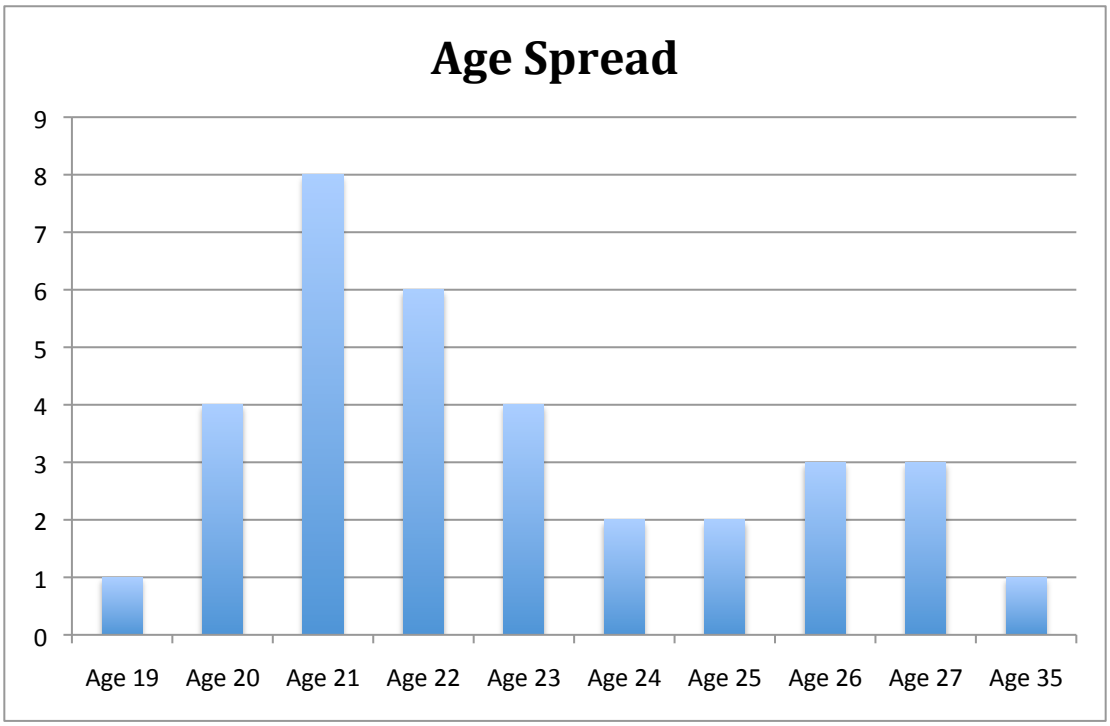

Figure 7. Age spread of the study respondents.

Section 2. Results And Discussions

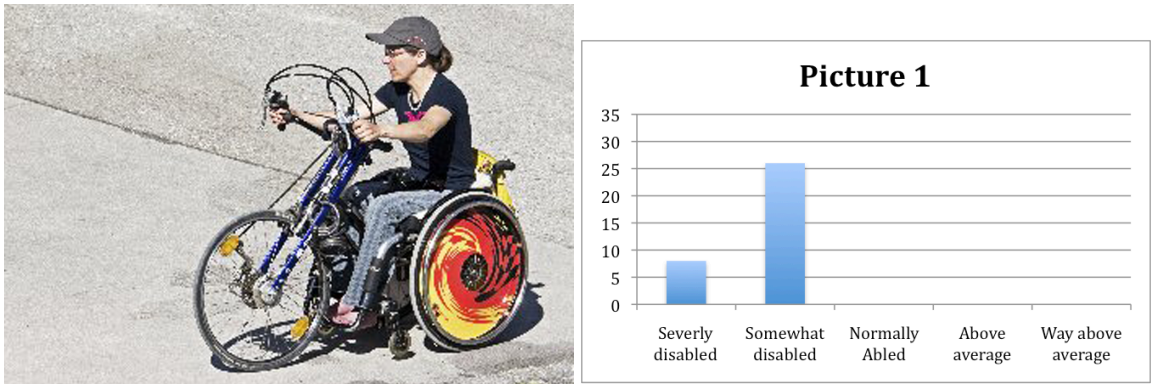

Figure 8. Picture 1 (VU, 2012), and frequency bar chart of picture 1.

Discussion of picture 1

Disability factor (Mean): 1.7; Confusion factor (Std. Deviation): 0.4, (see Appendix B).

The data suggest a device that attracts attention to disability, and thus might be stigmatizing. The combination of the two large wheels and the two small wheels plus a platform that the feet rest on suggest a wheelchair and a motor disability, although the handlebars and the large bicycle front wheel might suggest otherwise. Possibly, the visual symbol of motion on back wheels is not helping change disability image as Bispo & Branco (2008) propose.

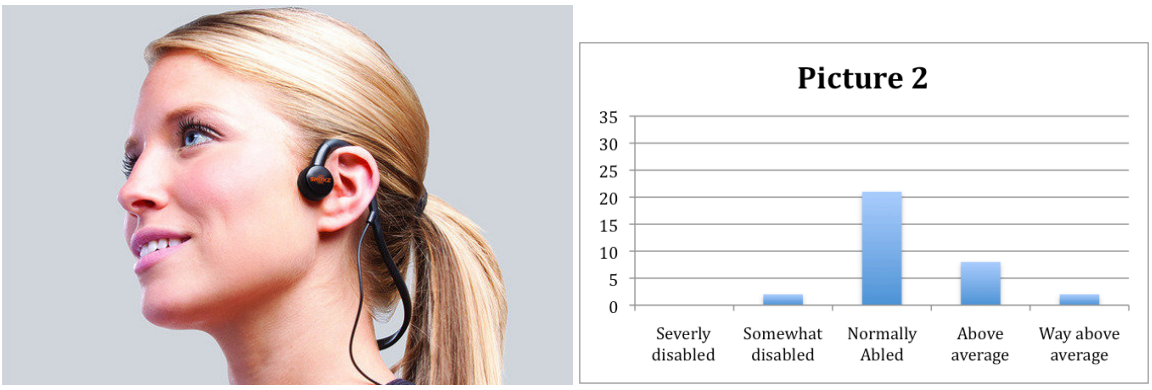

Figure 9. Picture 2 (TechHive, 2013), and frequency bar chart of picture 2.

Discussion of Picture 2

Disability factor: 3.3; Confusion factor: 0.6

Almost all of the respondents saw this person as Normally Abled or Above Average. The wearable device has the simple and familiar shape of earphones, making it look familiar and high-tech, suggesting that it enhances the user's normal ability.

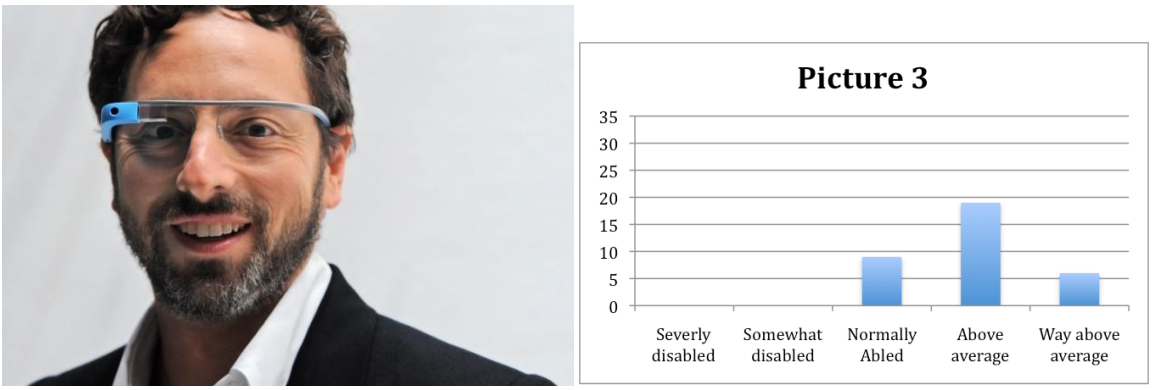

Figure 10. Picture 3 (Sciencewr, 2013), and frequency bar chart of picture 3.

Discussion of Picture 3

Disability factor: 3.9; Confusion factor: 0.6

All respondents saw this person as Normally Abled or Above Average. This suggests that the wearable device is seen as enhancing the user's abilities above those of the general population. The design is simple but asymmetrical. It can be seen that this is not a pair of lensed eyeglasses, but just a frame with some kind of cutting-edge technology mounted on it.

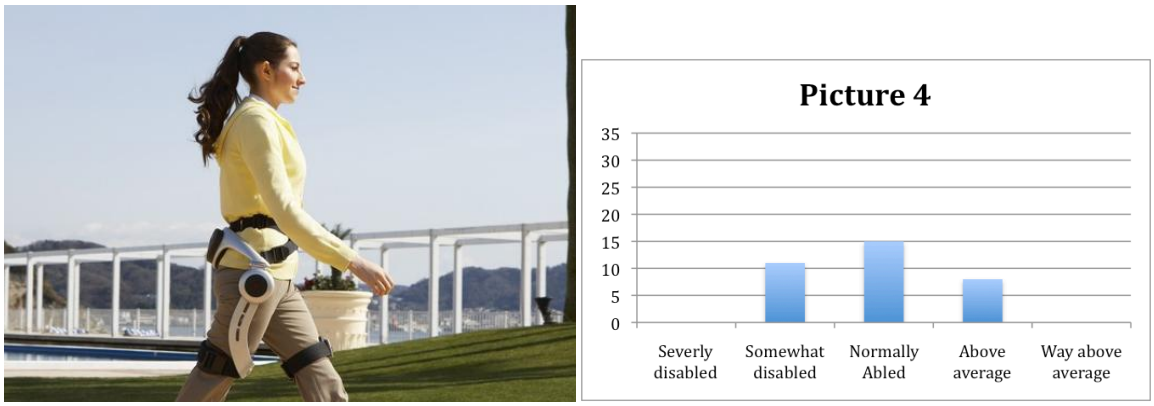

Figure 11. Picture 4 (Gizmag, 2012), and frequency bar chart of picture 4.

Discussion of Picture 4

Disability factor: 2.9; Confusion factor: 0.7

The dispersion in the data suggests confusion in perceiving this device's purpose. The device is not familiar. It is possible that people cannot assign meaning to such an unfamiliar device. There seems to be no evidence of a motor disability, since the woman is walking, and since she is not using a walker or a wheelchair. Thus the device is not clearly seen as an assistive device, and the person is perceived as a Normally Abled person by most respondents.

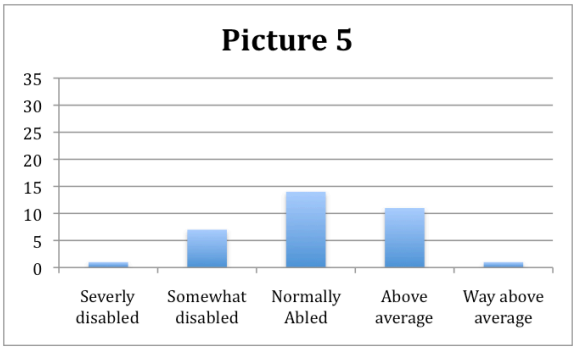

Figure 12. picture 5 (Cliff Keen Athletic), and frequency bar chart of picture 5.

Discussion of Picture 5

Disability factor: 3.1; Confusion factor: 0.8

The dispersion of the data suggests confusion about the purpose of this wearable device. Some respondents might have recognized it as an ear guard for wrestling. However, other respondents might not know that usage. The device covers the head. This might suggest to some that this device is an assistive device.

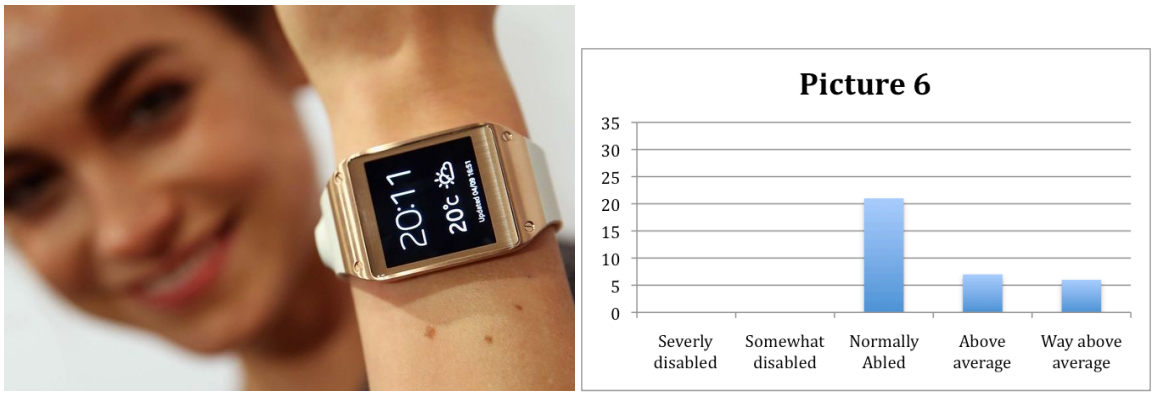

Figure 13. Picture 6 (Samsung's Gear smartwatch clock, 2013), and frequency bar chart of picture 6.

Discussion of Picture 6

Disability factor: 3.5; Confusion factor: 0.7

All respondents perceived this person as Normally Abled or above average. This smart watch is worn on wrist. Perhaps devices worn on the wrist, and with a conventional wrist-watch shape, will be seen as familiar, and thus are not be seen as an assistive technology.

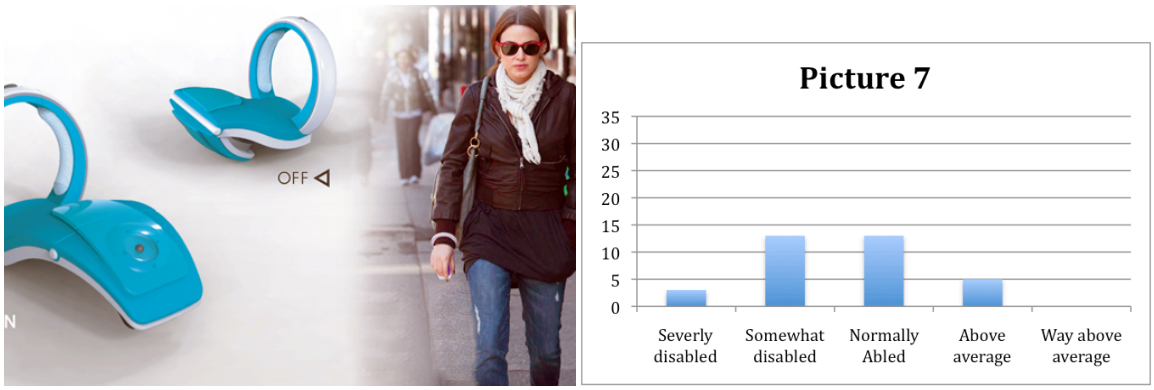

Figure 14. Picture 7 (Kim, 2010), and frequency bar chart of picture 7.

Discussion of Picture 7

Disability factor: 2.5; Confusion factor: 0.8

The dispersion of the data suggests confusion about the purpose of this device. As the device is worn on the wrist, it is hard to tell that this is a 'supersonic stick' that can be used as an alternative to a white cane, for a person with a visual disability. The data suggests that almost half of the respondents see the user as disabled – possibly because of the dark glasses that the person wears, and/or the close-up view of the device. Perhaps the respondents would have had a smaller chance to figure out the application of the product if they were not design students.

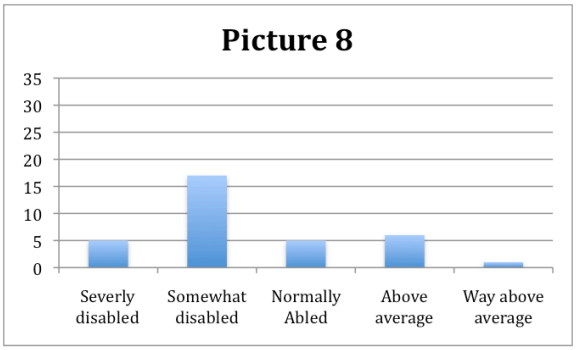

Figure 15. Picture 8 (Huseklepp, 2009), and frequency bar chart of picture 8.

Discussion of Picture 8

Disability factor: 2.4; Confusion factor: 1.0

It is hard to provide a simple explanation for the responses to this picture, as the data does not spread normally. Perhaps the robotic shape of the arm suggests to some respondents that it provides some extra abilities to the user. Although, people are unlikely to miss the fact that this person is missing one arm, she appears to be otherwise healthy. Note: The way she dresses might affect people's judgments.

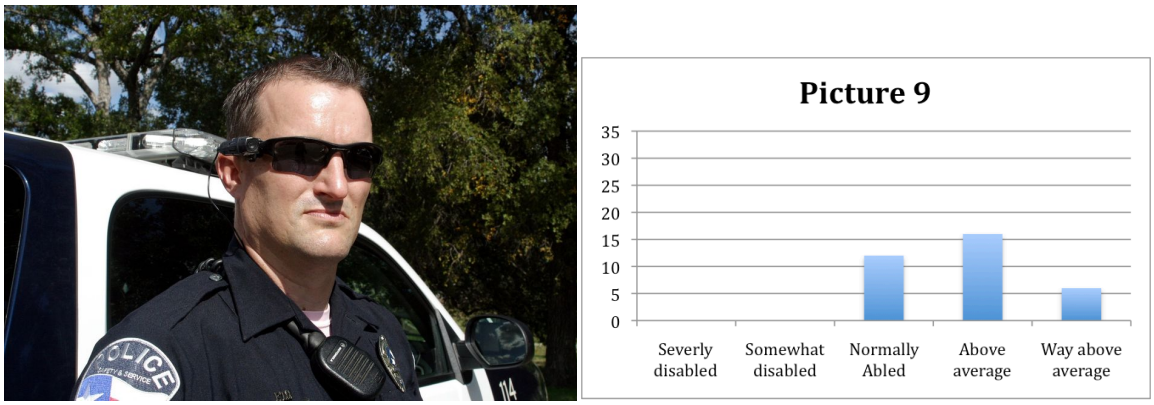

Figure 16. Picture 9 (Rice, 2013), and frequency bar chart of picture 9.

Discussion of Picture 9

Disability factor: 3.8; Confusion factor: 0.7

This officer was seen by all respondents as a person who has abilities at or above normal, in spite the fact that he wears an obvious asymmetrical camera on his sun-glasses. Perhaps police officers are unlikely to be associated with any kind of disability, as they should be physically able to face any unexpected dangerous situation.

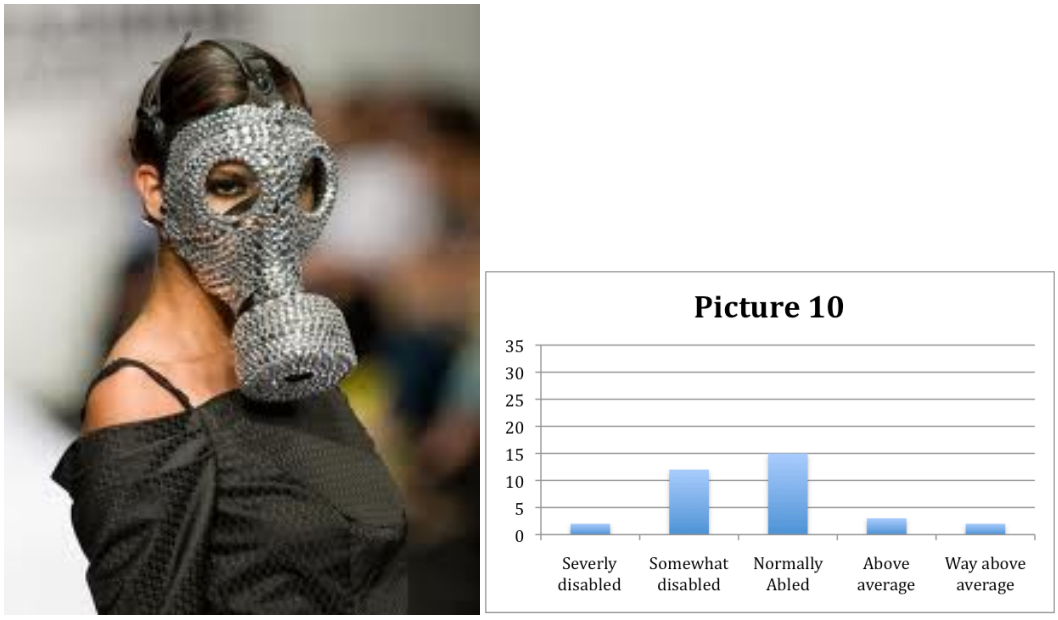

Figure 17. Picture 10 (Reni, 2013), and frequency bar chart of picture 10.

Discussion of Picture 10

Disability factor: 2.7; Confusion factor: 0.9

The data suggests a great deal of confusion about the purpose of this wearable device. Perhaps some people realized that the person is in a catwalk show. Despite the shiny ornaments on the mask, it is plausible that some people felt that the device she wears suggests a disability because it covers her face. According to scholars (Vaes et al.), wearing a mask can be stigmatizing.

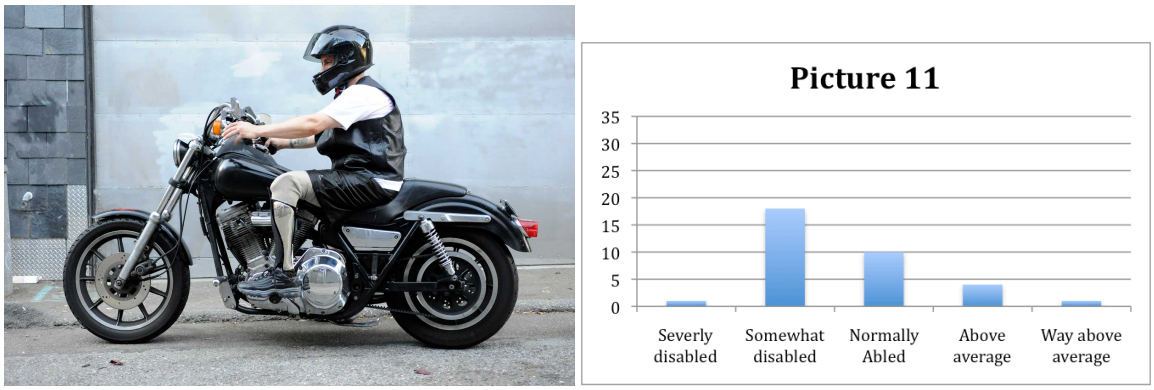

Figure 18. Picture 11 (Bespoke Products), and frequency bar chart of picture 11.

Discussion of Picture 11

Disability factor: 2.5; Confusion factor: 0.8

The majority of the respondents saw this person as disabled. However, a substantial minority saw the person as Normally abled, or even above average . Perhaps the harmony of the prosthetic material with motorcycle he rides, and form of the prosthetic (which closely mimics the shape of a normal leg) is the cause of confusion. Also, his upright posture does not suggest any disability in riding the motorcycle.

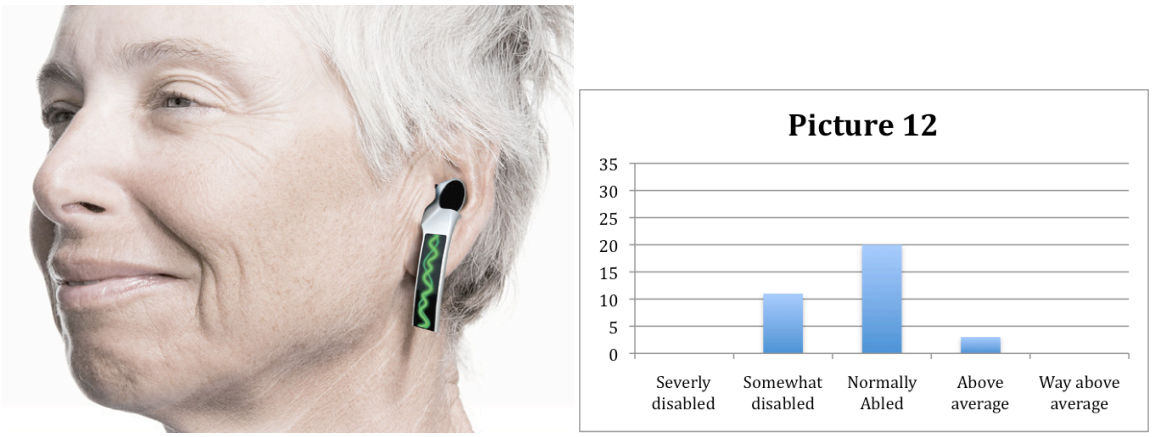

Figure 19. Picture 12 (Tang, 2012), and frequency bar chart of picture 12.

Discussion of Picture 12

Disability factor: 2.7; Confusion factor: 0.6

Despite the fact that this wearable device is inserted into the ear canal, the majority of participants saw this person as Normally Abled. Two factors might have affected these responses. First, the hearing aid is designed in the shape of an earring. Second, the digital sound wave design suggests a technology inside the earring. This might be perceived as a symbol of an extra hearing ability that a technology might provide to a person. However, it is clearly inserted into the ear canal, which apparently suggested to some respondents that the person has a disability. Altogether, the device seems to be somewhat ambiguous, which might be a good strategy to camouflage an assistive technology.

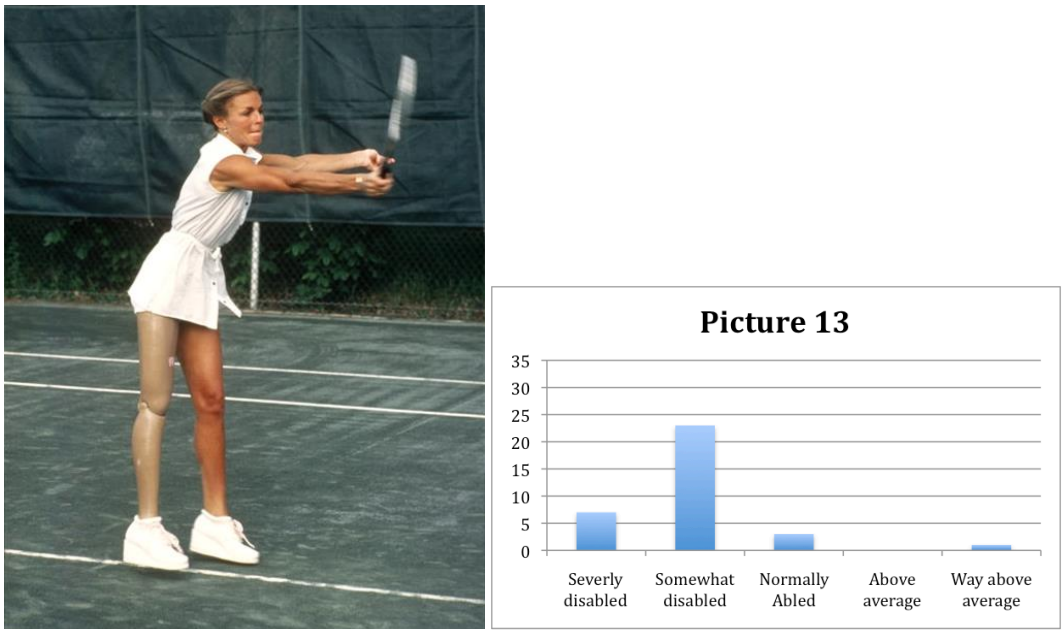

Figure 20. Picture 13 (Ursillo), and frequency bar chart of picture 13.

Discussion of Picture 13

Disability factor: 1.9; Confusion factor: 0.7

Some scholars (Cruz, 2012) have suggested that prosthetic arms can be de-stigmatized by designing them to look like normal arms. The person in this picture wears a prosthetic leg that resembles a normal leg, while playing tennis. However, it can be seen as a prosthetic leg because of the less-than-optimal color of the plastic material, and the visible discontinuity at the knee joint. Also, her somewhat awkward pose suggests a disability. Any or all of these factors might explain why almost all of respondents saw this person as disabled.

Figure 21. Picture 14 (Gretchen, 2012), and frequency bar chart of picture 14.

Discussion of Picture 14

Disability factor: 3.1; Confusion factor: 0.5

The data indicates that this person, who wears a bolo tie, a necklace, and a hat is perceived to be normally abled, or even somewhat above average. This suggests that jewelry or hats might be successfully used as camouflage for an assistive device.

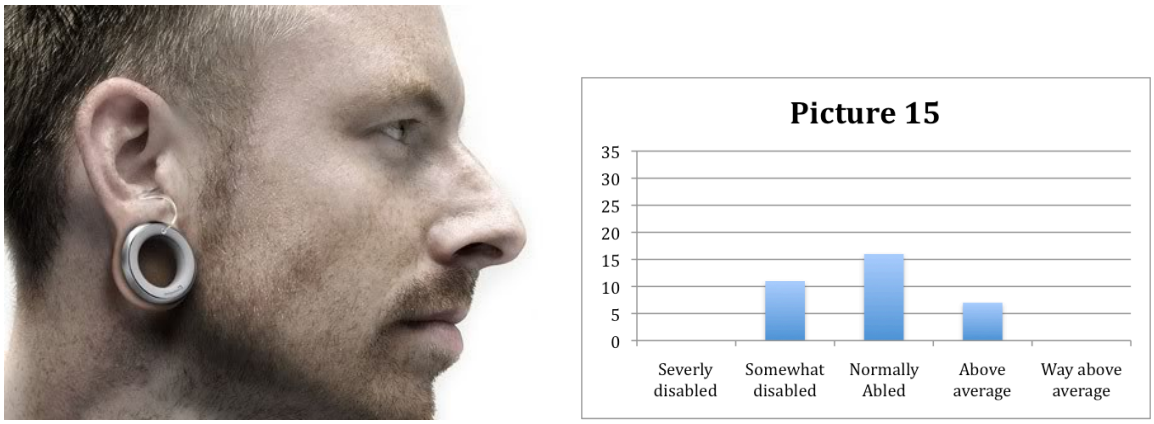

Figure 22. Picture 15 (Designaffairs, 2009), and frequency bar chart of picture 15.

Discussion of Picture 15

Disability factor: 2.8; Confusion factor: 0.7

This product is somewhat confusing, according to the data. A large majority of the respondents saw this person as Normally Abled or above. Perhaps that majority did not notice the tiny translucent tube that runs from the ear gauge hearing aid into the ear canal. However, while the tube is not salient, it is still visible, which probably accounts for the minority of respondents who saw this person as somewhat disabled.

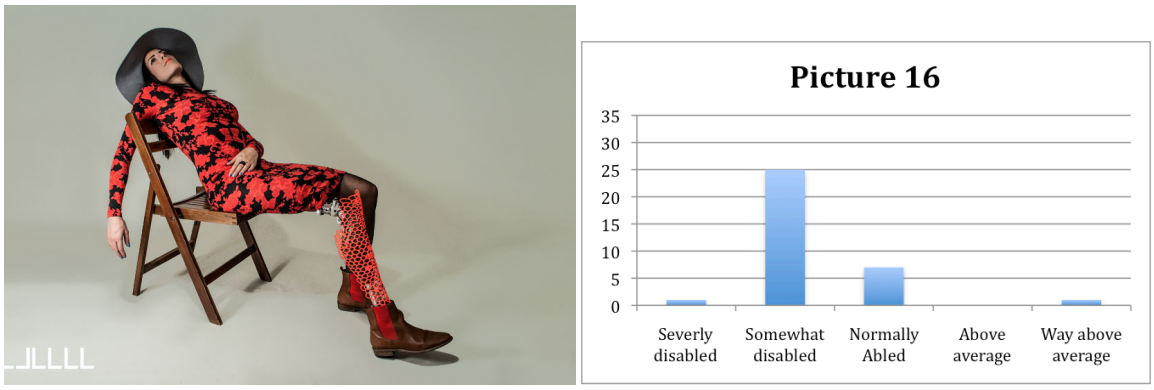

Figure 23. Picture 16 (Alleles), and frequency bar chart of picture 16.

Discussion of Picture 16

Disability factor: 2.2; Confusion factor: 0.6

The data shows some confusion in perceiving the prosthetic leg. The majority of respondents perceived the woman as somewhat disabled. The bare bones metallic prosthetic leg is fashionably covered in a meshed material that is color coordinated with the woman's dress, but the result still shows her disability. The responses suggest that, when it is obvious that an amputated limb has been replaced by a prosthetic, people still identify that person as disabled, regardless of how fashionably dressed the person is. The rather dramatic pose emphasizes the prosthetic leg in the photo. Perhaps the 8 'normally abled' responses suggest that designing a prosthetic to be customizable to match a wardrobe might moderate the perceived disability.

Figure 24. Picture 17 (Haupt & Alstin, 2005), and frequency bar chart of picture 17.

Discussion of Picture 17

Disability factor: 3.4; Confusion factor: 0.6

A device that completely covers the head could be stigmatizing. However, this data shows that only 6% of respondents felt that this person was even somewhat disabled. The rest of the participants perceived this person as Normally Abled, or above the general population. It is possible that presenting two pictures of the same person biased those responses. In one picture she wears the device on her head, but the other picture shows a normal woman who wears no device on her head.

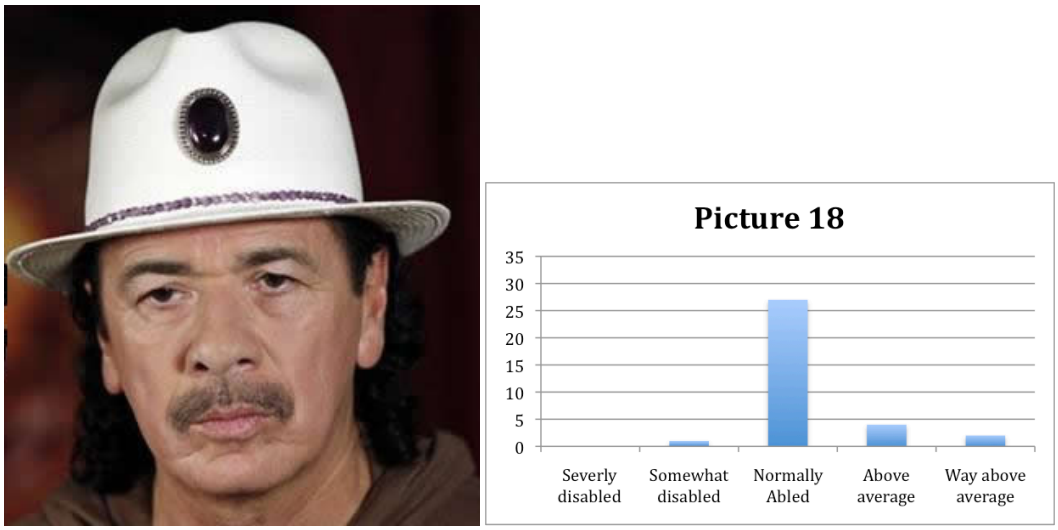

Figure 25. Picture 18 (Syracuse), and frequency bar chart of picture 18.

Discussion of Picture 18

Disability factor: 3.2; Confusion factor: 0.5

Virtually all of the respondents saw this person as Normally Abled. Perhaps the one respondent who saw him as somewhat disabled was due to the jewelry on the hat, which might suggest a camera. The 18% above average responses suggest that the hat might be perceived as enhancing his ability.

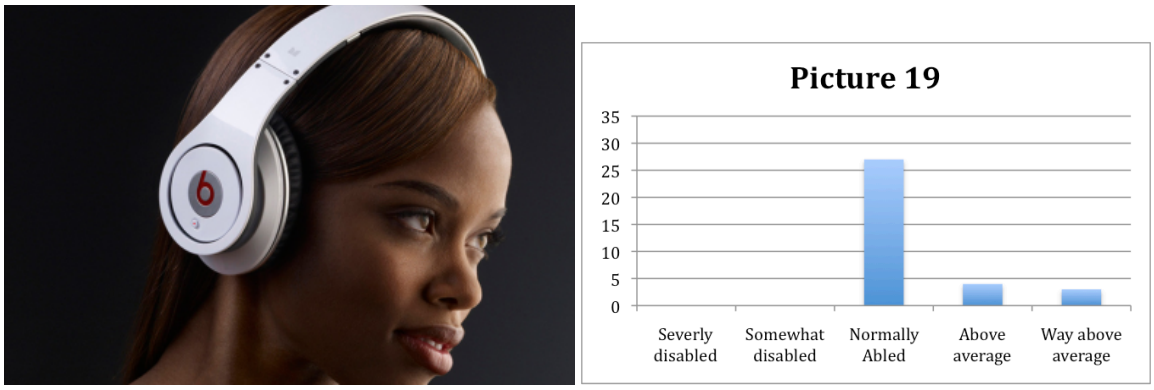

Figure 26. Picture 19 (Beatsbydre, 2009), and frequency bar chart of picture 19.

Discussion of Picture 19

Disability factor: 3.2; Confusion factor: 0.6

This is a popular product, in both brand and shape. The responses suggest that this product was recognized as normal headwear by the respondents in their 20s, and to 28% of respondents it even enhanced the perceived abilities of the user, in spite the fact that it covers the head and ears. This might provide a strategy for this target group to disguise an assistive technology.

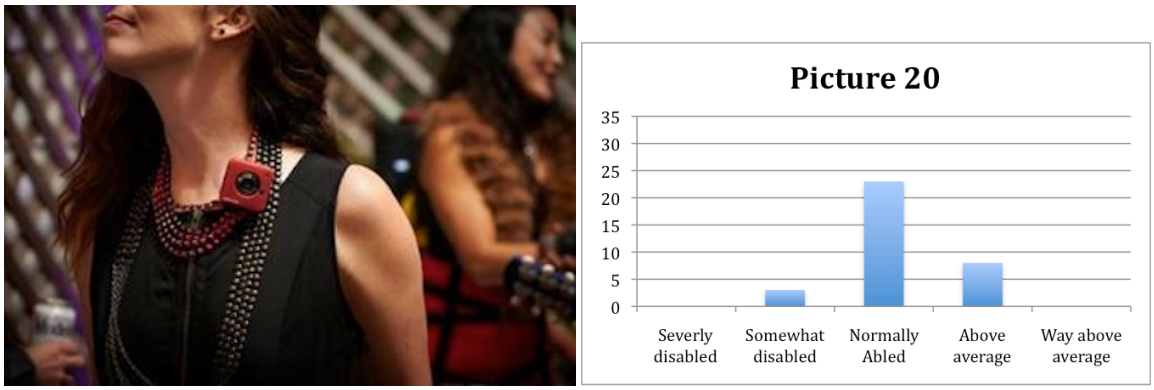

Figure 27. Picture 20 (Looxcie Wearable Camera , 2014), and frequency bar chart of picture 20.

Discussion of Picture 20

Disability factor: 3.1; Confusion factor: 0.5

The majority of respondents saw this person as Normally Abled. 23% felt that the wearable device enhanced the user's ability. Only 12% apparently saw the jewelry as indicative of a disability. This suggests a strategy of disguising a camera as jewelry.

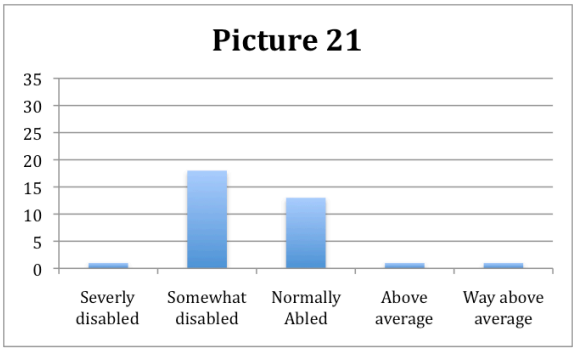

Figure 28. Picture 21 (Photobucket), and frequency bar chart of picture 21.

Discussion of Picture 21

Disability factor: 2.4; Confusion factor: 0.7

Perhaps the pose of the person (and the fact that he is a character of a TV series) produced some confusion in the response. This suggests that TV shows can influence the perception of disability. The data also suggests that the symbols on the cane mentioned as a strategy by Bispo and Franco (2008) did not eliminate the perception of a disability.

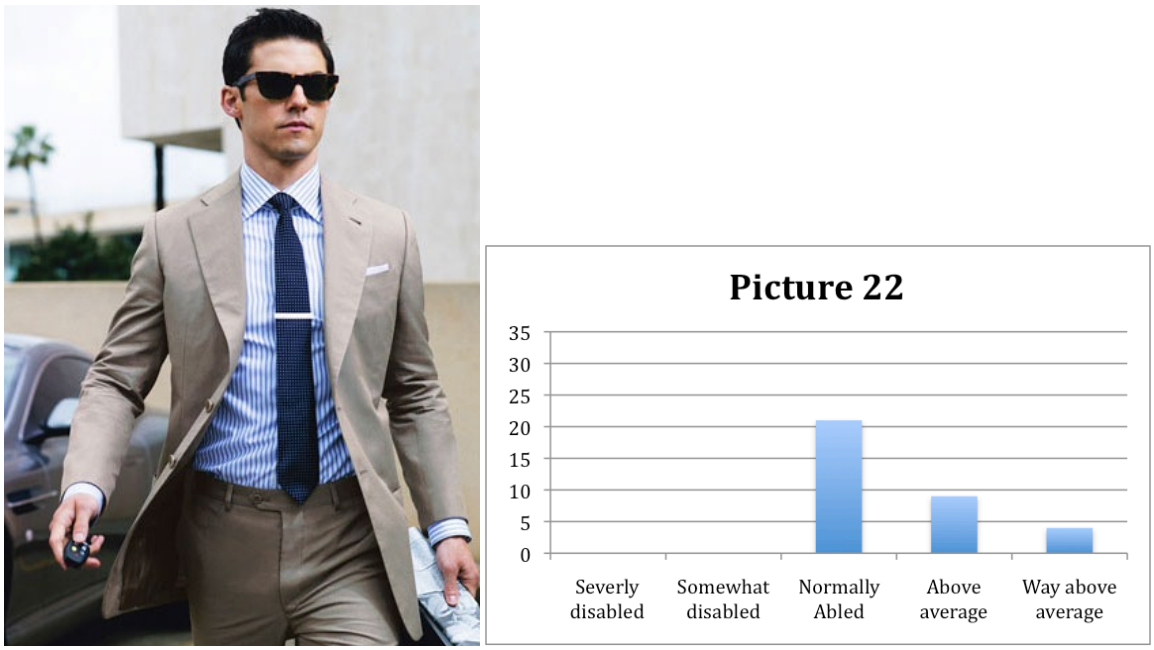

Figure 29. Picture 22 (GQ, 2008), and frequency bar chart of picture 22.

Discussion of Picture 22

Disability factor: 3.5; Confusion factor: 0.7

The majority of the respondents perceived this person to be Normally Abled or above average, despite the sunglasses. Some people apparently felt that his tie, tie bar, and sun glasses (participants were told to pay attention to these outfits) added to his perceived abilities. The car remote control in the person's hand and the car in the background possibly could affect this response as well. Perhaps a suit, tie and tie bar might offer opportunities to conceal or draw attention away from a hidden assistive technology.

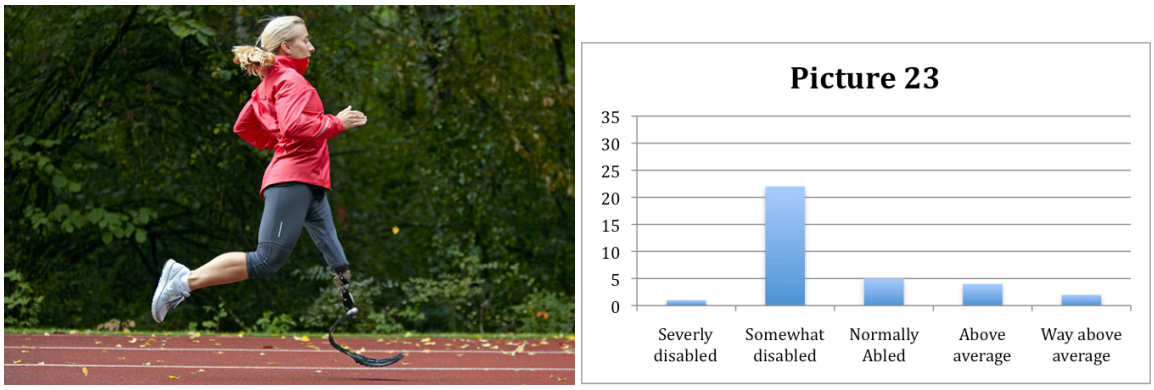

Figure 30. Picture 23 (Nikeinc, 2012), and frequency bar chart of picture 23.

Discussion of Picture 23

Disability factor: 2.5; Confusion factor: 0.9

The data shows confusion about this picture. The reason that the majority considered the person as someone with disability might be because the shape of the prosthetic is so strange. (It looks more like a kangaroo leg rather than a human leg.) The shape of the prosthetic brings attention to her disability. Many respondents felt that this person is Normally Abled or even has abilities above the general population. This might be due to a perception that the woman using the running blade might be able to run faster than a person with two normal legs, as the assistive device boosts her ability in running.

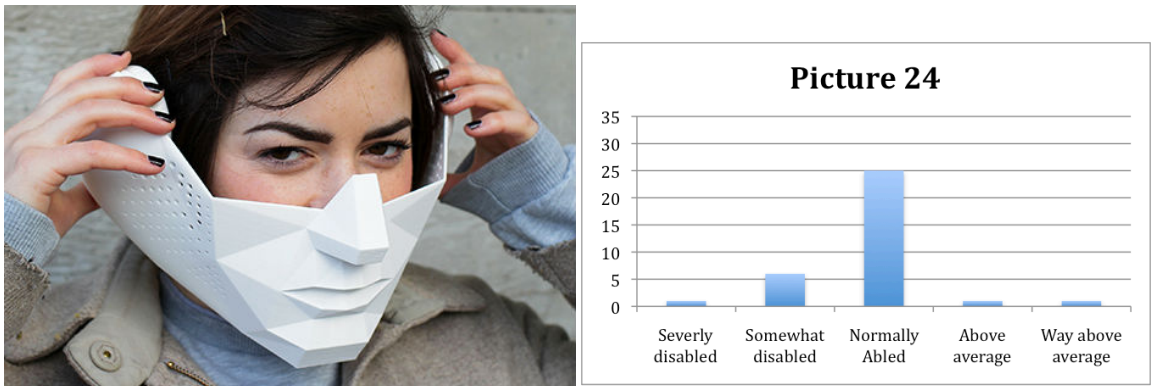

Figure 31. Picture 24 (Bouckley, 2012), and frequency bar chart of picture 24.

Discussion of Picture 24

Disability factor: 2.8; Confusion factor: 0.6

This device was confusing to respondents. The form that mimics a person's face might explain why the majority of respondents perceived the user as normal, despite the fact that covering face and ears might conceal a disability.

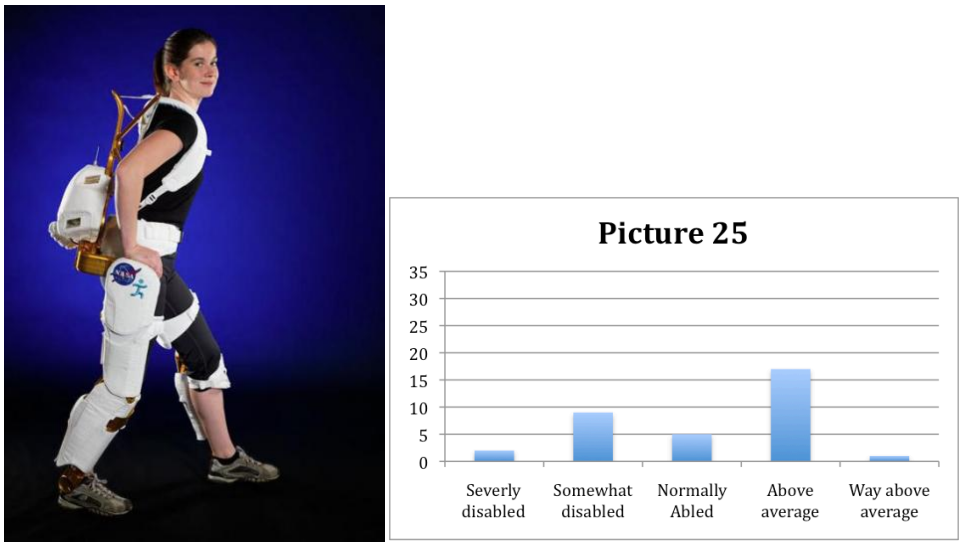

Figure 32. Picture 25 (NASA's Ironman-Like Exoskeleton, 2013), and frequency bar chart of picture 25.

Discussion of Picture 25

Disability factor: 3.1; Confusion factor: 1.0

The dispersion of the data suggests that respondents were uncertain about the purpose of the device worn by this person. The NASA logo and robotic form seems to have suggested an enhanced ability to almost half of the respondents. On the other hand, the apparent need for a robotic device and its complexity apparently suggested a disability to the other respondents.

Figure 33. Picture 26 (Fashion diva design, 2013), and frequency bar chart of picture 26.

Discussion of Picture 26

Disability factor: 3.2; Confusion factor: 0.6

The data shows that this person is perceived as Normally Abled or above average by a majority of the respondents, probably because the product is perceived as conventional necklace jewelry. Perhaps the large size and the complexity of the necklace raised some suspicions of disability among two respondents.

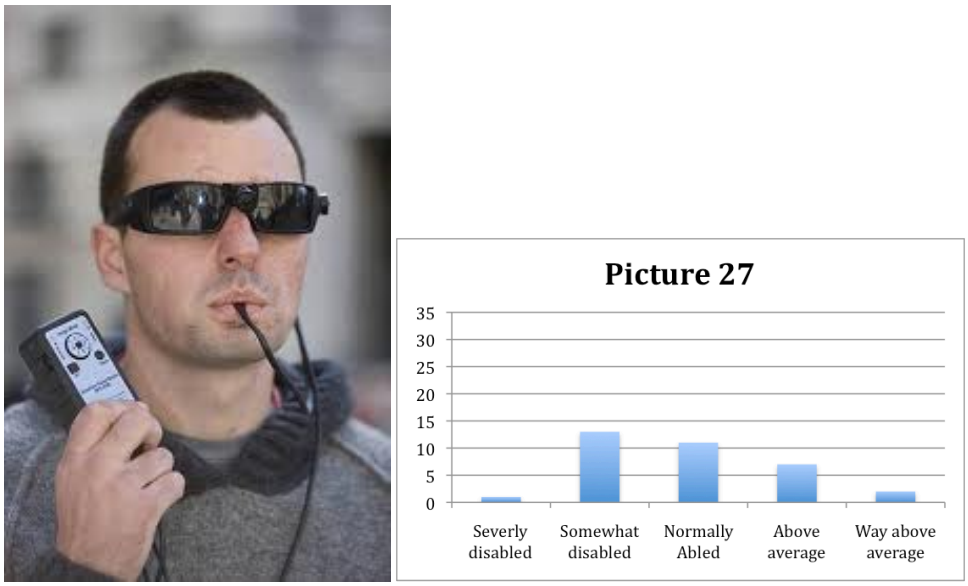

Figure 34. Picture 27 (BBC, Craig Lundberg, 2010), and frequency bar chart of picture 27.

Discussion of Picture 27

Disability factor: 2.7; Confusion factor: 0.9

The responses to this picture suggest that the respondents were uncertain about the purpose of the product being used by this person. The tube in the mouth of user is clearly unusual. Perhaps it was perceived by some as part of an assistive device, but perceived by others as an augmentation device for a Normally Abled person. The heavy, dark sunglasses and the electronic box in his hand probably added to the confusion.

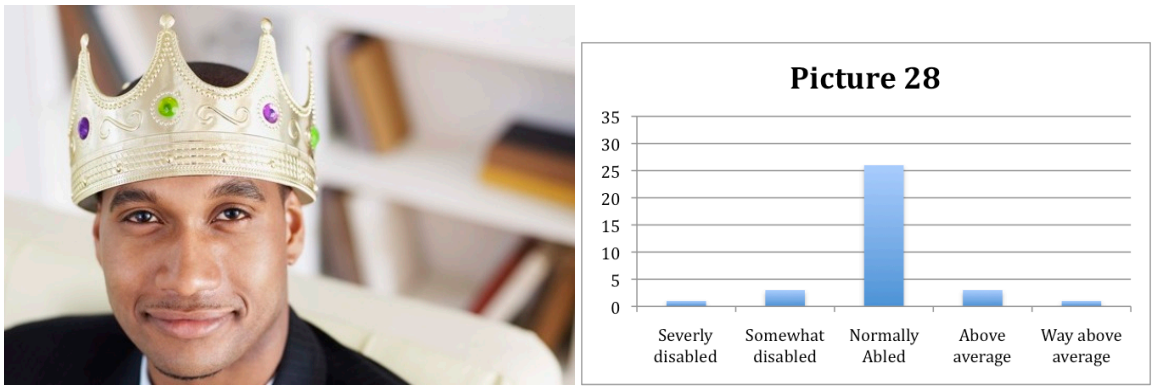

Figure 35. Picture 28 (Gold crown), and frequency bar chart of picture 28.

Discussion of Picture 28

Disability factor: 2.9; Confusion factor: 0.6

Although there seems to be some confusion, the majority of respondents thought this person is Normally Abled. The confusion can be a good sign for hiding an assistive technology in the crown without attracting much attention to its unusualness. However, it may seem socially awkward to see someone wearing a crown in daily life and it attracts attention, but probably the function of the crown does not suggest disability.

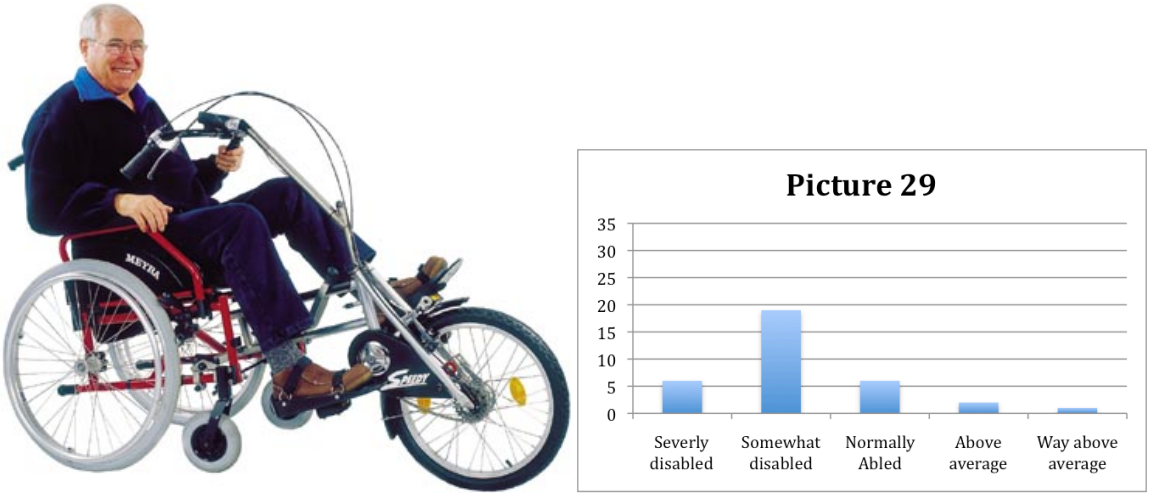

Figure 36. Picture 29 (Invacare, 2011), and frequency bar chart of picture 29.

Discussion of Picture 29

Disability factor: 2.2; Confusion factor: 0.9

The small wheels seem to be the symbol of motor disability. The hand-ring on the rear tire, and the type of seat does suggest a wheelchair, rather than a bicycle. The device is almost similar to the picture 1. Their only difference is the pedals in the current picture, which might be the cause of confusion in consensus about the ability of the user. Although, Having two straps on the pedals may suggest a disability.

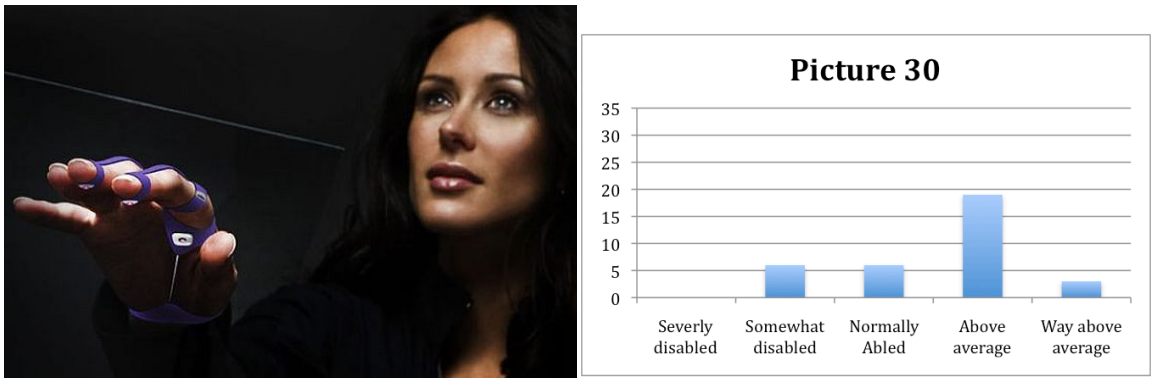

Figure 37. Picture 30 (AirMouse , 2010), and frequency bar chart of picture 30.

Discussion of Picture 30

Disability factor: 3.5; Confusion factor: 0.8

Although this could be an assistive rehabilitation device, the majority of respondents felt that this person was Normally Abled or above average, when compared to the general population. This suggests that wearing a device on hand is not perceived as a strong indicator of a disability.

Figure 38. Picture 31 (Steampunk woman), and frequency bar chart of picture 31.

Discussion of Picture 31

Disability factor: 2.3; Confusion factor: 0.8

The majority of respondents felt that this person has a visual disability. Only a few respondents perceived this product as a technology to boost normal abilities, rather than as a technology to assist with a disability. Perhaps covering the eye is a strong indication of a disability.

Figure 39. Picture 32 (Birdhouse hat), and frequency bar chart of picture 32.

Discussion of Picture 32

Disability factor: 2.6; Confusion factor: 0.6

More than half of the participants perceived this person as being Normally Abled or above, despite her very strange hat, only two participants imagined an enhancement in abilities. 44% of the participants saw this person as Somewhat Disabled, though it is unclear whether the hat was seen as an assistive device. Perhaps any unusual product that is not normally seen in daily life can be confusing, and might be associated with disabilities!

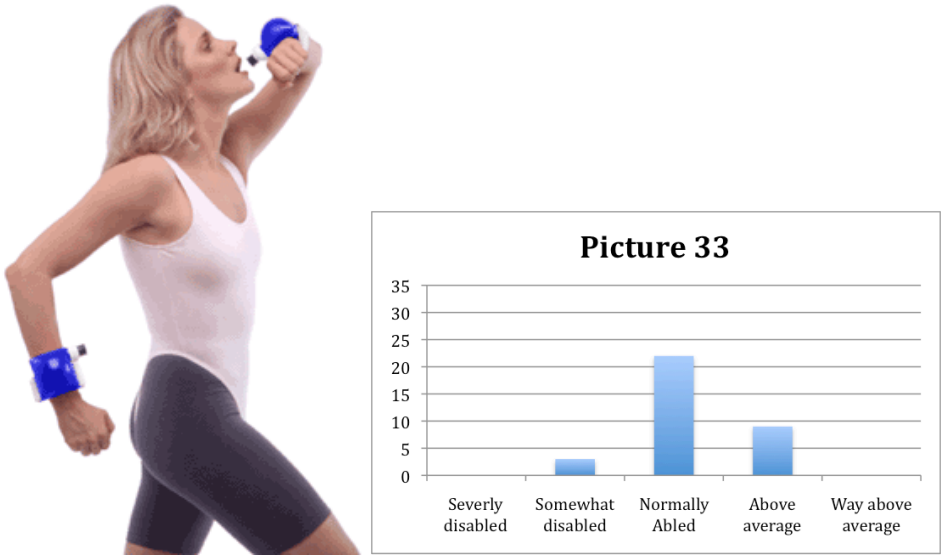

Figure 40. Picture 33 (Opulentitems Wrist Strapped Water Bottles), and frequency bar chart of picture 33.

Discussion of Picture 33

Disability factor: 3.1; Confusion factor: 0.5

The data shows only a small degree of confusion related to this product, which is worn on the wrist. The majority of participants (65%) felt that the person was Normally Abled or above average. It is not clear why three participants saw this person as Somewhat Disabled. Perhaps those respondents perceived an inability to hold a water bottle.

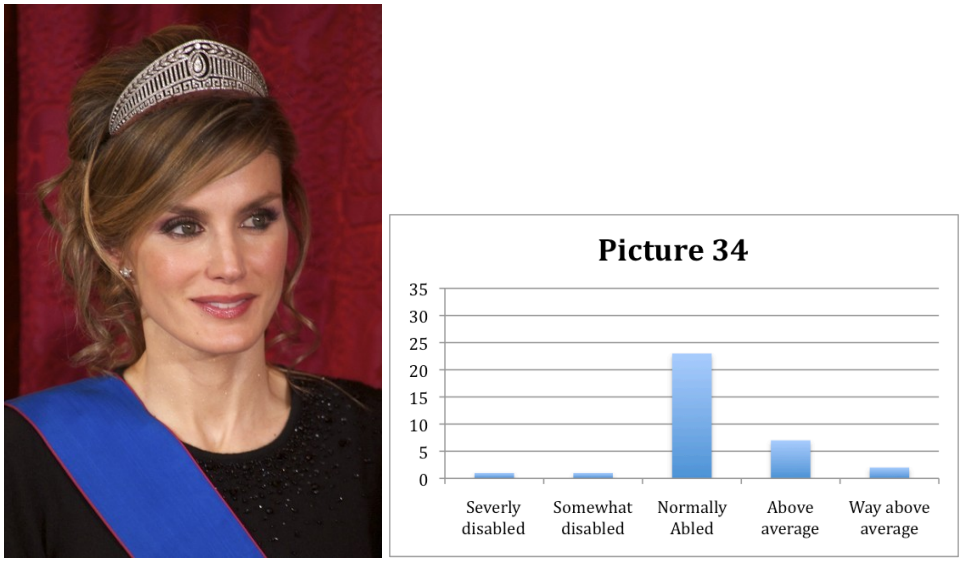

Figure 41. Picture 34 (Hellenic Tiara), and frequency bar chart of picture 34.

Discussion of Picture 34

Disability factor: 3.2; Confusion factor: 0.7

Only 9% of respondents felt that this person was disabled in any way. The response of the rest of participants suggest that a tiara worn in the hair might be a good disguise for an assistive technology, as it might be associated with regality, which usually is not related to disability.

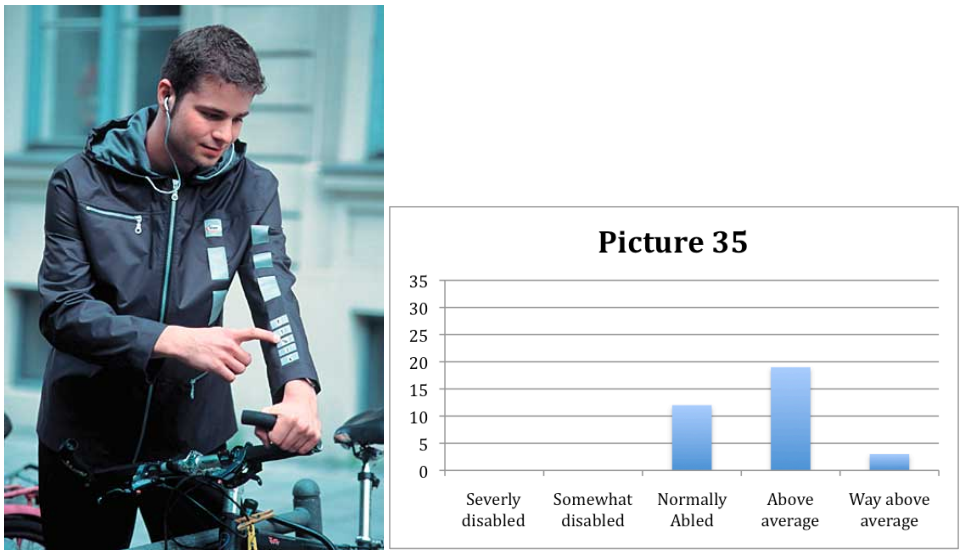

Figure 42. Picture 35 (O'Neill & Infineon Technologies AG's Snowboarding jacket, 2004), and frequency bar chart of picture 35.

Discussion of Picture 35

Disability factor: 3.7; Confusion factor: 0.6

All of the respondents saw this person as Normally Abled or above average. This suggests that clothing might be a good way to package assistive devices, and that the user interface might even be a prominent feature of such clothing.

Figure 43. Picture 36 (Waterproof iPod Shuffle), and frequency bar chart of picture 36.

Discussion of Picture 36

Disability factor: 3.5; Confusion factor: 0.6

The data shows that all of the respondents perceived this person to be Normally abled or above average. The iPod and its earphone seem to be a familiar device for respondents in their 20s and one in 30s. The gesture of the girl suggests a healthy person who is probably doing workouts or is ready to swim. This suggests that a small clip-on device might be a good way to disguise an assistive technology, because it does not draw attention to the disability, if it is a familiar looking device.

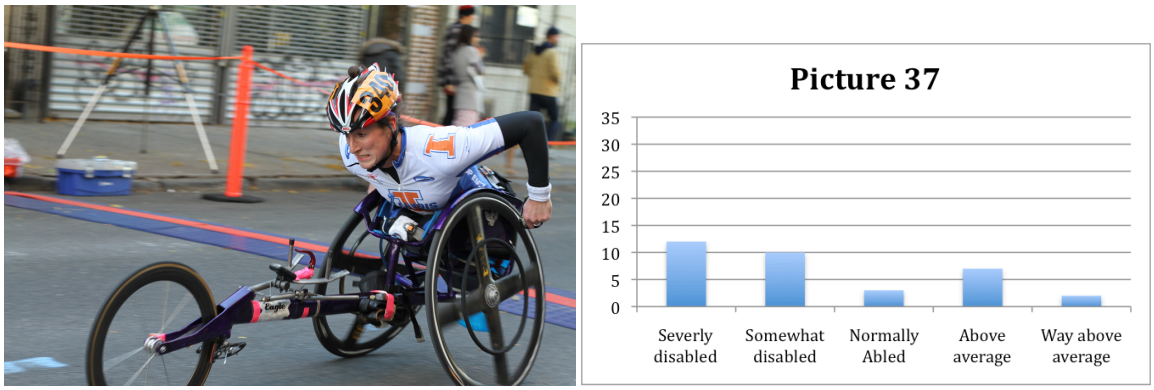

Figure 44. Picture 37 (Assistive technology and sports), and frequency bar chart of picture 37.

Discussion of Picture 37

Disability factor: 2.3; Confusion factor: 1.3

There was a wide variety of responses regarding this person's level of ability. The confusion might be the result of his pose, the helmet he wears, and the angled back wheels. All of these traits together suggest racing and speed. In spite the latter traits, it can be seen in the picture that he has no legs - an obvious sign of disability. It can be said that being in race or being active on a wheelchair might help change the image of disability that an observer might have.

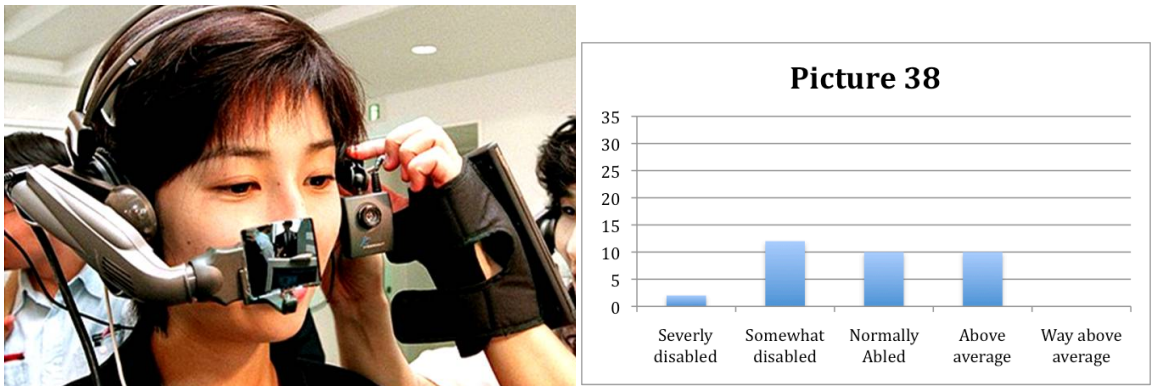

Figure 45. Picture 38 (Wearable Technology), and frequency bar chart of picture 38.

Discussion of Picture 38

Disability factor: 2.8; Confusion factor: 0.9

This data shows a wide disagreement about this person's level of ability. The depicted device is worn on head, it is unfamiliar, it is complex and consists of many different parts, wires, and a glove, making it very cumbersome to wear. This suggests that the user would wear it only if a disability demanded it, or if it offered greatly enhanced abilities to a Normally Abled user.

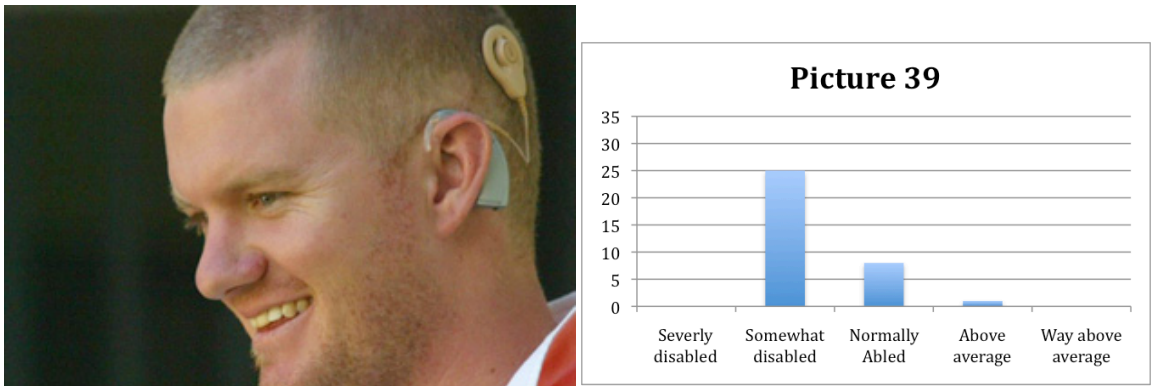

Figure 46. Picture 39 (Cochlear implant, 2008), and frequency bar chart of picture 39.

Discussion of Picture 39

Disability factor: 2.2; Confusion factor: 0.5

The data shows that the majority of respondents perceived this person (with a cochlear implant) as somewhat disabled. This perception might be drawn from its very visible position on the surface of the head and ear of the user, suggesting that it has been surgically implanted. The welcoming healthy face of the user with a smile on it might confuse participants, as if he is healthy and therefore happy, and the device is not an aid but a technology for a normal person that perhaps boosts his abilities.

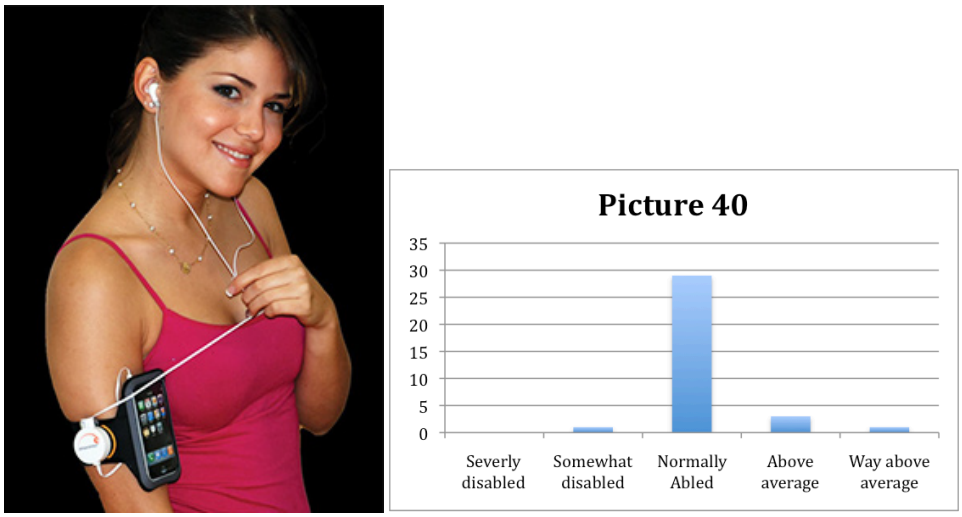

Figure 47. Picture 40 (Retractable Earphones, 2008), and frequency bar chart of picture 40.

Discussion of Picture 40

Disability factor: 3.1; Confusion factor: 0.4

The data shows a strong agreement that this person is Normally Abled. This might be the result of viewing a familiar smart phone and its earphones. However, there seems to be some slight confusion about whether this familiar device might boost the ability, of its user, or might be an indicator of disability for its user. It is plausible that wearing the smart phone on arm (which is not a common place to wear smart phones) along with an unfamiliar earphone retraction device on it, caused bias around the normality of the product.

Section 3. An Exploration Of Gender Influence On Responses:

While recognizing that the small sample size makes these results tentative, a *t*-test was performed to examine any differences in the disability perception between the genders of the respondents. "A *t*-test's statistical significance indicates whether or not the difference between two groups' averages most likely reflects a "real" difference in the population from which the groups were sampled" (Statwing , Unknown). The results (see Appendix C) showed no significant difference between the responses of the male and female respondents in perceiving the degree of disability of the individuals in all forty pictures.

Section 4. An Exploration Of Cultural Effects On Responses:

Another *t*-test was conducted (see Appendix D) to explore the effect of cultural differences on the perception of disability between the American and Asian participants. The results suggest that cultural background was a variable that caused significant differences in the perception of disability in seven of the forty pictures (Table 1).

Table 1. Comparing Mean and Standard Deviation values, in two Asian and American populations. The highlights show the highest value in each category.

Pictures	Culture	Mean	Std D
Picture 7	American	2.4	0.7
	Asian	3.5	1.0
Picture 10	American	2.6	0.6
	Asian	4.0	1.4
Picture 21	American	2.3	0.6
	Asian	3.5	1.0
Picture 38	American	2.7	0.9
	Asian	3.7	0.5
Picture 16	American	2.2	0.5
	Asian	2.0	0.0
Picture 36	American	3.5	0.6
	Asian	3.0	0.0
Picture 39	American	2.3	0.5
	Asian	2.0	0.0

Result of cultural difference on Picture 7:

Results for picture 7 showed that Asians participants perceived the person to be more abled than American participants, *t*(df) = -2.360, P<0.05, (American Mean = 2.4, Asian Mean = 3.5).

Discussion of cultural difference on Picture 7:

In picture 7, Asian Mean shows that wearing sunglasses and a product on the wrist are not indicators of disability. In comparison, it is possible that American participants perceived these products in the opposite way as indicators of disability.

Figure 48. Picture 7

Result of cultural difference on Picture 10:

Results for Picture 10 showed that Asians participants perceived the person to be more abled than American participants, *t*(df) = -3.318, P<0.05, (American Mean = 2.6, Asian Mean = 4.0).

Discussion of cultural difference on Picture 10:

In picture 10, Asian Mean might show that wearing a gas mask, covered with shiny ornaments, used in a catwalk, does not indicate disability. American participants Mean shows the opposite perception; this might be the outcome of the fact that the gas mask covers face and it might be important for American participants to see a person's face, since it plays an important part in people's interaction.

Figure 49. Picture 10

Result of cultural difference on Picture 21:

Results for Picture 21 showed that Asians participants perceived the person to be more abled than American participants, *t*(df) = -3.417, P<0.05, (American Mean = 2.3, Asian Mean = 3.5).

Discussion of cultural difference on Picture 21:

This person is an American TV series protagonist. He is dancing on one foot and pretends that he plays guitar with his cane. Possibly this happy image of him does not perceived as disabled by Asian participants because they are not familiar with the role he plays as a Doctor with disability. In contrary, the American Mean suggests that the dancing pose does not changing the disability image that American participants perceived through media.

Figure 50. Picture 21

Result of cultural difference on Picture 38:

Results for Picture 38 showed that Asians participants perceived the person to be more abled than American participants, *t*(df) = -2.162, P<0.05, (American Mean = 2.7, Asian Mean = 3.7).

Discussion of cultural difference on Picture 38:

Picture 38 shows a person wears a complex technology with different parts. The fact that the person is oriental might have affected the Asian Mean, which is above normally abled response. On the other hand, it seems that this fact does not affect American's Mean; This might because of the complexity of the technology that might makes it hard for American participants to realize the purpose of the product.

Figure 51. Picture 38

Result of cultural difference on Picture 16:

Results for Picture 16 showed that American participants perceived the person to be more abled than Asians participants, *t*(df) = 2.268, P<0.05, (American Mean = 2.2, Asian Mean = 2.0).

Discussion of cultural difference on Picture 16:

In picture 16 the positive attitude turn toward American participants, but the Mean difference is slight and both groups felt that the person in the picture has disability. This might suggest that no matter what cultural background people have, when a disability is observably visible, they might feel the person is at least somewhat disabled.

Figure 52. Picture 16

Result of cultural difference on Picture 36:

Results for Picture 36 showed that American participants perceived the person to be more abled than Asians participants, *t*(df) = 5.029, P<0.05, (American Mean = 3.5, Asian Mean = 3.0).

Discussion of cultural difference on Picture 36:

In picture 36, considerable difference can be seen between Means. All Asian participants with the Mean indicator of 3.0 and Std D of 0.0 agreed that the person is normal. This might suggest that American participants felt that a media player user can be a *normally abled* or a *cool* person. However, the means show that the media player can be a universal product that is an indicator of a normal person in two different cultures.

Figure 53. Picture 36

Result of cultural difference on Picture 39:

Results for Picture 39 showed that American participants perceived the person to be more abled than Asians participants, *t*(df) = 3.087, P<0.05, (American Mean = 2.3, Asian Mean = 2.0).

Discussion of cultural difference on Picture 39:

In picture 39, like picture 16, same impression seems to be applicable; although the American Mean is slightly bigger than Asian Mean, but it is still indicates that Americans felt the person has a sort of disability. This might suggest the visibility of disability.

Figure 54. Picture 39

Section 5. Discussion Of The Disability Perception Of The Respondents

The perceptions of disability were collected from the respondents in the form of survey responses on the following 5-point Likert scale:

1= Severely disabled

2= Somewhat disabled

3= Normally Abled

4= Above average

5= Way above average.

The 34 Likert-scale responses for each picture were then averaged across all the respondents, resulting in averages between 1 and 5. Response averages between 1 and 2.5 were labeled *Stigmatizing*, response averages between 2.5 and 3.5 were labeled *Normal* and response averages between 3.5 and 5 were labeled *Cool*.

Figure 95 shows the averages for Pictures 1-40, sorted from the lowest to the highest average. Mean values below 2.5 are categorized as *Stigmatizing,* and they are color coded with red. If Mean ≤ 2.0, the result will be *Extremely Stigmatizing*, which includes picture 1 and picture 13. If 2.0 < Mean ≤ 2.5, the result is interpreted to be *Stigmatizing*, which includes picture 1, picture 13, picture 29, picture 16, picture 39, picture 31, picture 37, and picture 8, picture 21, picture 23.

If 2.5 < Mean < 3.5, it is called *Normal*, which includes picture 7, picture 11, picture 32, picture 10, picture 12, picture 27, picture 38, picture 24, picture 15, picture 4, picture 28, picture 5, picture 20, picture 40, picture 14, picture 25, picture 33, picture 18, picture 26, picture 34, picture 19, and picture 2. This *Normal* range is color coded yellow.

Mean values above or equal to 3.5 are categorized as *cool*, and they are color coded with blue, which includes picture 17, picture 22, picture 6, picture 30, picture 36, and picture 35. If Mean ≥ 3.8, the result is interpreted as *Extremely Cool*, which includes picture 3 and picture 9.

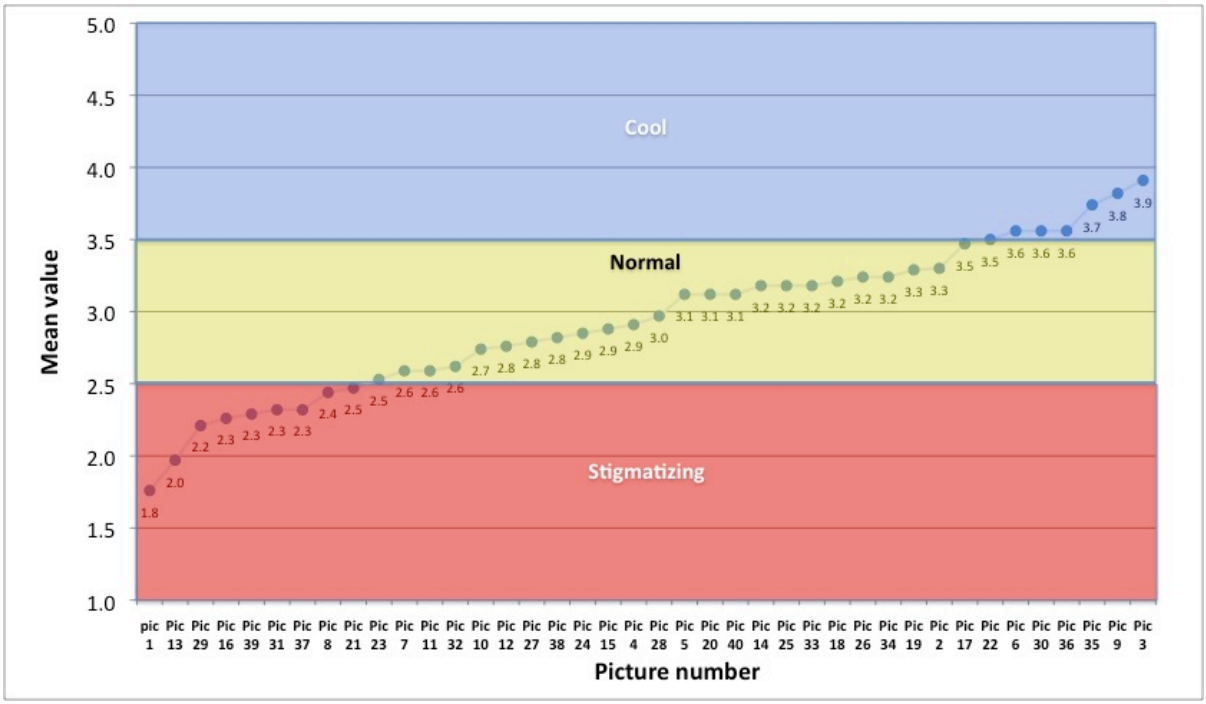

Figure 55. The bottom (red) area shows the mean values of pictures that were perceived to be stigmatizing. The middle (yellow) area shows the mean values of responses that were perceived to be normal. The top (blue) area shows the mean values of responses that were perceived to be cool.

"Basically, a small standard deviation means that the values in a statistical data set are close to the mean of the data set, on average, and a large standard deviation means that the values in the data set are farther away from the mean, on average" (Rumsey, 2011). Figure 96 show a plot of the Standard Deviations (Std. D) for each picture, sorted from lowest to highest. A higher Std. D suggests that the respondents were more confused about the purpose of the wearable product(s) depicted in the picture.

If the Std. D ≥ 1.0, the wearable technology was labeled *Extremely Confusing*, which includes picture 23, picture 8, picture 25, and picture 37. If 0.9 ≤ Std. D < 1.0, the wearable technology was labeled *Confusing*, which includes picture 11, picture 7,picture 5, picture 30, picture 27, picture 29, picture 10, and picture38.

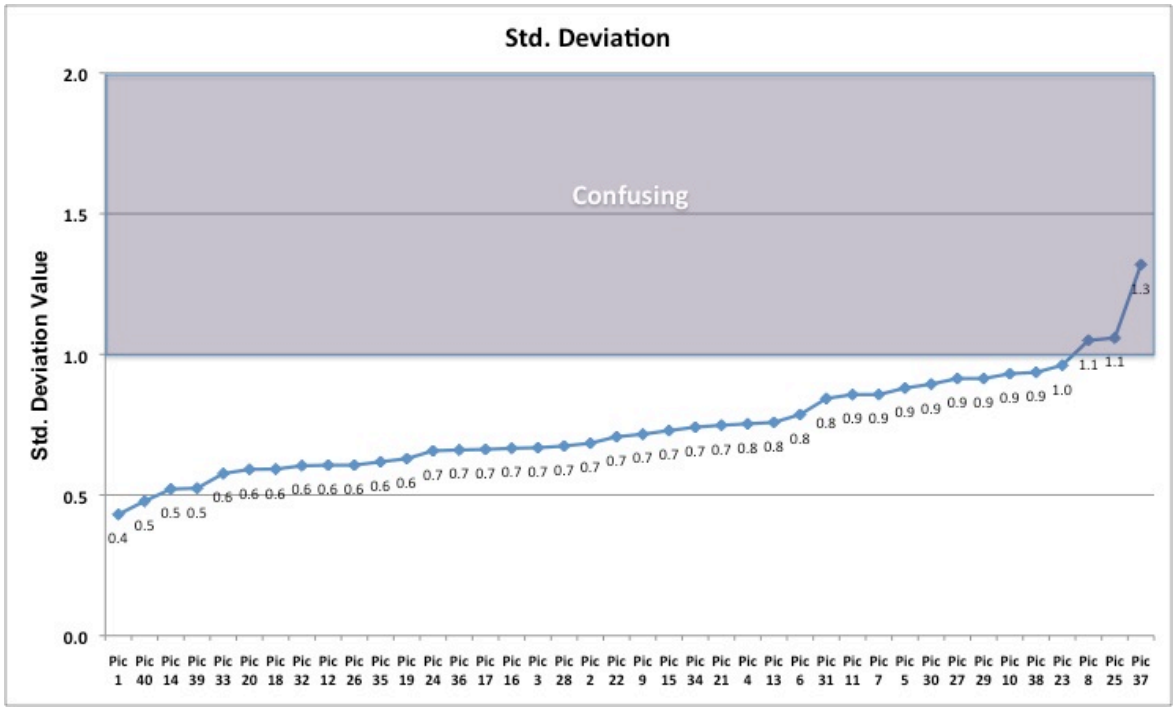

Figure 56. The top (purple) area includes the biggest Std. D values according to responses, which shows confusion in perceiving wearable technologies.

CHAPTER 5

CONCLUSION

Section 1. Introduction

Admittedly, the sample population for this survey was small. However, the fact that the survey results did not show significant differences between the responses of the male and female respondents suggests that their gender was not an important factor in their perception of disability.

Based on the results of this survey, two sets of guidelines are proposed for designers of assistive technology (AT) devices; (1) Guidelines about factors that should be considered when designing wearable AT devices, and (2) Guidelines for avoiding pitfalls when designing wearable AT devices. In current study, wearable technology is referred to accessories that are worn by people, which encompassing computer or advanced electronic technologies, such as wearable Bluetooth personal communicators and Goggle glasses.

Section 2: Guidelines About Factors That Should Be Considered When Designing Wearable AT Devices:

1. Consider cultural background as a possibly important factor

The mean values for the perceived disability levels given by the Americans and the Asians who responded to this survey were significantly different for 7 of the 40 pictures. These 7 pictures include: picture 7, 10, 21, 38, 16, 36, and 39. The responses to these 7 pictures suggest that there are some differences in the perception of disability by people from these two different cultural backgrounds.

Table 2. Difference of Mean and Standard Deviation values in responses according to different cultural backgrounds

Pictures	Culture	Mean	Std D
Picture 7	American	2.4	0.7
	Asian	3.5	1.0
Picture 10	American	2.6	0.6
	Asian	4.0	1.4
Picture 21	American	2.3	0.6
	Asian	3.5	1.0
Picture 38	American	2.7	0.9
	Asian	3.7	0.5
Picture 16	American	2.2	0.5
	Asian	2.0	0.0
Picture 36	American	3.5	0.6
	Asian	3.0	0.0
Picture 39	American	2.3	0.5
	Asian	2.0	0.0

Table 2 shows that Asian mean values for pictures 7, 10, 21, and 38 ranged from 3.0 to 4.0, all of which are Normally Abled or above. In contrast, American mean values for the same set of pictures ranged from 2.3 to 2.7, all of which are in the Somewhat Disabled category. Asian mean values for pictures 16 and 39 are 2.0 for both pictures. In contrast, American mean values for those same 2 pictures are 2.2 and 2.3. In summary, the American respondents perceived much greater disability in pictures 7, 10, 21, and 38, while the Asian respondents perceived slightly more disability in pictures 16, 36, and 39.

One possible explanation for this difference in perceptions of disability is a different degree of familiarity with the use of high-tech AT devices between these two populations. Americans (who might be more familiar with high-tech AT devices) might see the use of cumbersome or complex wearable technologies as suggesting a disability. In contrast, Asians (who might be accustomed to elaborate historical wearable artifacts) might not see those who wear complex wearable technologies as disabled. In contrast, Americans might perceive depicted people who clearly have a disability, but are also clearly are using a high-tech AT device, as less disabled, while Asians who are not so familiar with such devices might focus mostly on the evidence of disability. How

Note that the comments above should be treated as conjectures, and should not be blindly accepted. Clearly, more studies are needed to explain the effect of differing cultural backgrounds on perceptions of disability that were evidenced in this survey.

2. Tiny and small size is effective in avoiding stigma

Recent wearable products that are small (such as those shown in pictures 2, 6, 22, and 36) suggest cutting-edge technology, in comparison with earlier and bulkier AT devices, developed by engineers or doctors. Some of those older AT devices are big and clunky, complex, poor in aesthetics, and look like medical devices. Use of cutting-edge technologies to make AT devices tiny reduces stigmatization of users.

Figure 57. From left to right, pictures 2, 6, 22, and 36.

3. A familiar look or widespread use of a product across a large population reduces the perception of disability

Designing an AT device to have a familiar look is an important factor. Designing an AT device to also have appeal to the general population, or to look like a product that is in everyday use by the mainstream population helps hide the purpose of the AT device, and reduces potential stigmatization of the user. A good example of this is eye glasses to correct mild visual impairment, which is technically a disability. However, a person who wears eye glasses today is perceived to be a Normally Abled person, because a large portion of the mainstream population wears glasses in everyday life. (According to the National Eye Institute (NEI, 2006) more than 11 million people in the US need visual correction.) Other technologies that are seen as mainstream today can be seen in pictures 2, 6, 19, 36, 40.

Figure 58. From left to right, pictures 2, 6, 19, 36, and 40.

4. Products that are worn on the wrist, arm, hand, or as clothing are not stigmatizing

Any technologies that can be worn on the wrist, on the arm, on the hand, or as clothing are perceived as either traditional (as in picture 6, which shows a wristwatch) or as cutting-edge technology (as in picture 35, which shows an electronic jacket). Another example is the electronic glove in picture 30, which was seen by the respondents as an enhancement device (rather than as an assistive device).

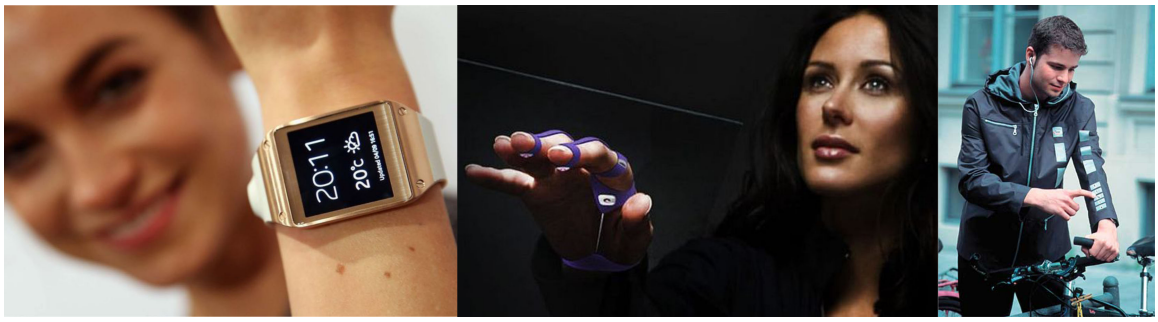

Figure 59. From left to right, pictures 6, 30, and 35.

5. Perceived power and/or status of the user affects the perception of disability

The perceived power and/or status of the user can influence the perception of his/her disability. Examples in the survey were the cofounder of Google wearing Google glass in picture 3, and the police officer wearing a camera on his sunglasses in picture 9. As mentioned in the Literature review Chapter, users of Google glass are currently experiencing some social stigma. However, the results of this survey for pictures 3 and 9 showed that the perceived power or status of these wearers placed these products into the *coolest* segment of responses in this study (see Chapter 4, Figure ?). This suggests that having a celebrity use a product publicly might be a good marketing strategy for wearable technologies.

Figure 60. From left to right, pictures 3, and 9.

6. An AT device that represents user activity and command reduces perceived disability

If an AT device is designed to suggest that the user is active, and fully in command, this helps reduce the perception of his/her disability. Good examples are the tricycle assistive technology in picture 37 which represents the ability to participate in an athletic race, or the running blade in picture 23 which represents the ability to participate in a foot race, or the pedal-driven wheelchair in picture 29 which represents the user as actively powering the traveling device, or the muscular-looking prosthetic arm in picture 8 which represents the ability to support a load.

Figure 61. From left to right, pictures 37, 23, 29, and 8.

7. Personalization and customization can counteract perceived disability

Some people use unusual or personalized wearable products to emphasize their individuality. Thus, personalization and customization might be a useful design strategy for hiding the true purpose of an AT device. The notion of personalization has been defined as "a process that changes the functionality, interface, information content, or distinctiveness of a system to increase its personal relevance to an individual" (Blom, 2000). Usually assistive technologies are designed by engineers or doctors, and then simply given to users. However, pictures 11, 12, and 15 show AT device designs that allow users to assert their own individuality through use of a personalized AT device that suits their tastes and habits, while deemphasizing the visibility of their disability.

Figure 62. From left to right, pictures 11, 12, and 15.

8. Disguised AT

Many wearable products have stereotypical uses that are not associated with any stigma. For example hats and jewelry are neutral products that are widely worn by the general population. Jewelry is typically a decorative accessory, which is worn as a personal ornament. A hat is another accessory that can be worn either for protecting head from harmful sun rays, or it can be worn as a personal adornment. The survey data for pictures 18, 14, 20, and 26 show that these artifacts are perceived as accessories, rather than assistive devices. In picture 20, even though a small camera was attached to the jewelry (which might be used as part of an assistive device) survey participants perceived the person is Normally Abled. This suggests that these products have the potential to camouflage the use of an AT device.

Disguise is a good approach to reduce the disability that is perceived by observers. In picture 11, the custom design of the prosthetic leg makes it less visible in the presence of the user's motorcycle. In pictures 12 and 15 the hearing aids are well disguised in the form of earrings and gauges, as evidenced by the fact that many of the survey respondents saw these people as Normally Abled.

Figure 63. From left to right, pictures 18, 14, 20, and 26.

Section 3: Guideline For Avoiding Pitfalls When Designing Wearable AT Devices:

1. Avoid using stigmatizing symbols and avoid focusing attention on the disability

To reduce the perception of disability, it is best to avoid stereotyped product features that suggest disability. For example, in designing a wheelchair, it is better to avoid the use of obvious caster-like stabilizing wheels, a steering wheel, straps on the pedals, or a broad, flat seat, unless they are really necessary. Comparing the mean value of picture 4, (which shows Honda's walking aid that includes no stereotypical feature associated with assistive technology) with the mean values for pictures 1 and 29 (which include many stereotypical features of wheelchairs) shows how stereotypical features can emphasize the perceived level of disability of users.

Figure 64. From left to right, pictures 4, 1, and 29.

AT designs should avoid focusing attention on the disability. Attention can be focused by salient features of the design, or by the posture (or the pose) that user must employ to use it. For example, the mean value given by respondents for picture 13 indicates a perceived disability, perhaps because of the awkward stance of the user. Also, the salient features of the designs shown in pictures 1, 16, 39, and 31 suggested a disability to the respondents.

Figure 65. From left to right, pictures 13, 1, 16, 39, and 31.

2. Do not obstruct the view of the user's face

Do not cover any portion of the user's face. People are very sensitive to the facial expressions, the eye movements, and the mouth movements of others. In picture 10, despite the fact that the product is used as facial jewelry on a Catwalk in a fashion show, obscuring the person's face with the gas mask resulted in a mean disability value of 2.7 which indicated a perceived disability. An exception is seen in picture 24, in which the facial mask was designed to represent the obscured facial features, and where edges were used as a style and to emphasize the facial contours of the designed form.

Figure 66. From left to right, pictures 10, and 24.

3. Do not design complex products

Complex wearable technologies are distracting. The term complex means that the design consists of multiple parts whose shapes are not in harmony with each other or (in the case of wearable AT) the overall form does not follow the body contours of the user. Wearable technologies designed with complex forms are often perceived as products designed by a non-designer, and might be perceived as a medical device that is intended to manage some impairment. These complex products sometimes have components that *stick out* in an awkward manner. Contrast this with wearable products that are worn by the general population, which generally have simple forms that flow with the shape of body (such as a wristwatch) or a have simple shapes (such as rectangular cell phones). Pictures 8, 25, and 38 had unusually high Standard Deviation values of 1.0 or above, which indicate that the respondents were confused about the purpose of these highly visible products. If it cannot be hidden, an AT device should look like some type of mainstream product, to avoid stigmatizing the user. However, if this is not possible, some ambiguity about the purpose of the wearable product might prevent it from being seen as an AT device - a design method that overlaps with the camouflage strategy.

Figure 67. From left to right, pictures 8, 25, and 38.

4. In disguising an AT device, consider the context in which it will be used

A wearable product will be used in a social context. The general population will perceive a person who uses a disguised product that is out of context as a strange or socially awkward person. The mean value of the survey results for picture 28 indicates a person who is Normally Abled. However, the high Standard Deviation of those results suggests that some of the respondents were uncertain about his abilities, possibly because the crown was seen as socially awkward. When disguising an AT device, it is important to consider how the use of that disguise might cause social awkwardness in various contexts.

Figure 68. Picture 28.

5. Graphical elements are not helpful unless they moderate/alter the stereotypical meaning of the artifact

The survey used graphical elements in picture 1 to test the Bispo & Branco (2008) suggestion that graphical elements on AT devices might reduce stigma. The survey results for pictures 1 show the inefficiency of these graphical elements in completely hiding the purpose of the AT device. However, the graphical sound waves on the ear ring in picture 12 did seem to moderate the perception of the device as a hearing aid (since the sound waves suggest a cutting-edge technology product) thus making it look less like an AT device. Perhaps graphical elements are more effective in moderating the perception of disability if they convey some specific meaning.

Figure 69. From left to right, pictures 1, and 12.

6. Do not cover the head

Covering the head with a wearable product which purpose is not readily recognizable seemed to cause confusion about the product's purpose, and left some respondents wondering whether it might be an AT Device. For example, the large standard deviation for the product in picture 5 indicates confusion.

Figure 70. Picture 5.

Section 4: Future Work

Considerations for methodology improvements on future surveys:

A more comprehensive and structured methodology should be employed in choosing the pictures for use with the survey. In general, pictures of celebrities (or other recognizable people) should not be used, as preconceived notions about their level of disability can bias the answers given by the respondents. (For example, the respondents may have had preconceived notions about the disability level of the co-founder of Google in picture 3, or the actor who plays Dr House in the TV series in picture 21.) Pictures should only include people who are actually wearing or using the product. The backgrounds in the pictures should be studied, as they might bias the answers given by respondents. (For example, the car in the background of picture 22 might have led respondents to assume that the person depicted was able to drive.) Products should not be depicted close-up, but should only be shown is use by a person. (For example, the close up image of the product in picture 7 might have led the respondents to the conclusion that the person was wearing an assistive device, rather than a bracelet.)

Additional data might also be collected, by asking respondents to answer multiple questions about each image. For example, this survey simply asked respondents to indicate to what degree they saw each depicted person as *disabled*. It might also be useful to ask questions such as how *strange* or *socially awkward* the person looks.

Questions to be explored in future studies

During the process of conducting this study, several other questions arose, whose answers might impact the design of AT devices. Time did not permit exploration of the following questions, but they could be answered in future studies.

1. There are two sides for stigma that arises from using an assistive technology. One area is society's point of view as observers of AT users, whose perception of using an AT and

thus behavior toward the users, might be stigmatizing. This study explored society's perspective, however, the other important area that wasn't covered in this study is learning disability from the viewpoint of users with disabilities. Accordingly, before designing any product for future AT users, designers should take into account their point of view and spend time with the person, possibly in form of participatory design. Therefore, assistive technology design would benefit from asking this question: What do the users of various wearable AT devices think of the product, and what factors in its design do they consider to be stigmatizing from their point of view.

2. What features of wearable technology devices currently used by the mainstream population might provide ideas to inspire and/or guide the design of AT, or its personalization.
3. Knowing the aspects of current mainstream wearable technologies that make people look strange or socially awkward in the eyes of others could help with the design of wearable AT devices. For example, some people react negatively around others who wear Google glass in their presence, because of its tech awkwardness. As discussed in chapter 2 the socially awkwardness or strangeness of this wearable technology has caused some social stigma for those who wear it.
4. Some people enjoy being *different* from others, even when it causes some social stigma toward them from others who don't share their values. For instance, heavy tattooing might be stigmatizing, but the tattooed person might be proud of being in a special group. However, most people do not want to be perceived as disabled.
5. Social awkwardness is perceived differently by different generations of people. It might be useful to conduct a study to compare the perception of stigma and stereotyping across different age groups.
6. Face-to-face interviews with survey respondents might clarify and add information about *why* certain people in the pictures in this survey were perceived as disabled.

7. A study of good and bad symbols and stereotypes that are associated with AT in the minds of respondents might be useful for designing new AT devices. For example, a study of the good and bad stereotypes associated with various types of eye glasses might help with the design of a visual AT, or Google glass.
8. It might be useful to ask respondents if they would be comfortable having conversation with the person depicted.
9. It might be useful to ask respondents whether they would be willing to try using, or wearing, the depicted product?
10. It might be useful to arrange a situation where the researcher could observe the reactions of members of the public as they encounter what they believe are disabled persons using various types of AT devices.

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APPENDIX A

QUESTIONNAIRE

Questionnaire: Assessment of Wearable Assistive Technology

Age_____ Gender_____

The country you went to high school in_____

Fill in the bubbles in the sliding scale to the right. Please fill in only one bubble per category or row.

INSTRUCTIONS

Work quickly. Do not spend too much time thinking about the questions. Respond with the first words or image that comes to mind:

	Severely disabled	Somewhat disabled	Normally abled	Above average	Way above average
1. This person is:	⬭	⬭	⬭	⬭	⬭
2. This person is:	⬭	⬭	⬭	⬭	⬭
3. This person is:	⬭	⬭	⬭	⬭	⬭
4. This person is:	⬭	⬭	⬭	⬭	⬭
5. This person is:	⬭	⬭	⬭	⬭	⬭
6. This person is:	⬭	⬭	⬭	⬭	⬭
7. This person is:	⬭	⬭	⬭	⬭	⬭
8. This person is:	⬭	⬭	⬭	⬭	⬭
9. This person is:	⬭	⬭	⬭	⬭	⬭
10. This person is:	⬭	⬭	⬭	⬭	⬭
11. This person is:	⬭	⬭	⬭	⬭	⬭
12. This person is:	⬭	⬭	⬭	⬭	⬭
13. This person is:	⬭	⬭	⬭	⬭	⬭
14. This person is:	⬭	⬭	⬭	⬭	⬭
15. This person is:	⬭	⬭	⬭	⬭	⬭
16. This person is:	⬭	⬭	⬭	⬭	⬭
17. This person is:	⬭	⬭	⬭	⬭	⬭
18. This person is:	⬭	⬭	⬭	⬭	⬭
19. This person is:	⬭	⬭	⬭	⬭	⬭
20. This person is:	⬭	⬭	⬭	⬭	⬭
21. This person is:	⬭	⬭	⬭	⬭	⬭
22. This person is:	⬭	⬭	⬭	⬭	⬭
23. This person is:	⬭	⬭	⬭	⬭	⬭
24. This person is:	⬭	⬭	⬭	⬭	⬭
25. This person is:	⬭	⬭	⬭	⬭	⬭

	Severely disabled	Somewhat disabled	Normally abled	Above average	Way above average
26. This person is:	⬭	⬭	⬭	⬭	⬭
27. This person is:	⬭	⬭	⬭	⬭	⬭
28. This person is:	⬭	⬭	⬭	⬭	⬭
29. This person is:	⬭	⬭	⬭	⬭	⬭
30. This person is:	⬭	⬭	⬭	⬭	⬭
31. This person is:	⬭	⬭	⬭	⬭	⬭
32. This person is:	⬭	⬭	⬭	⬭	⬭
33. This person is:	⬭	⬭	⬭	⬭	⬭
34. This person is:	⬭	⬭	⬭	⬭	⬭
35. This person is:	⬭	⬭	⬭	⬭	⬭
36. This person is:	⬭	⬭	⬭	⬭	⬭
37. This person is:	⬭	⬭	⬭	⬭	⬭
38. This person is:	⬭	⬭	⬭	⬭	⬭
39. This person is:	⬭	⬭	⬭	⬭	⬭
40. This person is:	⬭	⬭	⬭	⬭	⬭

Comments _ any further comments you may wish to add!

_____

_____

_____

_____

_____

_____

_____

Thank you for your participation!

APPENDIX B

RESULTS TABLE

Table 3. Mean and Standard Deviation of responses for each picture

Picture Number	Mean	Standard Deviation	Min	Max	Median
Picture 1	1.8	0.4	1	2	2
Picture 2	3.3	0.7	2	5	3
Picture 3	3.9	0.7	3	5	4
Picture 4	2.9	0.8	2	4	3
Picture 5	3.1	0.9	1	5	3
Picture 6	3.6	0.8	3	5	3
Picture 7	2.6	0.9	1	4	3
Picture 8	2.4	1.1	1	5	2
Picture 9	3.8	0.7	3	5	4
Picture 10	2.7	0.9	1	5	3
Picture 11	2.6	0.9	1	5	2
Picture 12	2.8	0.6	2	4	3
Picture 13	2.0	0.8	1	5	2
Picture 14	3.2	0.5	3	5	3
Picture 15	2.9	0.7	2	4	3
Picture 16	2.3	0.7	1	5	2
Picture 17	3.5	0.7	2	5	3.5
Picture 18	3.2	0.6	2	5	3
Picture 19	3.3	0.6	3	5	3
Picture 20	3.1	0.6	2	4	3
Picture 21	2.5	0.7	1	5	2
Picture 22	3.5	0.7	3	5	3
Picture 23	2.5	1.0	1	5	2
Picture 24	2.9	0.7	1	5	3
Picture 25	3.2	1.1	1	5	4
Picture 26	3.2	0.6	2	5	3
Picture 27	2.8	0.9	1	5	3
Picture 28	3.0	0.7	1	5	3
Picture 29	2.2	0.9	1	5	2
Picture 30	3.6	0.9	2	5	4
Picture 31	2.3	0.8	1	5	2
Picture 32	2.6	0.6	2	4	3
Picture 33	3.2	0.6	2	4	3
Picture 34	3.2	0.7	1	5	3
Picture 35	3.7	0.6	3	5	4
Picture 36	3.6	0.7	3	5	3
Picture 37	2.3	1.3	1	5	2
Picture 38	2.8	0.9	1	4	3
Picture 39	2.3	0.5	2	4	2
Picture 40	3.1	0.5	2	5	3

APPENDIX C

T-TEST RESULTS FOR GENDER

Table 4. t-test Results Comparing Males and Females on Attitudes, pictures 1 to 20.

Picture	Gender	N	Mean	t-value	df	P(two-tailed)
Picture 1	male	26	1.7	0.1	32	0.91
	female	8	1.7	0.1	10.9	0.91
Picture 2	male	25	3.2	-0.3	31	0.73
	female	8	3.3	-0.2	9.1	0.79
Picture 3	male	26	3.9	0.1	32	0.86
	female	8	3.8	0.1	12.4	0.85
Picture 4	male	26	2.8	-0.3	32	0.71
	female	8	3.0	-0.3	11.7	0.71
Picture 5	male	26	3.1	0.4	32	0.67
	female	8	3.0	0.4	14.0	0.64
Picture 6	male	26	3.5	-0.7	32	0.44
	female	8	3.7	-0.7	10.3	0.48
Picture 7	male	26	2.5	-0.6	32	0.55
	female	8	2.7	-0.5	11.36	0.56
Picture 8	male	26	2.5	0.5	32	0.56
	female	8	2.2	0.6	14.3	0.52
Picture 9	male	26	3.7	-0.7	32	0.43
	female	8	4.0	-0.9	16.7	0.35
Picture 10	male	26	2.6	-0.9	32	0.36
	female	8	3.0	-0.7	9.2	0.46
Picture 11	male	26	2.5	-0.6	32	0.55
	female	8	2.7	-0.5	11.3	0.56
Picture 12	male	26	2.8	0.7	32	0.46
	female	8	2.6	0.8	14.1	0.42
Picture 13	male	26	1.9	-0.1	32	0.90
	female	8	2.0	-0.1	18.2	0.87
Picture 14	male	26	3.0	-2.1	32	0.4
	female	8	3.5	-1.2	7.3	0.24
Picture 15	male	26	2.8	0.0	32	0.97
	female	8	2.8	0.0	10.3	0.97
Picture 16	male	26	2.2	-0.5	32	0.60
	female	8	2.3	-0.3	8.0	0.72
Picture 17	male	26	3.5	1.7	32	0.09
	female	8	3.1	1.7	11.6	0.10
Picture 18	male	26	3.1	-1.6	32	0.10
	female	8	3.5	-1.1	7.9	0.28
Picture 19	male	26	3.2	-1.0	32	0.29
	female	8	3.5	-0.7	8.3	0.45
Picture 20	male	26	3.0	-0.7	32	0.47
	female	8	3.2	-0.8	15.7	0.41

Table 5. t-test Results Comparing Males and Females on Attitudes, pictures 21 to 40.

Picture	Gender	N	Mean	t-value	df	P(two-tailed)
Picture 21	male	26	2.4	-0.1	32	0.90
	female	8	2.5	-0.1	17.9	0.87
Picture 22	male	26	3.4	-0.5	32	0.57
	female	8	3.6	-0.4	9.2	0.64
Picture 23	male	26	2.5	-0.3	32	0.75
	female	8	2.6	-0.2	9.6	0.79
Picture 24	male	26	2.7	-1.3	32	0.18
	female	8	3.1	-1.1	9.2	0.29
Picture 25	male	26	3.1	0.1	32	0.87
	female	8	3.1	0.1	11.0	0.88
Picture 26	male	26	3.2	-0.07	32	0.93
	female	8	3.2	-0.09	16.4	0.92
Picture 27	male	26	2.7	-0.2	32	0.78
	female	8	2.8	-0.3	13.1	0.76
Picture 28	male	26	2.9	-0.7	32	0.46
	female	8	3.1	-0.5	8.4	0.59
Picture 29	male	26	2.1	-0.1	32	0.87
	female	8	2.2	-0.1	16.1	0.85
Picture 30	male	26	3.5	-0.2	32	0.81
	female	8	3.6	-0.2	11.5	0.81
Picture 31	male	26	2.4	1.2	32	0.22
	female	8	2.0	1.3	13.0	0.20
Picture 32	male	26	2.5	-1.3	32	0.17
	female	8	2.8	-1.3	10.8	0.21
Picture 33	male	26	3.1	-0.4	32	0.68
	female	8	3.2	-0.4	15.3	0.64
Picture 34	male	26	3.1	-0.6	32	0.55
	female	8	3.3	-0.7	18.3	0.45
Picture 35	male	26	3.7	-0.07	32	0.94
	female	8	3.7	-0.07	10.3	0.94
Picture 36	male	26	3.5	0.2	32	0.77
	female	8	3.5	0.2	10.3	0.80
Picture 37	male	26	2.1	-1.0	32	0.30
	female	8	2.7	-0.8	9.3	0.40
Picture 38	male	26	2.8	0.6	32	0.50
	female	8	2.6	0.6	12.0	0.50
Picture 39	male	26	2.3	1.0	32	0.30
	female	8	2.1	1.3	18.8	0.20
Picture 40	male	26	3.1	-0.04	32	0.96
	female	8	3.1	-0.06	17.1	0.95

APPENDIX D

T-TEST RESULTS FOR CULTURE

Table 6. t-test Results Comparing Americans and Asians on Attitudes, pictures 1 to 20.

Picture	Culture	N	Mean	t-value	df	P(two-tailed)
Picture 1	American	29	1.7	0.1	31	0.84
	Asian	4	1.7	0.1	3.5	0.87
Picture 2	American	28	3.2	-0.6	30	0.50
	Asian	4	3.5	-0.7	4.3	0.47
Picture 3	American	29	3.8	-0.3	31	0.69
	Asian	4	4.0	-1.0	28.0	0.29
Picture 4	American	29	2.8	-1.6	31	0.10
	Asian	4	3.5	-2.0	4.5	0.09
Picture 5	American	29	3.2	1.5	31	0.14
	Asian	4	2.5	1.3	3.6	0.25
Picture 6	American	29	3.4	-0.6	31	0.51
	Asian	4	3.7	-0.5	3.5	0.62
Picture 7	American	29	2.4	-2.3	31	0.02
	Asian	4	3.5	-1.9	3.5	0.13
Picture 8	American	29	2.4	0.2	31	0.77
	Asian	4	2.2	0.3	4.0	0.76
Picture 9	American	29	3.7	-1.2	31	0.21
	Asian	4	4.2	-1.7	5.0	0.14
Picture 10	American	29	2.6	-3.3	31	0.002
	Asian	4	4.0	-1.9	3.1	0.145
Picture 11	American	29	2.4	-1.1	31	0.25
	Asian	4	3.0	-0.7	3.2	0.52
Picture 12	American	29	2.7	-0.8	31	0.40
	Asian	4	3.0	-0.6	3.4	0.55
Picture 13	American	29	1.9	-0.1	31	0.86
	Asian	4	2.0	-0.1	3.7	0.88
Picture 14	American	29	3.0	-2.0	31	0.05
	Asian	4	3.5	-0.8	3.0	0.45
Picture 15	American	29	2.7	-1.2	31	0.23
	Asian	4	3.2	-0.9	3.4	0.41
Picture 16	American	29	2.2	0.8	31	0.41
	Asian	4	2.0	2.2	28.0	0.03
Picture 17	American	29	3.5	0.05	31	0.95
	Asian	4	3.5	0.03	3.2	0.97
Picture 18	American	29	3.1	-1.4	31	0.14
	Asian	4	3.5	-0.7	3.1	0.48
Picture 19	American	29	3.2	-0.9	31	0.33
	Asian	4	3.5	-0.5	3.2	0.60
Picture 20	American	29	3.1	0.4	31	0.67
	Asian	4	3.0	0.3	3.4	0.76

Table 7. t-test Results Comparing Males and Females on Attitudes, pictures 21 to 40.

Picture	Culture	N	Mean	t-value	df	P(two-tailed)
Picture 21	American	29	2.3	-3.4	31	0.002
	Asian	4	3.5	-2.3	3.3	0.09
Picture 22	American	29	3.4	-0.9	31	0.35
	Asian	4	3.7	-0.6	3.3	0.53
Picture 23	American	29	2.5	1.7	31	0.08
	Asian	4	1.7	2.6	5.9	0.03
Picture 24	American	29	2.8	-1.2	31	0.22
	Asian	4	3.2	-0.6	3.1	0.55
Picture 25	American	29	3.1	-1.1	31	0.26
	Asian	4	3.7	-1.9	8.0	0.08
Picture 26	American	29	3.2	-0.8	31	0.37
	Asian	4	3.5	-0.9	4.0	0.39
Picture 27	American	29	2.7	0.08	31	0.93
	Asian	4	2.7	0.05	3.2	0.95
Picture 28	American	29	3.0	1.0	31	0.31
	Asian	4	2.7	0.6	3.2	0.55
Picture 29	American	29	2.2	0.4	31	0.67
	Asian	4	2.0	1.1	28.0	0.26
Picture 30	American	29	3.4	-1.7	31	0.09
	Asian	4	4.2	-2.6	6.2	0.03
Picture 31	American	29	2.3	-1.0	31	0.32
	Asian	4	2.7	-1.4	5.7	0.18
Picture 32	American	29	2.6	-0.3	31	0.69
	Asian	4	2.7	-0.2	3.2	0.80
Picture 33	American	29	3.2	1.6	31	0.11
	Asian	4	2.7	1.8	4.1	0.14
Picture 34	American	29	3.1	-1.5	31	0.12
	Asian	4	3.7	-1.2	3.4	0.29
Picture 35	American	29	3.6	-0.1	31	0.85
	Asian	4	3.7	-0.2	4.3	0.83
Picture 36	American	29	3.5	1.8	31	0.07
	Asian	4	3.0	5.0	28.0	0.00
Picture 37	American	29	2.3	0.8	31	0.40
	Asian	4	1.7	0.7	3.6	0.49
Picture 38	American	29	2.7	-2.1	31	0.03
	Asian	4	3.7	-3.3	6.3	0.01
Picture 39	American	29	2.3	1.1	31	0.26
	Asian	4	2.0	3.0	28.0	0.005
Picture 40	American	29	3.1	0.5	31	0.60
	Asian	4	3.0	1.4	28.0	0.16

APPENDIX E

IRB EXEMPTION

ASU Knowledge Enterprise Development

EXEMPTION GRANTED

Joseph Velasquez
The Design School
480/965-7862
JOSEPH.VELASQUEZ@asu.edu

Dear Joseph Velasquez:

On 3/10/2014 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	Assistive Technology in Low Vision Student Populations and the Need to De-stigmatize Its Use Through Product Design to Affect Broader Usage Adoption.
Investigator:	Joseph Velasquez
IRB ID:	STUDY00000761
Funding:	None
Grant Title:	None
Grant ID:	None
Documents Reviewed:	• Ronak Valamanesh_HRP-503a - TEMPLATE PROTOCOLSOCIAL BEHAVIORAL.docx, Category: IRB Protocol; • Ronak Valamanesh_verbal-script.pdf, Category: Recruitment Materials; • RONAK VALAMANESH_Questionnaire.pdf, Category: Recruitment Materials; • Ronak Valamanesh_Assistive technology assesment presentation.pdf, Category: Recruitment Materials;

The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (2) Tests, surveys, interviews, or observation on 3/10/2014.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).