

THERE'S AN APP FOR THAT: THE VISUALLY IMPAIRED AND MOBILE PHONE
APPLICATIONS

by

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ABSTRACT

Background: Visual impairment is life-changing. There are over 285 million visually impaired people worldwide. In the United States alone, 20.6 million adults have reported experiencing vision loss. The dramatic advancement of technology has the capacity to create many solutions for those with visual impairment. Mobile phone and tablet applications have made an astounding impact on the daily lives of those with vision loss. This study is a review of the various kinds of apps available as well as a comparison of the effectiveness and usability of these assistive technologies.

Methods: Over the academic year of 2014-2015 information was compiled about the available applications for the visually impaired. The apps were classified, and their usability and effectiveness were determined through trial and consumer reviews. To standardize the evaluation, a point-based rubric was created to assess each app. The search for applications was conducted through the two main application stores for the iPhone and Android systems using keywords associated with visual impairment.

Results: Various apps were analyzed based on cost, consumer reviews, and the reviewer's opinion of usability and functionality. Apps from the Magnifying and Navigation classifications proved to be most valuable. **Conclusions:** The profession of optometry and standard of care for patients with vision impairment has changed dramatically over the years with the advancement of technology. Mobile phone applications made specifically for those with vision loss can increase quality of life and provide a new facet of low vision rehabilitation care in optometry.

TABLE OF CONTENTS

	Page
LIST OF TABLES.....	v
LIST OF FIGURES.....	vi
CHAPTER	
1 INTRODUCTION.....	1
2 METHODS.....	2
3 RESULTS.....	3
4 DISCUSSION.....	13

LIST OF TABLES

Table		Page
1	Summary of Apps.....	20

LIST OF FIGURES

Figure	Page
1 Main Interface for the Ray App for Visually Impaired.....	4
2 !NotNav Accessibility Interface.....	6
3 Example of Magnifying Glass with Light Negative Contrast.....	8
4 High Contrast Text with Text Detective App.....	9
5 iBlink Radio Station Interface.....	10

CHAPTER 1

INTRODUCTION

In the United States, 20.6 million adults have reported experiencing vision loss.¹ In addition, approximately 6.5 million people are considered to be visually impaired.² This is a significant number of individuals that are burdened with the task of navigating through a world that is geared for those with sight. Fortunately, with the advancement of technology, many solutions have become available to those with visual impairment.

Assistive technology, defined as an item or piece of equipment that enables individuals with disabilities to enjoy full inclusion and integration into society, has helped those with vision loss gain independence in everyday life.³ Traditional assistive technologies include white canes, screen readers, leader dogs, walkers, handheld magnifiers, etc. While these tools allow for increased independence, there is still room for additional technologies to help those without sight.

Mobile applications, or 'apps,' have become a major facet of smartphone and tablet technology⁴. An application is a software program specifically designed for mobile devices such as smartphones and tablets.⁵ Applications ranging from navigation to simply magnifying objects are available and easily acquired with every smartphone. This software has the potential to dramatically increase the quality of life for the visually impaired by increasing independence and ability to function in the sight-dependent world. A review of the various kinds of apps available as well as a comparison of the effectiveness and usability of these assistive technologies has been conducted.

CHAPTER 2

METHODS

From August 2014 through January 2015 information was compiled pertaining to select available apps for the visually impaired. The search was completed on the two main application stores for the iPhone (Apple Store) and Android systems (Play Store). Searches were conducted with the following keywords: *visually impaired, blind, low vision, text to speech, vision loss*. Supplemental research was also achieved through the PubMed database for relevant journal articles pertaining to mobile phone applications and the visually impaired. To standardize the evaluation, a point-based rubric was created to score each app based on each of the following topics: consumer reviews, cost, reviewer opinion based on ease of use, and reviewer opinion based on functionality. Each topic was allowed a maximum of 10 points and a total possible score of 40 points. Consumer reviews on the app stores are calculated out of 5, so this rating was doubled. For assessing cost, a value of 10 points was awarded to apps that were free while those that must be purchased received fewer points scaled based on the fee. Lastly, the same reviewer assessed each app and graded both the ease of use and functionality on a scale of 1 to 10. A total of 32 applications were evaluated. The reviewer classified the 10 highest scoring apps into the following groups: interface, navigation, magnifying, text-to-speech, and miscellaneous.

CHAPTER 3

RESULTS

Interface

The accessibility of smartphones has increased dramatically compared to the earlier generation of this technology. The standard accessibility settings of both the iPhone and Android systems were evaluated. The iPhone is equipped with a gesture-based screen reader, called VoiceOver, which has the capability of describing everything on the phone's screen in over 30 languages.⁶ There are also features that allow text-to-speech for easier emailing and texting, as well as a Braille keyboard. The majority of apps for the iPhone are compatible with the VoiceOver feature, making the phone completely accessible to those with impaired vision. The Android system also has its own screen reading program, called Talkback, pre-installed in all phones.⁷ This program uses automated speech for all actions, describing the movement of the user's fingers on the screen, and events, such as an incoming call or text message. The Android system is also equipped with an additional program, Kickback, which provides the user with haptic feedback through vibration, and Soundback, which alerts the user of his/her actions on the phone with sound feedback. Most Android apps are compatible with the Talkback system making Android smartphones very accessible.

In addition to the pre-installed programs, there are phone interface apps that are easily acquired for the visually impaired. There are many apps designed to make a smartphone touchscreen easier to manage through simple interfaces that allow the user

to complete basic functions. The Ray App for Visually Impaired by Project Ray for the Android system proved to be popular on the Google Play Store with over 5,000 downloads and received a rating of 4.4/5 from consumer reviews yielding a score of 8.8/10.⁸ The app provides a simple, high contrast interface to manage the basic functions of the phone with verbal and haptic feedback, so it was assigned a 7/10 for usability. The Ray program has additional apps to help the user with everything from maps to finding the nearest public transportation schedule, all of which use the same interface for comfortable continuity, so a score of 8 was given for functionality. The cost of this app is free, therefore 10 points was awarded for the cost, making it a great option for visually impaired users with a total score of 33.8/40. Figure 1 presents the main interface for the Ray App for Visually Impaired.

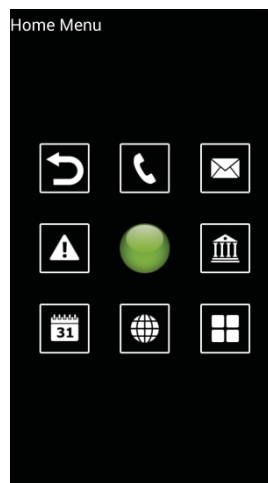


Figure 1. Main Interface for the Ray App for Visually Impaired

Navigation

The ability to navigate from point A to point B is perhaps the most important factor in determining a person's independence. Reduced mobility can result in social isolation and depression.⁹ With the help of navigation apps, visually impaired users can

easily overcome this obstacle. The Google Maps application is one of the many pre-installed programs on Android system smartphones and is credited with over 1 billion downloads.¹⁰ This voice-guided GPS navigation app allows for easy navigation via car, biking, public transportation and walking. Consumer reviews rate this app 8.6/10 points. This app is compatible with the Talkback program and allows for quick and easy searching for desired locations and turn-by-turn directions giving this app a total usability score of 9/10. With over 1 billion downloads, this app has proven to be an extremely functional program that is compatible with Android smartphone accessibility features earning a 10/10 points for functionality. This app is pre-installed on all Android smartphones, so no additional costs are necessary giving this program 10/10 for the cost category. The total score for this app is 37.6, making it a must-have application for the visually impaired.

The iPhone Maps app is just as impressive as the Android Maps app.¹¹ The app is pre-installed on every iPhone, so there is no additional expense and therefore awarded 10/10 points for cost. Consumer reviews ring in at 8/10 with great overall user satisfaction. It features spoken step-by-step directions for all modes of travel and is compatible with the VoiceOver program. Usability and functionality scores are 9 and 10, respectively. The iPhone Map app rubric evaluation yielded 37 points.

In addition to the pre-installed applications, there are many available apps that cater to the needs of those with decreased vision. !NotNav Accessibility by Les Smithson is an orientation aid for the blind and visually impaired.¹² This app simply announces the compass heading, street address, and nearest crossroads or point of interest. The user

also has the capability to create a waypoint reference location. Consumer reviews report great user satisfaction and rate this app 9/10. As shown in Figure 2, the interface is easy to use with only 4 available options – pause/start, speak last, update waypoint, and settings. The reviewer rated the usability as 8/10. This app also has the capability of working while the screen is off or while another app is running, allowing a continuous update of location for the user. The app is only optimal for walking navigation, so the functionality of this app rates as 7/10. !NotNav Accessibility is a great navigation tool for visually impaired patients for directionality and on-foot travelling.

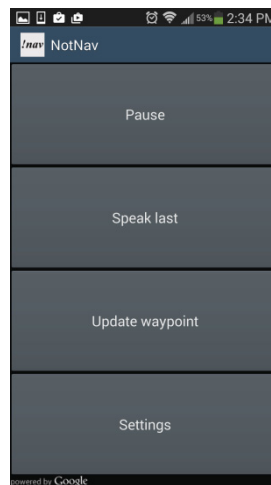


Figure 2. !NotNav Accessibility Interface

Magnifying

Magnifying lenses are an essential low vision assistive technology for visually impaired patients. As technology has advanced, digital magnifiers such as closed circuit televisions (video magnifiers) and handheld digital readers have been great additions to the low vision tool arsenal. With the help of select apps, users can turn their smartphones or tablets into handheld digital magnifiers. Numerous magnifying apps were found on both the Google Play Store and Apple App Store ranging from free to

\$19.99. Upon evaluation of multiple magnifying apps, the two apps with the highest scoring from the rubric are highlighted.

Magnifier by Mmapps Mobile for the Android smartphone rated very well on the rubric with a total score of 38.6/40. Consumer reviews rate this app 8.6/10. Its many features include: high magnification factor, zoom and exposure controls, flashlight for low light situations, a negative contrast mode, and a freeze option where images can be saved and shared.¹³ The interface is clean and simple with icons for each feature making the app extremely easy to manage, so the usability was rated 10/10. The ability to freeze and save images is a great feature. Users can freeze the image and continue to zoom in to allow for more comfortable use. The app can also increase contrast by switching to negative mode as well as increase lighting by utilizing the flash light of the smartphone. The functionality was rated 10/10. The best feature of this app is that it is free, yielding 10/10 for cost on the rubric scale. Overall, it is a great option for users that require magnification.

Magnifying Glass with Light by Falcon in Motion, LLC for the iPhone is another great magnifying app. This app features up to 5x magnification, a negative contrast option, and LED lighting for enhanced contrast. An example of a magnified negative contrast image is shown in Figure 3. Consumer reviews rate this app with a total of 9/10. It also has a 'crystal clear' mode which uses an advanced video processing engine for a better image.¹⁴ The interface is simple with scrolls for magnification and contrast adjustment. With a shaking motion, the icons will disappear to allow for a full image view. There is also a freeze feature that can allow for additional zoom with the pinching

motion on the screen. Usability was rated a 10/10 as it is extremely easy to manage the app. All of the available features make this app very useful for users that need high contrast magnification, so the app was awarded 10/10 for functionality. Magnifying Glass with Light can be downloaded for the price of \$1.99, so a score of 8/10 was given for cost.

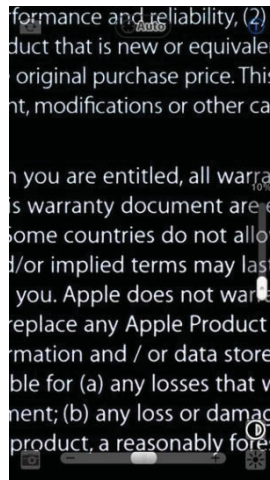


Figure 3. Example of Magnifying Glass with Light Negative Contrast

Text-to-Speech

The ability to read is the most valued task among daily life activities and dramatically impacts a patient's quality of life¹⁵. Technology has helped patients overcome this challenge with the use of text-to-speech features. As previously mentioned, the Android and iPhone systems both have programs that can read text on the screen which creates endless possibilities for those that have challenges with visual reading. There are also text-to-speech applications that supplement the available accessibility functions of smartphones.

Text Detective by A9 Innovations, LLC is an app that reads text from any picture taken with the smartphone.¹⁶ This application is available for both iPhone and Android

systems. Text Detective reads text from photos taken by the smartphone camera which can be stored, edited, copied and pasted. The program is also compatible with the VoiceOver and Talkback programs, making it a great text-to-speech option for visually impaired users. Consumer reviews rate this app 7.6/10. It is important to keep the smartphone stable while taking the picture to capture the text. The reviewer found that, during the testing of this app, the text deciphered by the phone was only accurate about 75% of the time. Due to these factors, the reviewer has rated the usability as 5/10. The app could potentially be used to read menus, mail, and even books and works best when used with high contrast black text against a white background as seen in Figure 4. A score of 6/10 was assigned for functionality. While this app would be great for the above uses, the inaccuracy makes it difficult to use the app. The cost of this application is free resulting in a score of 10/10 for cost making the total score 27.8/40.

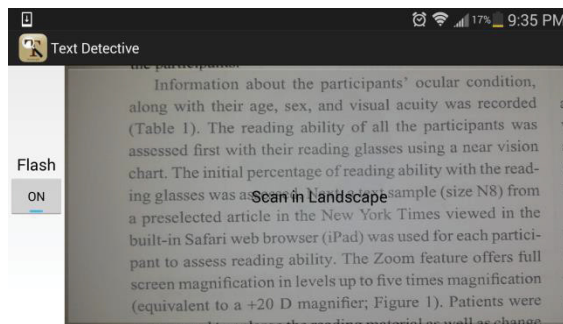


Figure 4. High Contrast Text with Text Detective App.

Another text-to-speech app available is Say Text by Haave Oy for the iPhone.¹⁷ This app also reads text from photos taken by the smartphone. The app received a total score of 28/40. Consumer reviews rate this app 6/10. The application beeps when a document has been detected and also automatically captures an image. Once the app has deciphered the words, the user swipes the screen to the right and the text is read

aloud. These features make the app easier to use, but the reviewer found a steady hand was very important in order to obtain accurate text readings. A rating of 6/10 was given for usability. Say Text has a great potential to allow for those with decreased vision to have access to material like menus and books, but inaccuracies of the app lead to decreased functionality, rated 6/10.

Miscellaneous

There are so many available apps for those with decreased vision that can help with daily life activities. After extensive review, two additional apps for the visually impaired are discussed. iBlink Radio by Serotek Corporation is an app for the blind and visually impaired community and can be used by both Android and iPhone systems.¹⁸ This app provides radio stations, podcasts and reading services catered to those with decreased vision. Consumer reviews rate this app 7.6/10. The interface provides a simple list format of the various stations, podcasts, and reading services as seen in Figure 5.

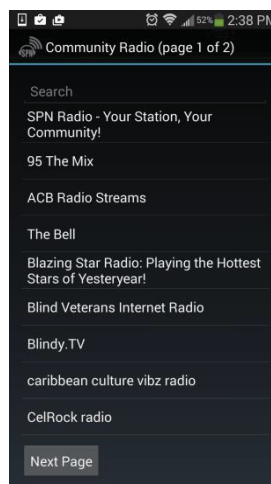


Figure 5. iBlink Radio Station Interface

In addition, iBlink Radio is compatible with the VoiceOver and Talkback programs. The usability was rated 7/10. The lists of available stations and podcasts, while simple to operate, may be time consuming to the user if utilizing the screen reading programs to browse. The podcasts available with this app are made by the blind and visually impaired and cover a range of relevant topics about vision loss, independent living, and much more. The user also has access to many narrated newspaper and magazine titles such as *USA Today*, *The New York Times*, and *The Wall Street Journal*. This app can provide an introduction to the visually impaired community for its users in addition to providing entertainment. The functionality was rated 8/10. The cost of the app is free, giving it a 10/10 for cost. The total points accumulated are 32.6/40.

The Be My Eyes app by Be My Eyes is a great use of smartphone technology. This app connects a blind or visually impaired user to a sighted volunteer through a live video connection.¹⁹ This app is available for the iPhone with an Android compatible program is under development. Consumer reviews rate this app 7/10. A visually impaired user can request a sighted volunteer to describe what he/she sees where the user's rear-facing camera is pointing. This app is compatible with the VoiceOver program and has an easy to use interface with large icons. Usability was rated 8/10. Presently, there are over 10,000 visually impaired users and 115,000 sighted volunteers. This app can be used to help a visually impaired person differentiate canned goods, help determine locations, and much more, thus functionality was rated 8/10. The app is free to

download making the cost 10/10 with a total score of 33/40. For a complete list of the apps with rubric scoring, please refer to Table 1.

Table 1. Summary of Apps

App	Consumer Review	Usability	Functionality	Cost	Total
Interface					
Ray App for Visually Impaired	8.8	7	8	10	33.8
GPS/Navigation					
Google Maps	8.6	9	10	10	37.6
iPhone Maps	8	9	10	10	37
!NotNav Accessibility	9	8	7	9	34
Magnifiers					
Magnifier	8.6	10	10	10	38.6
Magnifying Lens with Light	9	10	10	8	37
Text-to-Speech					
Text Detective	6.8	5	6	10	27.8
Say Text	6	6	6	10	28
Miscellaneous					
iBlink Radio	7.6	7	8	10	32.6
Be My Eyes	7	8	8	10	33

CHAPTER 4

DISCUSSION

After examination of the various apps, it is clear that there are many smartphone accessibility options for visually impaired users that can be helpful for activities of daily life. The two highest scoring categories were the magnifying and GPS/navigation apps. Magnifier by Mmmaps for the Android system received the highest score of 38/40. This app proved to be very functional, easy to use, and cost-efficient with a high consumer review. Magnifying Glass with Light by Falcon in Motion, LLC for the iPhone also scored high with functionality, ease of use and consumer ratings. The app does cost \$1.99, so it is not as cost-efficient as Magnifier. Both Google Maps for Android and iPhone Maps with scores of 37.6 and 37, respectively, would likely be a valuable asset to visually impaired users. The navigation programs are extremely accessible, cost-efficient, and functional.

The lowest scoring app category was text-to-speech. Text Detective by A9 Innovations, LLC scored the lowest with 27.8. The process of taking a picture to decipher text was very difficult in order to obtain an accurate text conversion that would be particularly challenging for visually impaired users. Say Text by Haave Oy consumer reviews were the lowest of all reviewed applications reflecting the decreased functionality secondary to the inaccuracies of the program's text deciphering. While the idea behind these applications is well-founded, the inaccuracies of the programs have impeded their usability and functionality for visually impaired users.

The development of a rubric for evaluating new and updated apps as they enter the market may prove helpful to doctors involved in low vision rehabilitation. The rubric developed for this study worked well and minimized reliance on one reviewer, balancing the opinion of the reviewer with reviews from the general public.

The app study is not without limitations. A factor that may have affected the research includes how many of the public reviews were actually from visually impaired users, which is unknown. Any app reviewing system requires opinions from the users. Users with visual impairment may rate functionality and usability of the apps very differently than fully-sighted users. In addition, the reviewer in this study was not visually impaired, although she was well-educated on low vision rehabilitation and the functional struggles caused by ocular disease as an optometric doctoral candidate. Even from one visually impaired user to another, opinions can vary widely about apps. Thus the study relies on both public reviews and one consistent reviewer.

Further research is warranted in the field of handheld mobile devices and smartphone and tablet technology for visually impaired users. Large scale studies would be appropriate for determining and quantifying the improvement of quality of life and independence of visually impaired patients with the use of assistive mobile technologies. Also, quantifying and classifying the various applications available to the visually impaired community may be helpful for practitioners when recommending vision rehabilitation options to patients.

The profession of optometry and standard of care for patients has changed dramatically over the years with the advancement of technology. Mobile phone applications made specifically for those with vision loss can increase quality of life and provide a new facet of low vision rehabilitation care in optometry. It is important for all optometrists be aware of these innovations to provide the best care possible for patients.

REFERENCES

1. Blackwell DL, Lucas JW, Clarke TC. Summary health statistics for U.S. adults: National Health Interview Survey, 2012. National Center for Health Statistics. Vital Health Stat 10(260).
2. Blindness Statistics. (2014, August 6). Retrieved February 4, 2015, from <https://nfb.org/blindness-statistics>
3. Hakobyan, L., Lumsden, J., O'Sullivan, D., & Bartlett, H. Mobile assistive technologies for the visually impaired. Survey of Ophthalmology, 513-528.
4. Meyer, C., Stanzel, B., Moqaddem, S., & Brohlburg, D. Healthcare "Apps" for Smartphones : Relief or toy for patients and the visual impaired?. Ophthalmologie, 109, 21-29.
5. App. (2012, September 22). Retrieved February 4, 2015, from <http://techterms.com/definition/app>
6. iPhone Accessibility Voice Over. Available at: <http://www.apple.com/accessibility/ios/voiceover/>
7. Android Accessibility TalkBack. Available at: <https://play.google.com/store/apps/details?id=com.google.android.marvin.talkback>
8. Ray App for Visually Impaired. Available at: <https://play.google.com/store/apps/details?id=com.ray.manager>
9. Legge, G., Beckmann, P., Tjan, B., Havey, G., Kramer, K., Rolkosky, D., ... Bex, P. (2013). Indoor Navigation by People with Visual Impairment Using a Digital Sign System. PLOS ONE, 8(10), 1-15.
10. Android Maps. Available at: <https://play.google.com/store/apps/details?id=com.google.android.apps.maps>
11. iPhone Maps. Available at: <http://www.apple.com/ios/maps/>
12. <https://play.google.com/store/apps/details?id=com.smithson.notnav>
13. !NotNav Accessibility. Available at: <https://play.google.com/store/apps/details?id=mmapps.mobile.magnifier>
14. Magnifying Glass with Light. Available at: <https://itunes.apple.com/us/app/magnifying-glass-light-digital/id406048120?mt=8>
15. Haji, S., Sambhav, K., Grover, S., & Chalam, K. (2014). Evaluation of the iPad as a low vision aid for improving reading ability. Clinical Ophthalmology, (9), 17-21.
16. Text Detective. Available at: <https://play.google.com/store/apps/details?id=com.blindsight.textdetective>
17. SayText. Available at: <https://itunes.apple.com/us/app/saytext/id376337999?mt=8>
18. iBlink Radio. Available at: <https://play.google.com/store/apps/details?id=com.serotek.iblink>
19. Be My Eyes. Available at: <https://itunes.apple.com/us/app/be-my-eyes-helping-blind-see/id905177575?mt=8>