

EMPOWERING INCLUSIVE COMMUNICATION: USING AI ASSISTIVE TECHNOLOGIES TO HELP VISUALLY IMPAIRED COMMUNICATE BETTER

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Abstract

While life itself is tough, people with disability have it tougher. Over time different euphemisms have been invented to brighten people with disabilities mood. *Crippled* was dropped in favour of *disabled* which at some point sounded too negative and was dropped in favour of *handicapped*, which in some arenas is giving way to *physically challenged*, which currently, is largely dropped in favour of *differently abled*. However, no matter how beautiful the intentions behind these euphemisms are, they cannot lessen or clean up the reality of their disabilities. In Nigeria, people with disabilities face significant barriers to effective communication, which have impeded their full participation in social, educational and professional activities. This research therefore concerns itself with providing answer to how AI technology can be assistive to people with visual disability in Nigeria to communicate better. The objectives of the study were to evaluate the exposure of people with visual impairment to AI assistive technologies, their usability and effectiveness. This study adopted a mixed method research using Focus Group Discussion and Quasi-Experiment. The study found out that the respondents have low exposure to AI assistive technologies that can help them communicate better. The study also found out through the quasi-experiment that the usability of AI assistive technologies is high. Lastly, the study found out that AI assistive technologies are effective in helping people with visual disability communicate better. The study recommended that the government and stake holders should invest resources and time into exposing and training individuals with visual disability how to communicate better with the use of AI assistive technologies.

Introduction

Life is tough, as such, people with disability have it tougher. Over time, different euphemisms have been invented to brighten people with disabilities mood. *Crippled* was dropped in favour of *disabled* which at some point sounded too negative and was dropped for *handicapped*, which in some arenas is giving way to *physically challenged*, which currently, is largely dropped in favour differently abled (Harris, 2018).

However, no matter how beautiful the intentions behind these euphemisms are, they cannot lessen or clean up the reality of their disabilities, while there are many forms of disabilities, this study focuses on visual impairment. Even though no part of the body is useless, the eyes is the window of the body and

thus a very sensitive part through which optical vision is attained. Vision is a sense used by an individual to collect information about the environment around them (Madake et al., 2023). People with visual impairment experience vision problems from birth or because of an accident or injury. Visual impairment is a disability resulting in partial or complete loss of vision. It results in the quality of life. It results to hindrance in performing daily chores, thereby decreasing the quality of life. According to World Health Organization (Who, 2022), at least 2.2 billion people encounter vision Problems while 1 billion of them have vision impairments that can still be addressed. In addition, the WHO estimates that 36% of people long-distance vision problems are the result of refractive errors or vision problems caused the lack of proper

concentration of light on the retina due to the shape of the eye. WHO also stated that 17% of people with vision problems because of cataracts (Manirajee, 2024).

In other to help people with visual impairment, many assistant devices have been introduced. Assistive technology for the visually tend and Blind people is concerned with "technologies, equipment, devices, apparatus, services, systems, processes and environmental modifications" that enable them to overcome various physical, social, infrastructural and accessibility barriers to independence and live active, productive and independent lives as equal members of the society. Vision is an extremely vital sensory modality in humans, the loss of it affects the performance of almost all activities of daily living and instrumental activities of daily living; thereby hampering an individual's quality of life, general lifestyle, personal relationships and career. Therefore, technology that facilitates accessibility, safety, and improved quality of life has a very relevant social impact (Kajimoto, Suzuki, Kanno, 2014).

However, the advent of AI technology proves to be a game changer with the introduction of many AI tools that can help an individual with visual impairment communicate better. The loss of vision is a terrible thing and even if AI cannot replace the eyes for the visually impaired, it can be helpful for communication. Substituting the need for human help for AI help. According to Shanker and Kant (2022) people with disabilities can Use assistive technology to live healthy, productive, independent and dignified lives while also participating in school, the labor market, and civic life.

Recently google released Lookout to help the blind communicate with their environment, Apple has the Siri, Amazon released Alexa, Google's Google Assistant and Microsoft Cortana are different AI empowered technologies which help people achieve different communication and information goals. Brill (2018) holds it that Siri, Alexa, and other digital assistants are rapidly becoming embraced by consumers and are projected to grow from 390 million to 1.8 billion for the period of 2015 to 2021. Brill et al, (2019) further assert that Individuals can use digital assistants to perform basic personal task

management functions as well as for more advanced capabilities and connected device integrations. Yet, the functional and topical use of a digital assistant tends to vary by individual. As such this study focuses on AI assistive technology and improving communication for the visually impaired.

Statement of the Problem

Just like every technology, the advent of AI technology holds many promises and probable peril for the society. Early 2024, media reported that Elon musk Neuralink company has successfully implanted a chip in the brain of disables and it is proving effective in changing their disability condition (Hern, 2024). But this is still in its testing phase and not open to everyone as well as its side effect. However, for the study, the focus is on AI tools such as Alexa, Siri etc. and not implant. There remains a gap in knowledge as to how the newly invented AI technologies can help the visually impaired communicate better. Especially in a developing nation like Nigeria inundated with technological knowledge gap. Studies already abound on the use of assistive technology (AT) with students with visual impairments (VI) and blindness, and have equally shown that there is a potential to improve many student outcomes related to academics and learning (e.g., Bouck et al. 2011; Bowers et al. 2001; Ferrell 2006; Lovie-Kitchin et al. 2001; Spindler 2006; Theoret et al. 2004). Yet, the new AI inventions hold powerful position to help the visually impaired, but there remains an obscurity as it concerns its adoptability among people with visual impairment in Nigeria. Hence, this study is necessary to fill a research gap.

Objective of the Study

1. To examine the extent to which people with Visual impairment are exposed to AI assistive technologies to communicate better.
2. To examine the usability and effectiveness of AI assistive technology for communication among people with visual impairment.

Literature Review

Overview of Artificial Intelligence

Artificial Intelligence (AI) has rapidly evolved from a theoretical concept to a transformative technology that is reshaping various aspects of our lives. The advancements in AI have been driven by the convergence of several factors,

including the availability of vast amounts of data, increased computational power, and the development of sophisticated algorithms and models. One of the most significant developments in AI is the rise of machine learning (ML), a subset of AI that enables systems to learn and improve from data without being explicitly programmed (Nilsson, 2022). Machine learning has enabled AI systems to recognize patterns, make predictions, and make decisions with remarkable accuracy in domains such as computer vision, natural language processing, and predictive analytics (Goodfellow et al., 2021).

Deep learning, a subfield of machine learning inspired by the structure and function of the human brain, has been instrumental in achieving breakthroughs in AI (LeCun et al., 2015). Deep neural networks, with their ability to learn hierarchical representations of data, have revolutionized tasks like image and speech recognition, language translation, and game-playing (Schmidhuber, 2022). AI has also made significant strides in the field of natural language processing (NLP), enabling machines to understand, interpret, and generate human language (Bahdanau et al., 2015). This has led to the development of intelligent virtual assistants, chatbots, and language translation systems that can engage in natural conversations and provide personalized assistance (Qian et al., 2021).

Another area where AI has made significant progress is in robotics and automation. AI-powered robots are increasingly being used in manufacturing, logistics, healthcare, and various other industries, enhancing efficiency, precision, and safety (Sadrifaridpour & Wang, 2021). Additionally, autonomous systems, such as self-driving cars and drones, are leveraging AI to navigate complex environments and make real-time decisions (Grigorescu et al., 2020). Despite the remarkable achievements, AI also faces significant challenges and limitations. One of the major challenges is the issue of bias and fairness in AI systems, which can perpetuate and amplify societal biases present in the training data (Mehrabi et al., 2021). Additionally, the lack of transparency and interpretability in some AI models, particularly in deep learning systems, raises concerns about accountability and trust (Gunning et al., 2019).

Another critical aspect of AI development is the ethical and societal implications of these technologies. As AI systems become more advanced and integrated into various domains, issues such as privacy, security, and the impact on employment and workforce displacement need to be carefully addressed (Floridi & COWls, 2021). To address these challenges, researchers and policymakers are actively working on developing ethical frameworks, guidelines, and governance models for AI (Jobin et al., 2019). Efforts are also being made to enhance the transparency, interpretability, and robustness of AI systems through techniques like explainable AI (XAI) and adversarial machine learning (Nguyen et al., 2022).

Role of AI in Improving Disabilities

Artificial Intelligence (AI) has emerged as a powerful tool in addressing various challenges faced by individuals with disabilities, offering innovative solutions and enhancing their quality of life. The integration of AI technologies has revolutionized the way disabilities are understood, assessed, and supported, fostering greater independence and inclusivity. One of the key areas where AI has made a significant impact is in assistive technologies. AI-powered devices and applications have opened up new avenues for individuals with disabilities to overcome physical, cognitive, and sensory limitations. For example, AI-driven speech recognition and natural language processing (NLP) technologies have enabled individuals with speech impairments to communicate more effectively (Ballati et al., 2020). Similarly, AI-powered computer vision and object recognition systems have assisted individuals with visual impairments in navigating their surroundings and accessing information (Ahmetovic et al., 2021).

AI has also shown promising results in the field of prosthetics and rehabilitation. Machine learning algorithms have been employed to develop advanced prosthetic limbs that can adapt to the user's movements and provide more natural and intuitive control (Huang et al., 2021). Additionally, AI-powered virtual reality (VR) and augmented reality (AR) applications have been used for rehabilitation purposes, offering immersive and engaging environments for physical and cognitive therapy (Perez-

Marcos et al., 2021). Moreover, AI has proven invaluable in the early detection and diagnosis of various disabilities. Machine learning models have been trained to analyze medical data, such as brain scans, genetic information, and electronic health records, to identify patterns and biomarkers associated with specific disabilities (Jiang et al., 2021). This early detection can facilitate timely intervention and support, improving overall outcomes for individuals with disabilities.

AI has also contributed to the development of personalized learning experiences for individuals with disabilities. Adaptive learning systems powered by AI can tailor educational content and teaching methodologies to individual needs, enabling more effective and inclusive learning environments (Drigas & Argyri, 2020). Additionally, AI-driven virtual tutors and conversational agents have been explored as support tools for individuals with learning disabilities, providing personalized assistance and feedback (Hafizan et al., 2020).

Theoretical Framework

Uses and Gratification Theory

This theory was adopted for this study. The theory was developed by Katz, Blumler and Gurevitch to explain what the audience does with the media instead of what the media do to the audience (Egede & Nwosu, 2013). The theory focuses mainly on the audience's functional use of the media. It posits that members of the audience seek out the mass media for the purpose of satisfying individual needs.

According to Blumler and Katz (1974), media consumers exercise the liberty to choose how they use media contents and how those contents affect them. The audience is seen as having the ability to selectively choose, attend to, perceive and retain media messages based on his/her needs or requirements (Folarin, 2005). The uses and gratification theory shift our attention from how media messages are produced and transmitted to how they are consumed and for what purpose. While illustrating how the theory works, basking, Aronoff and Lattimore (1997) explain that everyone is not regularly exposed to newspapers, television, radio or even Facebook at the same time and rate. Rather, people choose when and for how long they are exposed to them. The authors identify that some

of the ways people use the media include for entertainment, scanning the environment for items that are personally important, diversion, substitution of personal relationship and a check on personal identity.

Considering the focus of this theory on audience's use of the media being determined by their perceived gratification, this theory is very valuable to our current study. Adoption of AI assistive technology will be based on respondents' usage and gratification from their exposure to the AI technology. Dissonance may creep up if there is no gratification from usage, and acceptance might be inevitable in the situation of gratification that comes from usage.

Methodology

This study adopts a mixed method research technique of Focus Group Discussion and Quasi-experimental study. This method is adopted for the study as it best proffer solution to the objectives of the study. The FGD is directed towards the first objective while the quasi-experimental study was adopted to proffer Solution to the second objective.

The population for the study is 12, which is considered the highest population size for a FGD discussion (Amana, 2023). With their consent, the' FGD population was further experimented upon to form population size for the quasi-experimentation. Due to the relatively low population size, the entirety of the population became the sample.

Sampling Technique

The study adopted a purposive sampling technique to select 12 blind students from post-graduate student hostel in the University of Nigeria, Nsukka campus. This type of sampling permits the researcher to select respondents based on the researcher's judgement which is based on certain predetermined characteristics available in the sample. The researcher purposively selected 12 blind respondents as they serve the purpose of the research best since the study is aimed at the visually impaired.

For the quasi experiment, the study adopted a within-group randomized experiments also known as within-subject designs or repeated-measures design (Campbell & Stanley, 1963). The within-group randomized experiment allows the researcher to focus on one group

where different participants are assigned at random to different treatment conditions (Fisher, 1926). Within- group randomized experimentation allows the researcher to focus on individual participants and juxtapose their overall performance to other subject members of the group (Kirk, 2013). The participants were assigned to the different treatment (test) conditions. In the study, only one group consisting of 12 participants was experimented upon and individuals were assigned to the different treatment (test) conditions.

Research Instruments

The research instrument used for this study are four. They include FGD guide, Performance Task, Communication Logs and Psychometric Test of Communication Skill Scale for the blind (CSS-B) The FGD guide aim to gather the thoughts of the respondents as it relates to their exposure to AI assistive technology tool. The Communication log helps the students to express their perception about the AI, while Performance task was used to gauge the usability of the AI by the respondents and psychometric Tests was used to evaluate the communication skills of the respondents. It was used to provide quantitative data for the study.

Experiment Procedure

This study was conducted by exposing the visually impaired respondents to AI assistive communication tools which are: Google's Lookout and Google Assistant. These tools were used as instructional lesson tools and was also used as the treatment for the study. The researchers contracted two AI experts in media psychology who worked hand-in hand with the researcher to assess the usability as well as the effectiveness of the respondents to the AI assistive technology tools. The experimentation process was divided into three parts. Part one exposed respondents to the AI tools and its benefits and its applicability studying their demeanour and interest level. Part two teaches the respondents how to use the AI assisted technologies to communicate better. The third part evaluates the usability and effectiveness by the respondents. The performance log carries 12 major tests which are: 1. Chatting on social media 2. Reading news 3. Navigating their route 4. Journaling 5. Calling contacts and responding to calls 6. Navigating the weather condition 7. Recognising currencies 8. Playing music 9. Responding to text messages 10.

Reading books 11. Recognising objects and sign posts 12. Recognising digital image contents. The experimentation period took 30 days. The researcher and the experts attend to respondents individually. However, comparing their individual performance to the overall group performance. The study was analysed using simple bar charts and, mean table. For the FGD, it was analysed qualitatively using a discuss analysis method.

Result

The findings from the FGD for the study revealed that the respondents are not exposed to AI assistive technologies that can help them communicate better, only one respondent heard about it, but clueless about its workings. Even though it was evident that they face serious communication problem as 9 out of the 12 participants need the help of someone to communicate better especially as it relates to reading and sending messages online as well as decoding visual elements The remaining 3 respondents rely on Screen readers and Braille displays which have limitations. One of the participants gave his opinion thus:

I have not heard about assistive AI technology, even though I know of assistive technologies such as Braille and screen readers, But AI assistive technology is fresh to my ears (P1, FGD). Yes, I have heard about it, but not sure how it will help me (P7, FGD).

Table 1: Usability Test

The research objective two was achieved through the quasi-experiment. The objective aimed to (table 1) ascertain the usability of AI assistive technology by the visually impaired to communicate better. Findings from the table indicates that respondents were exposed to 12 performance tests.

Among the 12 respondents, 2 of the responding to calls 6. Navigating the weather condition 7. Recognising currencies 8. Playing music 9. Responding to text messages 10. Reading books 11.

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AI assistive technology can help me replace My vision

5 7 - - - 12 4.42
Mid Effectiveness

I agree that AI assistive technology is a game changer for my visual impairment

12 - - - - 12 5.0
Largely Effective

Grand Mean = 4.86 Largely Effective

Psychometric Test, 2024

Table 2 above represents the effectiveness of AI assistive technology, done on a 5 point CSS-B psychometric test, the table has a mean score of 4.86 in a 5.0 total mean available, which implies that AI assistive technologies are very effective in assisting the respondents to communicate better (Table 2). All the respondents agreed to 3 items on the table. out of the 4 while 7 admit averagely to the third item which states that AI assistive technology cannot replace their lost vision. However, as presented on the table and from the performance log observed by the researcher and the experts, it is evident that the AI assistive technology tools helped the respondents communicate better and effective.

Discussion of Findings

The findings of this study are discussed in line with the objectives and data gathered on the table above. Objective one aim to ascertain the extent to which people with visual impairment are exposed to AI assistive technologies to communicate better. This objective was achieved through a Focus Group Discussion which found out that the respondents are not exposed to AI assistive technologies that can help them communicate better. The foregoing infers that their exposure level to AI assistive technology is to no extent and therefore can be considered as low. This finding corroborates with Garcia-Macias et al (2019) who avers that there are several existing products and features to help the visually impaired such as Braille display, screen readers, gesture recognition, image recognition, ultra-haptics technology, launchers on smartphones, and PC operating systems having speech recognition for

navigation, but AI assistive technologies is relatively new. The implication of the foregoing is that due to the relatively new nature of AI and the visual impairment condition of the respondents, they seem not to be aware of the possibility of AI especially as orchestrated by their optical health. A kind of limitation. The foregoing also connects with Muradyan (2022) who opines that technologies can be used together, which greatly speeds up the interaction with the computer but, a visually impaired student cannot use a computer without proper knowledge.

The second objective aims to ascertain the usage as well as the effectiveness of AI assistive technology in improving communication for the visually impaired. The finding indicates that the usability of the AI assisted technology is high among the respondents, therefore, AI assistive technology is usable to improve communication for the visually impaired as indicated by the data presented on table 1. All the respondents scored 75% of the test undertaken which is a good score. Also, from table 2, the study ascertained the effectiveness of AI assistive technology, done on a 5-point CSS-B psychometric test, the table had a mean score of 4.86 in a 5.0 total mean available, which implies that AI assistive technology was very effective in assisting the respondents to communicate better. The foregoing connects to Shanker and Kant (2022) who aver that people with disabilities can use assistive technology to live healthy, productive, independent and dignified lives while also participating in school, the labour market, and civic life. Also, the study corroborates with Uses and Gratification theory which the study was anchored upon. AI assistive technology tools were efficient in helping the visually impaired communicate better due to the gratification derived from usage. Also, according to Brill et al, (2019) individuals can use digital assistants to perform basic personal task management functions as well as for more advanced capabilities and connected device integrations. From the foregoing, inference is drawn that AI assistive technology is effective in helping visually impaired communicate better.

Conclusion and Recommendation

The advent of AI technology proved to be a game changer with the introduction of many AI

tools that can help an individual with visual impairment communicate better. The loss of vision is a terrible thing and even if AI cannot replace the eyes for the visually impaired, it can be helpful for improving their communication. Substituting the need for human help for AI help. As such, this study therefore concludes that AI assistive technology tools is usable and effective in improving communication for the visually impaired. From the findings, this study therefore recommends that:

1. Government and stake holders should invest resources and time into exposing and training individuals with visual disability on how to communicate better with the use of AI assistive technology tools.
2. Further studies should be conducted by experimenting on blind children

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