Safe Streets:

A Solutions Paper on the Mobility Challenges Faced by Visually Impaired Pedestrians

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ABSTRACT

Physical activity is a great challenge for visually impaired people. A movement toward a safer environment for visually impaired pedestrians is needed in New York City. The fear of navigating chaotic streets can cause people with little or no vision to stay inside. The lack of proper infrastructure and implementation of technology on these busy streets can make physical activity even more difficult. However, with up-and-coming new technologies, we can support the independence of visually impaired pedestrians and help them feel secure while walking outside. Technical innovations along with the help of local sighted-persons can go a long way in helping visually impaired pedestrians travel safely.

INTRODUCTION

Among the many disabilities that present themselves worldwide, one of the most prominent in the world, and in New York, is visual impairment. Visual impairment, or vision loss, can be defined as a decrement in a person's eyesight that can result in the functional limitation of the eye(s) and vision (Dr. Ananya Mandal).

There are many terms and classifications used to describe vision loss and visual impairment. They establish set criteria in order for physicians to diagnose patients with varying degrees of visual impairments. Here are some: Low Vision, Partially Sighted, Legally Blind, and Totally Blind. Low vision refers to the loss of visual acuity while still retaining some vision. There are two types of people with low vision, myopic and hyperopic. People with myopic, low vision are "near-sighted" and unable to clearly see distant objects whereas those with hyperopic low vision are "far-sighted" and are unable to see objects that are close to them. "Partially-sighted" is a technical term used to describe people with visual impairments that require certain educational services such as audiotaped texts, readers, raised line drawings, among others.

Two terms that are heard very frequently are legally blind and totally blind. Legally blind includes people whose eyes are less than 20/200 vision benchmark or a field vision that is at 20 degrees or below at its widest angle. People who are blind, unlike legally blind people who may still have very little vision that may help them out, yet will need more resources at their disposal in order to go on about their day. People with complete vision loss need Braille (A touch system for reading and writing where there are raised dots that represent alphabetical letters), audio

recordings, and other non-visual media in order to be able to access content that contains visuals (DO-IT).

Vision loss is a real struggle for those who live in condensed urban areas due to the fact that there is much going on and they simply are unable to use such a reliable human sense to become aware of that which surrounds them. Touching upon the causes of visual impairment, they are numerous. Some of these causes deal with age-related macular degeneration, others deal with the formation of cataracts, diabetic retinopathy, and raised pressure within the eyes that lead to glaucoma (Dr. Ananya Mandal). These are not the only causes that lead to visual impairment, however. Damage caused to the eye through any means or failures of the brain in receiving signal cues from retinal nerves can also cause vision loss. As mentioned before, visual loss is most commonly seen in the elderly pool of people as their eyesight wears out and becomes weaker as they grow older. This being said, it is also highly possible that visual loss can be inherited at birth or later manifested during one's childhood in various degrees of visual loss or impairment. Fortunately, some of these cases can be reversed if treated with the right medication or glasses.

Boiling down to the facts, it can be estimated that around 3.5 million people, solely in New York City, dwell within the category of the visually impaired. Rough estimates calculate that around eighty million adults over the age of forty and fifty are legally blind or have an eye-related problem and about 2-3% of the population suffers from Amblyopia (Department of Health). Touching back to the point of their hardship in major cities around the world, one that will be mentioned is New York City. With streets and places designed to resemble mazes and the cacophony of sounds that distort any one auditory cue, visually impaired people walk amidst

constant danger not knowing what could happen to them at any moment in any place. While a few measures have been taken to help those with vision loss or impairment, there is not enough and there can still be much more to be done for them in order to make their life easier to navigate. Some of the measures that have been taken can be seen as one walks through a few streets of New York City. Crosswalks, for example, now have electronic boxes tied to them which make sounds to alert people with visual impairment that it is their turn to cross the street. However, the problem doesn't arise with the chirping box itself, rather how the city is going about in implementing them and other helpful tools for the visually impaired on the streets. Not all the crosswalks in the city can be seen this equipped as the majority of them don't have them at all.

Given the insensitivity towards the visually impaired on the city's part to help them feel safe when they feel like leaving their homes, they seem prone to staying home and less likely to ask for help to cross or in using whatever scarce tools are available. If the city of New York had better and a higher quantity and quality of technology, as well as more monetary resources put into resolving these issues, reliance from people on the visually impaired side, would greatly decrease and help them feel safer and better. However, this technology comes with a hefty price tag and is limited as a result of governmental regulations and requirements. The question arises of where research efforts should be focused.

A simple solution, and one that already exists, is the crosswalk signal boxes for the visually impaired. The majority of the city still does not have these boxes implemented in their streets. Most of these boxes also seem to be placed in areas where there are wealthy people, which is a problem because the visually impaired don't necessarily thrive financially. Therefore,

as a simple but yet effective tool for those with vision loss, a solution would be to at least scatter them throughout the city in areas where it is most condensed in order to lower accidents if the city can not afford to place them everywhere. However, technological solutions alone can't solve the problem as a whole. There are sociological problems as well that need to be addressed and resolved. Such problems and possible solutions will be explored.

PROBLEM

Pedestrian Accessibility

Greater risk of social isolation due to low physical activity can only be combated by increasing daily physical activity, however, visually impaired individuals face an increasingly complex pedestrian environment. Physical activity is also important to help combat other diseases of old age such as heart health and muscular strength and bone density. In terms of physical activity amongst disabled adults, about half report physical inactivity. The goal should be to motivate inactive, visually impaired people to navigate their often difficult pedestrian environments. Only by increasing physical activity can we can have a positive impact on this negative feedback cycle. A possible, statistically significant, mobility motivator is the use of computer assistive devices. Assisted technology makes visually impaired individuals more likely to engage in social sports. In fact, active adults with visual impairments are 24% more likely to report the use of computer-assisted devices than their inactive counterparts (Jaarsma, 2014). Assisted technology can help facilitate outdoor physical activity and provide greater accessibility for people with low-to-no vision.

Assisted crosswalks are important environmental features that helps visually impaired pedestrians travel on a daily basis. A lack properly equipped crosswalks is currently an issue in New York City. Only 2.5% of crosswalks in the city are accessible for the visually impaired. Moreover, the crosswalks that do exist are primarily located in Manhattan below 96th Street, Brooklyn and Queens. Staten Island and the Bronx have a combined total of 47 assisted pedestrian signals which is a disproportionate distribution based on the present population. Around 30% of the city's population resides in these two boroughs but they only house 12% of the city's assisted crosswalks (New York Department of Transportation, 2018).

A lack of environmental technology is a barrier to transportation for people with visual impairments or no vision at all. Nearly half of the visually impaired people in the Jaarsma survey who identified as physically inactive cited transportation as the number one environmental barrier to their lack of sufficient physical activity. The transport barrier affected physically active participants as well but to smaller degrees (Jaarsma, 2014). Thus, pedestrian accessibility and physical activity seems to be correlated. In order to support the independence and overall health of New Yorkers with visual impairments, it is imperative that we build accessible pedestrian environments.

Poor Physical Activity

Environmental and personal factors impact physical activity in people with visual impairments. Barriers to psychosocial well-being such as physical activity, mental health, and public access only confound accessibility issues. Visually impaired persons are less likely to participate in social sports because of transportation barriers and lack of peer support. Transportation was the most significant environmental barriers to physical activity amongst

inactive visually impaired participants. Two psychosocial barriers to physical activity for active, visually impaired persons were required supervision and a lack of comfortability in social settings (Jaarsma, 2014).

The impacts of social isolation and low physical activity are dangerous. Numerous population-based surveys have established a significant correlation between a visual impairment diagnosis and the onset of depression. Visually impaired individuals who reported low physical activity and visually impaired female participants were more likely to suffer from depression, suicidal ideation, and stress (Cho, 2015). Anxiety and a higher risk of suicide have also been correlated to visual impairment in the United States and internationally. However, the driving force is reported to be low physical activity (Cho, 2015). Low physical activity is a common occurrence in low-to-no vision persons. Low physical activity is the most significant risk factor for serious mental health disturbances in these individuals. It is not the visual impairment itself that is impacting mental health, rather, it is sedentary behavior caused by visual impairment. If we want to alleviate mental health symptoms, we need to gain a more comprehensive understanding of the barriers to physical activity for adults with low-to-no vision.

Social Isolation

No vision, or loss of vision, necessarily increases a visually impaired person's dependence on other individuals and puts stress on social support networks as a consequence. Dependency status can add stress to these relationships because a blind person will need family members, friends, and other close associates to help them carry out daily tasks. This dependency dynamic can negatively impact close relationships. It is not uncommon for close family and friends to withdraw from the relationship. It is important that we be able to identify any

tendencies towards social isolation as soon as possible in visually impaired patients. Social isolation can compound physical illness and mental health problems in these individuals.

Numerous factors can increase one's risk of social isolation. These factors include: difficulties communicating, decreased mobility, deteriorating physical and mental health, and transportation barriers (Coyle, 2017). People who are visually impaired experience these challenges more often than sighted individuals. As a result, the visually impaired are more likely to be at risk of social isolation.

A sample of the National Health and Nutrition Examination Survey (NHNES) shows that persons with low-to-no vision are more likely to be unmarried than persons with visual acuity. Moreover, the research suggests that sighted people are at lower risk for social isolation because they are more likely to be married, have extensive emotional support networks and larger numbers of friends than those with low-to-no vision (Coyle, 2017). This is interesting because a romantic partnership is an intimate bond that can help people to feel supported and connected. We should note that this research does not explore the psychosocial impacts of being unmarried as it only lists marital-status as an accurate predictor of social isolation.

The NHNES sample documents clinical and self-reported incidences of visual impairments. The supporting research for the association between visual impairment and social isolation is more credible than other statistical analyses because the work assesses both clinical diagnoses and self-reported diagnoses. Most work in the field tends to be based on self-reporting only. However, self-reports of low-to-no vision are better at risk prediction than clinical reports of visual impairment because self-reporting reveals an individual's personal beliefs about their ability to be successful in a social setting (Coyle, 2017). This nuance of self-disclosed reporting

illuminates a correlation between the psychological perception of one's vision status and the quality and amount of their social interactions. If someone has negative perceptions about their visual disability, and perceive themselves to be less worthy of social connection, they are at greater risk for social isolation. Therefore, a change in visual status can degrade the social support systems of affected individuals. The psychological impacts of the loss of vision also explain the increased risk of social isolation in these individuals.

SOLUTIONS

People with visual impairments use a variety of tools and skills to make sure that they can travel through the human built environment. However, people with visual impairments find themselves in a very difficult situation with the pedestrian environment constantly changing. Usually, people with visual impairments have an issue with asking for help from strangers when they are in need of assistance. People with visual impairments have difficulties with their ability to see and with an ever changing environment, they would remain secluded and isolated from the outside world because of the dangers of speaking to strangers and the anxiety that comes with putting trust in a stranger in this day and age. Technology that could assist people with visual impairments have been developed to help people that are visually impaired be able to go outside, even within the ever changing built environment. Technology used by the visually impaired, in order to be able to navigate through the environment, include GPS smartphone applications, and ultrasonic technology, etc. Technology built in the environment with the purpose of being able to help people with visual impairments include smart paint, and talking signs and autonomous vehicles, etc.

The purpose of the solutions portion of the paper is to put a spotlight on the creative innovations of technology that strive to better assist those people with visual impairments in everyday travel. Also to help support the independence of people with visual impairments.

Built Environment Navigation

People with a visual impairment sometimes need a different way of getting information readily available to other pedestrian through vision. People with visual impairments travel to stores, on buses, planes, etc. just like any other person. In the past, the main thing people with visual impairments would use to travel is the sound of traffic and using their other senses to figure out the way the traffic was moving. The way traffic was moving can help someone with visual impairment determine if the street was one way to two way and determine the distance to the intersection and how close they are to the street. A person with visual impairment uses this knowledge and their own memory of how the environment is laid out to determine where to go and where they, in order to navigate. This was used by people who were blind for many years and many skills taught by orientation and mobility were developed to take advantage of the traffic flow information.

But the environment doesn't stay the same forever, significant changes have been made to the environment that a person with visual impairment have dedicated to memory, in which they use to travel. Corners were built to be more rounded to be able to provide a greater turn radius for large vehicles, intersections have been built larger for there to be increased traffic flow, signals are increasingly linked to create platooning, intersections are more commonly differ so that traffic signals can react to the presence or lack of presence of vehicles, and there are new

and more complicated intersections in use and being built for the future. This is a problem for people with visual impairment that have taken it in memory.

One of the earlier changes to the built environment that impacted people with visual impairments was the creation of wheelchair ramps. These ramps were necessary to allow wheelchair users the ability to easily move between the sidewalk and street without having to deal with large level changes. However, once these ramps were becoming more prevalent, it was evident that people with visual impairments would often walk into the street without realizing it. Detectable warnings in the form of truncated domes were developed to be able to solve this issue, to provide a way to detect a change in surface meaning a change in walkway. These surface changes made it more plausible to detect between the walking surface and the road surface but do not provide any information of the sort of alignment information for people with visual impairment are traveling.

When a pedestrian who has visual impairment is at a legal crossing place, they determine when to begin crossing is to listen for the traffic that is moving parallel with the person that has visual impairment intended line of travel. Although, if there is no traffic, if the environment is noisy, or if the pedestrian that has visual impairment has a problem perceiving the traffic, their ability to travel and cross the street in a safe manner, can be hindered. Also " some [visually imapired pedestrians] believe getting help from strangers is not desirable." (Riazi, A., 2016) A solution for this issue of accessibility is the accessible pedestrian signals. This solution provides a pushbutton on each corner of an intersection that a pedestrian pushes when they wish to cross a street. At the appropriate time in the traffic, which would be when the visual walk signal is lit for pedestrian, an auditory signal is produced that indicates that the visual walk signal is lit.

Many forms of the system also provide a vibrotactile signal, vibration to the touch, so that a pedestrian who is deaf and blind can access the information. Note that the system does not indicate whether it is safe to cross, but only that the visual walk signal is lit, so there are still plenty of improvements to be made.

The need for additional guidance and access to information has become more necessary with the increase of advances to vehicle transport. As intersections have grown larger and traffic signals have become more complex, keeping track of traffic has become more difficult for pedestrians with visual impairment. It is easy for a pedestrian who is blind to confuse a turning traffic movement with a parallel surge of traffic. The existence of the accessible pedestrian signals is designed to address this set of issues. One of the latest developments in the built environment that is impacting the independent travel of pedestrians who are blind is the use of more complex intersection. Roundabouts present a particular problem for people who are with visual impairment because traffic does not have to stop and because walking paths and roadways are generally curved, often making it difficult to judge where the crossing points are for someone with visual impairment.

When crossing at a roundabout, a pedestrian who is blind must either determine that a large enough time exists between vehicles to allow a crossing, cross in front of a stopped vehicle, or force a vehicle to stop. Determining that a large enough gap exists but if traffic is heavy, a pedestrian might not have a large enough time. In these cases, it has been shown that the longer a pedestrian with visual impairment is forced to wait, the more risk the pedestrian with visual impairment is willing to assume in their crossing decisions. If a pedestrian with visual impairment is not able to determine that they have enough time to cross as a pedestrian with

visual impairment, then a person with visual impairment will try to identify when a car has stopped, but a vehicle simply stopping does not provide the same amount of information to a pedestrian with visual impairment. The driver might be stopping for a reason unrelated to the pedestrian with visual impairment. If there are two lanes of traffic, a stopped vehicle in the first lane might auditorily mask the sound of an approaching vehicle in the second lane. There is a suggestion of holding arms spread open, to indicate that a pedestrian with visual impairment is attempting to cross, but these strategies not only, do not provide absolute safety but also many pedestrians with visual impairment will not feel confident in using such strategies. Which is why implementing accessible pedestrian signals are so important for the safety of those pedestrians with visual impairment. Many of these intersections create extremely confusing paths and interfering sounding cues for pedestrians with visual impairment.

Smartphone Applications

Now a days there is a large increase in the use of cell phones. According to a survey conducted by researchers Birmingham 69% of visually impaired students access the internet through their mobile phones.(Elbes, M., & Al-Fuqaha, A., 2013) Therefore it is best to resort to something that is comparable and easily accessible such as phone apps. There are several apps that were made with the sole purpose of helping the blind navigate through new environment. These apps will allow blind pedestrians to even navigate through the most unfamiliar of environments. Cities, countries, new places and new neighborhoods can be explored thoroughly by the blind with the assistance of these navigation tools. Navigating can be a thing of little to no stress for the visually impaired if the app are being used in congruent with apps that were built for the purpose of navigation. It is the hope of everyone involved that these apps will prove

to be useful and will be able to prove to be of help for visually impaired pedestrians. Furthermore, these apps can help the process of navigating for visually imapired without needing to know the layout of the land before hand, or before they even decide to go to a certain place, the visually impaired can use these apps to help them throughout the tough times of exploring.

These apps can change the way that pedestrians of the visually impaired persuasion walk through life. The visually impaired no longer need to worry about getting to a certain unknown location, or have the worries of moving through a weird new area without the assistance of those around them. Traveling to a new place can give jitters to most pedestrians, having never been there and never seeing the things that are over there, can give anxiety to the toughest of pedestrians; with these apps, there can be a new wave in confidence in pedestrians that are visually impaired. The new confidence in the visually impaired can be that of having the freedom to explore anywhere they so desired. The visually impaired will no longer have to worry about such things as not being able to navigate from place to place.

The main issue that the apps tackle, or challenge or struggle towards, is the goal of helping pedestrians that are visually impaired have the option of navigating the world without the assistance of other pedestrians, after the pedestrians that are visually impaired are explained and walked through the function of the app and how to use such an app. Although visually impaired pedestrians can not see the app on the phone or may have difficulties in navigating the option to download the app due to lack of sight, to install the app, it is hoped that since studies show that blind pedestrians are more willing to ask for help from family members, that they could ask a family member to install and talk them through this app. An app to help pedestrians that are visually impaired navigate throughout the world. But not a single app but multiple apps that can

help the visually imapired to travel the world on their own, to feel like they do not have to be bound to any set location, with the fear of being lost out in the world. These apps can help the visually impaired strive forward into the world and explore it to the limits.

There are also user wearable assistance devices that can be used by the visually impaired in times of need. They can use these devices, that can help the visually impaired, with recognizing certain objects out in the world, and even if the visually impaired person does not know what is around them, they can certainly have this device to help through the tough situation. Going through an unknown situation with this device can make and change the situation for the better and help the visually impaired through out life and face the challenges of going through the streets not knowing what is around them, because this device will help them be able to know exactly what is around them. This wearable device is wearable on the face of a person and in the hands of someone that is visually impaired, that person can find this device most useful, because this device can tell someone that is visually impaired what is around them, since the person that is visually imapired is unable to see it for themselves. The wearable device is able to distinguish between objects that show up in front of someone that happens to be visually impaired and identifies several objects because it is able to distinguish the objects in front of it, juxtaposing it to other objects in the same view.

In the exceedingly changing environment, pedestrians that are visually imapired need new ways of finding their way around. Knowing more or less where they need to go or if they have been shown how to get to a certain area with guidance in the past can be entirely lost to them now. The environment created by pedestrians are constantly changing and will continue to change throughout further years in countless ways. The way the cities, towns, everything

changes is inevitable and pedestrians that are visually impaired have no way of adapting in a safe way. They are blind to the now new dangers that come with the environment shifting in a new way, especially for those pedestrians that are visually impaired and do not leave the house very often, perhaps retired elderly that are visually impaired and have no one to look after them, or refuse to have anyone look after them. A solution for such a problem like many of this time of age seems to be technology.

Technology can help so many pedestrians these days, and the target demographic is the pedestrians that are visually impaired. With the help of technology the visually impaired can go past the limits of needing outside help from other pedestrians, and no longer need to have fear and no longer need to have anxiety of having to ask for directions and hope the person they are talking to is a nice samaritan and not some would be criminal that they are now at the mercy to. Technology can free those pedestrians that are tied down to their houses due to anxiety or fear of the outside world. No longer will pedestrians need to be worried of being lost in a new environment that is constantly changing, if these pedestrians decide to take the steps into incorporating technology into their everyday life. Technology designed to increase accessibility for pedestrians with visual impairments involve a lot of technology that can be used in everyday life. The built environment by humans are for everyone, including those with visual impairment. And to go further with the point of the environment being built by people for the people, pedestrians that are visually impaired do not need to feel like they are being hindered by the new strides that are being taken into the future of the people in this creating a new, better environment. It should not matter whether a pedestrian with visual impairment is in a town or city or if their surroundings are constantly changing, for them to be able to explore and take in

the vast world around them. There are technology out there to help pedestrians that are visually impaired with this goal in mind. Technology made specifically to help them become greater individuals and become truly integrated into society, without feeling like they can not accomplish the same level of navigation as every other pedestrian that walks forward into the world today. Technology with the purpose of making navigation with visual impairment as easy as any other task that needs to be done in the day. Hopefully technology can be put in a better light and flourish in helping the pedestrians with visual impairment take steps forward to better navigation and have a higher form of awareness when exploring the outside world and interacting with the environment around them.

There are plenty of machines and technology that have been built to aid the visually impaired pedestrians, created throughout the years of technology booming with innovations and ideas with the hope of a better and easier life for all human beings of the world, working together to evolve the environment to the benefit of everyone. Technology that strive to better and impact the lives of pedestrians with visual impairment into the future where they can travel freely and move to the beat of their own drums may include but are not limited to the following: talking signs, smart paint, devices that communicate between the pedestrian and the built environment, autonomous vehicles, integrated travel systems, and accessible pedestrian signals. These technology may be the common ones that most people know of, or could be people that never heard of these technologies, there are also many more out there that are less talked about and can be the way of the future and create better assistance for those that are visually impaired all of the time and even in times that no one else can help them navigate. For instance the night comes with ever so more struggles, and in an environment that changed and is not the way that it was

before or how the pedestrian with visual impairment remembers it, it would be a tremendous help and ally if pedestrians with visual impairment had a tool in their pocket or on their very eyes to assist or on the very streets they walk in that can assist them in their need to navigate through the world with very limited sight.

SmartCane, O&M, and CrossWatch Technologies

Having proven that the visually impaired can not rely on the sighted while navigating around the city, an alternative method must now be addressed. This method must be reliable, easily accessible, and affordable as well. This method is known as technology, and as of currently in 2019, it has come a long way and improved immensely. As previously addressed, part of the problem faced by the visually impaired is the ability to walk safely on the sidewalks and cross the street. Given that most individuals that are identified as "legally blind" are given a white cane due to their affordability, ease of access, and small learning curve, they are practically set up for failure as several flaws were detected about the use of a white cane (Coughlan, 2015). These include but are not limited to, the inability to sense objects above the 2 foot range from the ground, the inability to sense moving objects until they have become within a threatening range of the visually impaired pedestrian, as well as the inability to detect traffic lights, signage, or upcoming road changes (Review Paper, 2015). However, with the newly innovated and highly affordable SmartCane, visually impaired pedestrians will be able to walk feeling at ease (Assistive Technology, 2017). The SmartCane is an electronic device that is sold as an attachment to the white cane for the visually impaired pedestrians. The way it works is as follows: the visually impaired personal simply attaches the SmartCane device atop their standard white cane in the configuration of a grip. From there, ultrasonic waves are sent out from the

device's sensors and received in the form of various vibratory patterns to send feedback back to the pedestrian depending on the height and distance of the approaching object (Chanana, 2017). This helps the visually impaired user detect any upcoming obstacles such as "low hanging tree branches, signboards, parked vehicles, or animals" and even potential dangerously incoming obstacles such as "fast-reversing vehicles". Plus there is always the included safety of keeping a comfortable distance from other fellow pedestrians on the sidewalk or crosswalk. (SmartCane, 2019). As shown, the SmartCane device promotes more independence for visually impaired pedestrians as it allows to walk safely and practically. However, it must be noted that the SmartCane does have its limitations as noted by the International Journal of Engineering Research & Technology. According to the "Enhancement of Smart Cane" paper, it is warned that sonar navigation devices such as the SmartCane are unable to detect stairs or objects that are outside the 1 meter range (Gnana, 2015). Similarly a plan is proposed to enhance the SmartCane, as well as other cane-like portable navigation devices. The main suggestions are that the devices be modified in such a manner that they become equipped with GPS which will be an added benefit given that it will provide the visually impaired pedestrian with "accurate location and position". As well as give the visually impaired user auditory feedback through the use of smartphones, which as addressed is accessible to the majority of the visually impaired population. In addition, sensors are suggested to help that can detect descends and dropoffs. (Gnana, 2015). As shown with any type of new and upcoming technology, there is always room for improvement.

Another technique that the visually impaired would most likely benefit from is Orientation and Mobility Training. This training is a form of rehab given by a certified specialist

that is certified through the Academy for Certification of Vision Rehabilitation and Education Professionals. The specialist teachers instruct the visually impaired, and give them visual techniques that are different than the ones they knew about if they were previously sighted, to help assist themselves in open spaces and in getting around spaces and getting a better sense of proprioception (Bowman, 2014). This idea of Orientation & Mobility is very old fashioned, time heavy, but does have room for improvement with the assistance of technology. Virtual Reality is a computer system that creates a simulated world that is very similar to the real world, and creates situations that the programmer wants to set up for the user. The potential here is great for the visually impaired society as it allows them to practice Orientation & Mobility techniques which are usually high risk as they test their judgement on whether it is safe to cross a street or not, without any of the risky consequences. A study done by Bowman and colleagues stated the researchers gathered two groups of people classified as having "low vision" and tested them using Orientation & Mobility techniques. The experiment proceeded as follows: one group was sent out in the 'real world' and the other group was in the virtual world using the Virtual Reality System. Both groups were tested in the same manner, as they were placed in an intersection type setting and needed to make a decision to utter the phrase "GO" whenever they felt it was safe to walk. Scores were kept track of if the user's decision was correct or incorrect based on if the "DON'T WALK" signal was on, as well as if the user choose to say at the proper time such as in the first half of the "WALK" signal and not the second half. The result the experimenters found was that Orientation & Mobility training did in fact improve the users' decision making, as they had a control experiment done prior which found that less than "50% of the GO calls from all participants fell in the DON'T WALK phase". After O&M training however, " 90% of the GO

calls fell in the early half of the pedestrian phase"(Bowman). The experimenters also concluded that they observed no difference between the virtual reality group and the group who went out in the real world. Thus concluding that the virtual reality system is a reliable way of training the visually impaired. However, it must be noted that the sample size of this test was very small, as it only included 2 subjects for the virtual reality group and 4 for the real world, and so it must be inferred and proceeded with caution that the results are susceptible to change with a large group. Regardless, this does indeed show a great deal of potential of the Virtual Reality systems and the visually impaired, especially given that are limited quantities of registered COMS or certified Orientation & Mobility Specialists (Bowman, 2015). Thus the mass production of equipment as such, as well as prioritizing a select group of Virtual Reality Systems to be classified as Medical Equipment would allow large insurance companies to see it's effectiveness and possibly cover the cost, making it affordable for those in great need, such as those legally known "Totally Blind". This system would be found common in pharmacies alongside white canes and blood pressure machines, and thus help million of visually impaired across the states, including the 3.5 million visually impaired pedestrians in New York. This whole process is however just a recommendation and does take a lot of time, funding, and political work to actually be successful.

Which is the same case for another set of systems that promotes the safety and independence of the visually impaired that are known as ZebraCrossing and CrossWatch. These two softwares are actually pretty similar as they are both smartphone applications that can be downloaded directly to a visually impaired user's phone and use GPS or a global location system to find the user's position along with the phone's camera to send audio feedback to the user to

inform them of an upcoming crosswalk (Ahmetovic, 2015; Coughlan, 2015). This allows the visually impaired pedestrian to recognize they are approaching an intersection and thus must adjust themselves so they are walking inside the lines of the crosswalk so they are able to get across safely. Unfortunately for such new technology they have not been tested on a study group yet and still require some crowd sourced funding in order to be mass produced, properly tested, and manufactured.

As shown the technology is very much here, and it has the potential to save plenty of lives from social inactivity as well as impending danger from intersections and obstacles found on sidewalks. The sole purpose of this specially designed technology, (as well as ones not yet to be specialized) is to enhance the lives of the visually impaired personal who is too reluctant to step outside or ask a fellow sighted pedestrian, friend, family member to take time out of their day just to help them, thus promoting independence. Although visually impaired pedestrians can not control the environment around them as well as the response of a sighted person who they thought about asking for help, they can very easily control their white cane along the other assistive accessories and technology that they choose to guide them. Thus concluding that the future is here. It just needs a little more financial help and support to expand and help the masses.

Costs of Technology

Assisted pedestrian signals are supplied by the Department of Transportation. The cost to install this technology, in 2018 dollars, is $60,903 per intersection (New York Department of Transportation, 2018). There are two ways to fund the installation of more of these devices in New York City intersections: lower installations costs or increase federal funding for the multi-national Vision Zero project.

The current cost to install assisted pedestrian signals is exacerbated but improper existing infrastructure. The price to equip a single intersection with eight assisted signal units is $8,080. However, because many traffic poles are not initially installed with the proper infrastructure to be furnished with this technology in the future, costs skyrocket from $8,080 to $60,903 per intersection (New York Department of Transportation, 2018). In many cases, the poles need to be replaced and the roads and sidewalks need to be resurfaced.

The New York City Department of Transportation currently funds the Vision Zero project which advocates for street safety to reduce the number of pedestrian deaths each year. The project is largely responsible for smarter New York City street designs that make intersections and crosswalks safer for pedestrians and cyclists. Congress currently funds the Vision Zero project and for improvements in city street infrastructure. An increase in this funding, would help the current de Blasio administration allocate the necessary funds for intersection enhancements, including the number of assisted pedestrian signals.

Visually Impaired Community Sports Programs

New York is home to multiple community organizations that facilitate sports programs and community fitness classes. The easier it is for the visually impaired to travel around the city, and even the state, the more likely these community members can attend these resource centers or sporting events. Playing on a sports team is a great way to build esteem and social support for people of all abilities. There are local sports teams and organizations that use technology to make common sports accessible for the visually impaired. For example, The Long Island Bombers are a baseball team that use beeping baseballs and buzzing bases to allow visually impaired athletes to play ball without sight. Court 16, a tennis operation in Queens, NY, is a tennis facility that

hosts visually impaired athletes for tennis instruction using beeping tennis balls. As this paper mentions in the problem sections, there are many psychosocial challenges that visually impaired people are confronted with because of their likelihood to remain indoors. Statistically proven facilitators of sport participation for the visually impaired are fun, health and social contacts (Jaarsma, 2014). These community sports programs can help low-or-no vision individuals establish meaningful, communal connections, find local support and promote physical activity.

RECOMMENDATIONS

At the moment, little research exists on the effectiveness of new assistive technologies because most smartphone technologies and GPS smart canes are still in their infancy stages. In order to provide robust solutions to the mobility challenges that people with low-or-no vision face, we are going to need to facilitate research that investigates possible correlations between smartphone assistive technology and increased mobility in people with low-or-no vision. The New York City Department of Transportation is interested in this research as well. They are actively looking for new technologies, specifically smartphone technologies, that can bolster the assisted pedestrian signal program. Currently, the NYC DOT has a contract with the University Transportation Research Center that exists to gather evidence to prevent pedestrian deaths (New York Department of Transportation, 2018). The research capital already exists for assistive technologies and so it would not be impossible to focus some of this work on pedestrian safety for New Yorkers with visual impairments.

The psychosocial impacts of vision disability is another area of research that could use an overhaul. The Jaarsma Survey, the Korean Ophthalmological Society and the National Health

and Nutrition Examination survey all had sample sizes between 700 and 2000 visually impaired participants. Although the control group for the Korean study had over 28,000 subjects, the data used for mental health comparisons for people with visual impairments was around 800 subjects. The Jaarsma survey was the only study that was not use cross-sectional databases to conduct its research. However, the response rate to the Jaarsma study was only 13% and the study admits that double registration probably occurred (Jaarsma, 2014). A lot of little-to-no vision individuals were not able to be reached due to their mental health and ability challenges. Therefore, it is apparent to us that two things need to happen; (1) More national research needs to be conducted experiments to observe the effects of visual impairment has on psychosocial well-being in subjects. Experimental and observational studies could provide more accurate results because patients would be under professional supervision over longer periods of time. (2) Future research studies must investigate, specifically and directly, the correlation between vision status and mental and physical health issues caused by poor physical activity. We were able to make connections using the available research but for more meaningful results, the field will need to focus its efforts in these directions.

Our final recommendation calls for public awareness campaigns that demand better fitness accessibility for blind and low-vision individuals. Many popular, privately-owned gyms and fitness centers are not accessible for people with low-to-no vision. Given common environmental barriers to fitness, such as inaccessible travel routes, it is important that widespread fitness centers have proper instruction and appropriate equipment to facilitate users with visual impairments.Currently, only a few sports teams exist in remote parts of the city which makes it difficult to facilitate these types of activities. Accessible local fitness centers in

areas with dense visually impaired populations would make recreational group fitness a possibility.

CONCLUSION

There are no clear-cut answers or solutions for complex disabilities such as visual impairment. Instead, small changes can be made to make this problem easier to bare. One of the main problems associated with visually impaired individuals is that they tend to isolate themselves from society and fall into depression. But this can be easily amended. With the new technology such as smartphone applications, built environment navigation, smart cane and crosswatch, it allows visually impaired individuals to venture out into the world and explore what is around them. They no longer have to stay inside in fear of getting lost or feeling unsafe.

When sighted-people leave their house, they are always cautious and aware of their surroundings for safety reasons. Visually impaired pedestrians, however, have a more difficult time gauging their own safety because low-vision, or lack of, and tend to isolate out of fear. Luckily, with new technology, this venture into the outside world can be made easier. With a voice-activated phone, visually impaired individuals can easily download apps that will help them to navigate outside. To ensure that these apps are downloaded, eye doctors or general doctors for the visually impaired should be informed when a new app comes out. They should then be required to tell all their patients about it and provide support in downloading the app. If every doctor does this, then it can lead to the uprise in the amount of visually impaired individuals that go outside by themselves and leave their isolation.

Remaining indoors comes with the problem of low physical activity. Unable to clearly see the world around them, visually impaired individuals will stay away from sports and other physical activities leading to physical and mental health issues. The best antidote for poor physical activity seems to be community sports programs that are accessible for the visually impaired. By joining these programs and communities, visually imapired individuals are more likely to leave their house and become active. These programs provide opportunities for social connection which facilitate friendships and support systems. The combination of technology, government funding and community engagement are the societal tools needed to support the independence of visually impaired pedestrians.

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