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ARTIGO

THE FOCUS OF VISUAL ATTENTION IN PEOPLE WITH MOTOR DISABILITIES THROUGH EYE TRACKING: AN EXPERIENCE IN PUBLIC BUILT ENVIRONMENT

O foco da atenção visual em pessoas com deficiência motora através do Eye tracking: uma experiência em ambiente construído público

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ABSTRACT: Getting a built environment accessible to everyone, including people with motor disabilities, that offers comfort and enables safe displacement is an important professional requirement for architects and designers. They are seeking to apply new technologies aiming to implement the principles of Universal Design and identify the Eye Tracking as a tool that allows you to know the perception of the user and assist the professionals in the decision-making processes. Being the Eye tracking an assisted technology that allows identifying objectively the visual perception, an experience was conducted to analyze the difficulties in the internal visual identification of the buildings. The article goal is to identify the focus of visual attention in people with motor disabilities using eye tracking glasses. To perform the experiment was used SensoMotoric Instruments (SMI) eye tracking glasses and was analyze the data with the BeGaze software version 3.6, with a wheelchair man, and a prosthetic user in the leg and a reduced mobility man (prosthesis user). The results indicate the lack of visual information causes difficulties for people to locate and identify the correct route for the offset inside a building, and the use of this assistive technology reducing the subjectivity in making decisions to make accessible environments. The tests show that the participants do not have fixed their gaze on specific points, because it remained looking for visual information into the building generating lack of orientation and difficulties to define the right route at offset. With this experiment was possible to validate an application of the device to contribute to the decision-making process of professionals to make accessible environments. In addition, they recognized the particularities in the use of Assistive Technology, the glasses eye tracker, and the possibility of being used in the analysis of various tasks contributing in the Design, in the Architecture, and the Engineering.

KEYWORDS: Eye Tracking; People with motor disability; Assistive technology; Proknow-C.

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RESUMO: Obter um ambiente construído acessível a todos, inclusive pessoas com mobilidade reduzida, que ofereça conforto e permita realizar os deslocamentos com segurança é uma importante exigência profissional para arquitetos e designers. Na procura de aplicar de novas tecnologias que visem implementar os princípios do Desenho Universal, identificou-se o Eye Tracking como uma ferramenta que permite entender melhor a percepção do(s) usuário(s) e auxiliar os profissionais nos processos de tomada de decisão. Sendo o Eye Tracking uma tecnologia assistiva que permite identificar objetivamente a percepção visual, realizou-se uma experiência que permite analisar as dificuldades na identificação visual interna das edificações. O objetivo deste artigo é identificar o foco de atenção visual em pessoas com deficiência motora usando o eye tracking. Para realizar a experiência utilizaram-se óculos do eye tracking da Senso Motoric Instruments (SMI) e analisam-se os dados com o software BeGaze versão 3.6, com um cadeirante e um usuário de prótese na perna. Os resultados indicam que a ausência de informação visual dificulta que as pessoas localizem e identifiquem a rota correta para o deslocamento dentro de um edifício, e o uso de tecnologias assistivas diminuem a subjetividade na tomada de decisões para tonar os ambientes acessíveis. As análises mostram que os participantes não fixaram o olhar em pontos específicos, pois permaneciam procurando a informação visual no prédio, condição que gerou falta de orientação e dificuldades para definir a rota certa no deslocamento. Em esta atividade foi possível validar uma aplicação do equipamento para contribuir na tomada de decisão dos professionais para tonar os ambientes acessíveis. Além disso, reconheceram-se as particularidades no uso da Tecnologia Assistiva, os óculos eye tracker, e a possibilidade de serem usados na análise de diversas tarefas contribuindo no Design, no projeto de Arquitetura e na Engenharia.

PALAVRAS-CHAVE: Eye Tracking; Pessoas com mobilidade reduzida; Tecnologia assistiva; Proknow-C.

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INTRODUCTION

Eye tracking systems collect eye movements during different kind of activities, like human activity recognition, perception of advertising, emotion monitoring, sports cognition, Human-Computer Interaction, people reading, using a web or driving assistance system, detection systems for drivers' fatigue, and others (ANDRIENKO et al., 2012; CHANDRA et al., 2015). It has also been used in the process of verifying the training effectiveness (CARROLL; KOKINI; MOSS, 2013; HASANZADEH; ESMAEILI; DODD, 2017). Similarly, Eye tracking was used to measure user satisfaction in usability tests (GOBBI et al., 2017) and measure user usability of LEV device (SCHMIDT et al., 2016).

The basic use of an eye tracking system is to record the constant motion of user eyes, and to analyze this information. For example, while people looking at a screen (CHANDRA et al., 2015) or when they are in a real environment (EID; GIAKOUMIDIS; EL SADDIK, 2016) before they has stop and focus on a particular area. Other domains include car navigation (SODHI et al., 2002) and indoor wayfinding (SCHUCHARD; CONNELL; GRIFFITHS, 2006).

This technology is based on tracking principles of the human eye movements while perceiving the visual scene. According Dedkova and Popelka (2015) this is the assistive devices of usability and user experience studies, and is considered as objective (non-biased) because the participant's opinion not influenced the results (as happen with other methods, such as questionnaires or interviews).

To identify and to analyze the human visual attention characteristics, the eye tracking system is used for measuring eye positions and eye movement according to the visual stimulus (CHEN; CHEN, 2017). The eye movement analysis is popularized as a tool for evaluating visual displays and interfaces. This process is employ by researchers to understand how their designs are used and to know the perceptive and problem solving (ANDRIENKO et al., 2012). Also is employed for improving the training feedback (CARROLL; KOKINI; MOSS, 2013; HASANZADEH; ESMAEILI; DODD, 2017). Eye tracking produces lots of information to be analyzed, which becomes a great challenge to be faced by researchers.

This technology measured the physiological responses to visual stimuli, and activity is recorded in real time (ANDRIENKO et al., 2012; CHANDRA et al., 2015; DEDKOVA; POPELKA, 2015). The study of eye movements can reveal valuable insights about how people understand the environment, especially when performing visuospatial tasks. Therefore, the recording device produces gaze trajectories, i.e., sequences of gaze location on the screen (DEMŠAR; ÇÖLTEKIN, 2017), which are essential for understanding the participant's environmental perception.

Thinking about the options that this technology has the authors of this article has identified that this equipment can provide relevant information to assess the needs of internal visual identification in people with reduced mobility when they are walking inside a building. To identify the perception of this group of people was designed an experiment to observe the needs that this identification raises. People with reduced mobility (PRMs) are a fraction of disability people.

Disability is the term for impairments, activity limitations and participation restrictions, relative to the difficulties of the interaction between an individual, the environment experienced and the personal factors (WHO, 2017). Almost a billion and a half people in the world have temporarily or permanently disability at some point in life - about 15% of the world's population, according to the World Report on Disability produced by World Health Organization (WHO) and the World Bank (WHO, 2011). PRMs can still use wheelchairs, crutches, or protests, either temporarily or permanently. Although part of the difficulties experienced by these people is related to their conditions of physical mobility, a great part of their problems originate in the characteristics of the built environment (COHEN;

DUARTE, 2013; COSTA; ARAUJO, 2013; ELALI; ARAUJO; PINHEIRO, 2010; GUIMARÃES, 2009) and the possibilities of orienting themselves in it (or way finding conditions - CARPMAN; GRANT, 2002; GIBSON, 2009; PASSINI, 1996). Halls narrow, stairs without points to hold, absence of offices' nameplates, vertical accesses (devices such as elevators, stairs, ramps) inappropriately positioned or dimensioned, and other factors, directly influence the way people walk and establish a relationship with the environment. To face that, special attention is required by the communicability of architecture; for this, the visual information is an important contribution to the identification of places and indication of routes inside of building.

Through eye tracking, it is possible to obtain temporal sequences of gaze locations, delimiting the gaze trajectories; raw gaze trajectory data are aggregated into scan paths, i.e., sequences of fixations and saccades (DEMŠAR; ÇÖLTEKIN, 2017). Fixations are the locations where the eyes are 'fixed' during a brief period of time (DEMŠAR; ÇÖLTEKIN, 2017). Involves focusing the eyes at one particular point, the fixations are instants (few seconds or even minutes) when the eyes appear to be relatively stationary for "encoding" the information (DEDKOVA; POPELKA, 2015). The authors indicate that during a fixation, eyes are relatively steady looking at one spot in the visual scene. Based on this understanding, some other metrics derived from the fixation as fixation duration, fixations per area of interest, number of fixation overall, spatial fixation density, repeated fixations, time to the first fixation, percentage of participants fixating an area of interest.

On the other hand, Saccades are the quick movements of the eyes between fixations. Saccadic movements rotate the eyes to fixate on the target. These type of movements are fast, jump-like, and interspersed with periods of relative stationary when the eye rests on the target-the so-called fix (DEMŠAR; ÇÖLTEKIN, 2017). After each saccade, the eyes move to the next viewing position (DEDKOVA; POPELKA, 2015). According to the authors, the Gaze is usually the sum of all fixation durations within a prescribed area. It is best used to compare attention distributed among targets. Raw gaze trajectory data are aggregated into scan paths, i.e., sequences of fixations and saccades.

After the eye tracking is analyzed, the Heat maps can be presented. They are representing some places on which user vision was mostly centered, and the Fixation maps too. They are demonstrating the route of the users gaze, and also the points at which he looked for the longest time, along with information how much time it lasted (CHYNAL; SOBECKI, 2016). Those analyses maps are presented in the results section.

A combined recording, visualization, and analysis of position and gaze seem to be a valuable and novel approach throws many research questions, but a discussion on the integration of people with motor disability into real buildings is currently lacking in the scientific literature.

The aim of current research is to identify the focus of visual attention in people with motor disabilities using eye tracking glasses. This article is structured as follows: Section 2 presents the methodology for selecting papers to fundament of eye tracking system works and the characteristics experiment. Section 3 describes the eye tracking applications. Section 4 presents the current experiment results. Finally, we have the conclusions in section 5.

METHODOLOGY

The search framework is considered Exploratory-Descriptive because seeks to deepen the aspects related to the eye tracking applications as support for people with motor disabilities perception. In relation to the collection of research data made use of primary data, the information was collected from participants using the device; and use of secondary data where it is used ProKnow-C as a tool to select the bibliographic portfolio (DUTRA et al., 2015; ENSSLIN et al., 2017, 2014; VALMORBIDA et al., 2016). This research presents a case study to identify the visual perception of two participants, and it makes qualitative description of the results.

PROKNOW-C

The Knowledge Development Process-Constructivist (ProKnow-C) tool is based on the constructivist approach. It comprises a sequence of stages that help researchers' knowledge for building and its posterior organization and use. The selection is made according to researcher´s delimitations and emphasis interests. In this process, they delimite the selection criteria of databases, keywords, time filters; and notably, parameters of inclusion/exclusion from papers in the Bibliographic Portfolio (BP) (DE OLIVEIRA LACERDA; ENSSLIN; ENSSLIN, 2014; DUTRA et al., 2015; ENSSLIN et al., 2017).

This structured process was introduced by Tasca et al. (2010) and developed by Laboratory of Constructivist Decision Aid Methodologies (LabMCDA-C) (DE OLIVEIRA LACERDA; ENSSLIN; ENSSLIN, 2014; DUTRA et al., 2015; ENSSLIN et al., 2017), with the goal of allowing the analysis of scientific production on a part of the literature.

For the bibliographic portfolio selection was defined the research command, selecting five databases, and searching in them. As proposed for the ProKnow-C (DE OLIVEIRA LACERDA; ENSSLIN; ENSSLIN, 2014; DUTRA et al., 2015; ENSSLIN et al., 2017; VALMORBIDA et al., 2016). The search in databases was made with two research commands: firstly ("Eye Tracking") AND ("Senso Motoric Instruments" OR "applications"). And secondly ("Eye Tracking") AND ("People with motor disability" OR "motor impairments"). The results of papers found in each database are present in table 1.

Table 1: Databases research results
Source: Developed by authors

Database	Research 1	Research 2
ProQuest	1552	2246
Scopus	488	166
Web of Science	337	101
Compendex	99	17
Science Direct	90	817
Total	**2566**	**3347**

The authors established delimitations to this study: making the research in the Journal Portal of Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - CAPES (Coordination for the Improvement of Higher Education Personnel) by Federal University of Santa Catarina (UFSC); select only papers assessed by experts, writing in English, printed from 2000 to 2017, and research on title, abstract, and keywords.

To select the bibliographic portfolio composition was applied the ProKnow-C parameters by authors delimitations, figure 1, obtaining as a result 21 papers to support the information presented in current research.

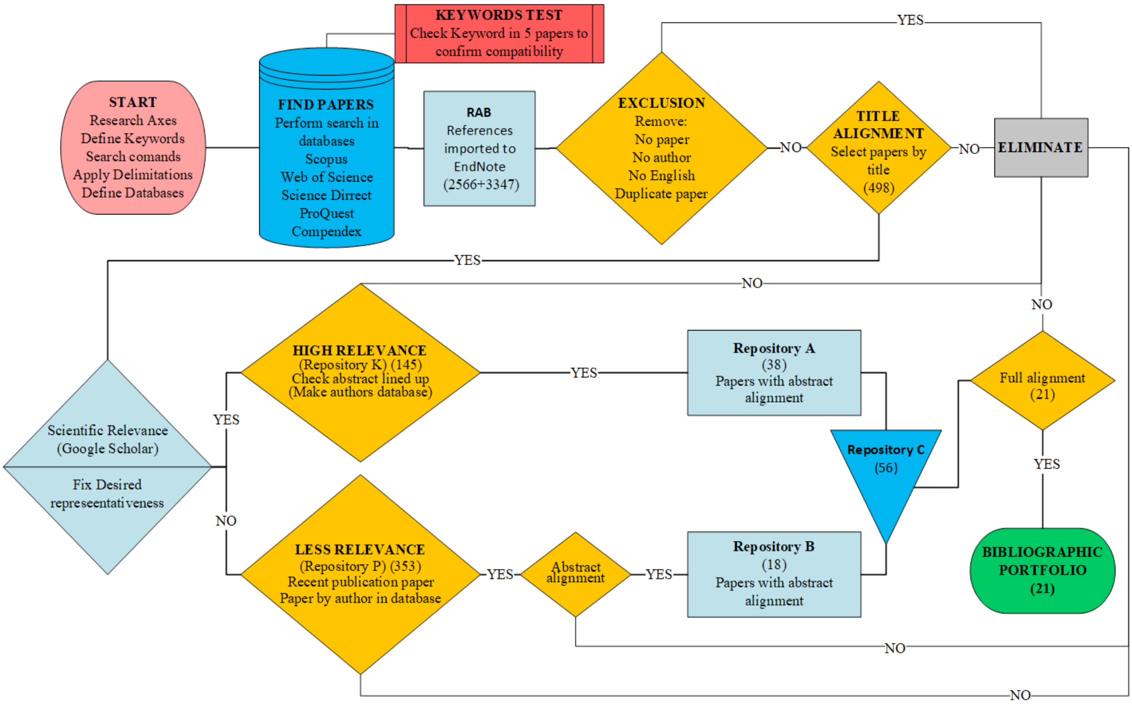

Figura 1: Bibliographic portfolio composition

Source: Developed by authors

Methodology of Information Collected

As For the current experiment were invited two people with different real motor disability: a wheelchair man, and a reduced mobility man by amputation of the left lower limb (prosthesis user). The activities were carried out taking in academic context, and into account the principles of research ethics by resolution 510/2016 of delimited National Council of Health of Brazil; all participants were voluntaries, they signed an informed consent (TCLE), and did not receive monetary compensation.

These experiments were performed with eye tracking glasses of the SensoMotoric Instruments (SMI) on smartphone to collect the video, and software BeGaze SMI version 3.6 to prepare the analyses.

The experiment was carried out in a real administrative building of the Federal University of Paraíba (UFPB) during normal business hours. The activity focus to these participants was going to the Committee for Inclusion and Accessibility (CIA) office located into this building. The participants did not know the localization of the office and the route. And it was the first time that these participants walk into this building. In the main door, it was informed to the participants the name of the office to find, without any further instructions. But, they can ask the office location to any worker or visitor into the building or use signs or posters existents in the building that could guide them. The scenarios used in this study are hall-reception, offices into the building, corridors, and doors.

The video captured was performed using the technic of collection tour accompanied, which consist in participants walking to its route in the building describing what he/she is thinking and feeling, and the researcher collected the reactions without interventions. Each test made the following protocol:

(1) Wear the eye tracker glasses on the participant
(2) Calibrated the eye tracker with three reference points
(3) Participant was informed of the office name that should look for
(4) Perform the offset to the location indicated by using eye tracker glasses on smartphone
(5) Capture video in real time by eye tracker device
(6) Take pictures are made of each area of the route

The experiment place (Technical Description)

The building chosen to carry out this experiment was the Hall of one mains UFPB´s edification in João Pessoa, Brazil: a large lobby with approximately 540m2 of area, figure 2, where occurs numerous activities such as scientific and cultural exhibitions, demonstrations, social events to support the contiguous auditorium (such as coffee breaks and cocktails). It was inaugurated in 1979 and its access can be made primarily by a large ramp, or lift and secondary stairs, figure 3. About 2,500 people per day spend both visitors and people working in the building, who come in search of information or to attend an event. The challenge was looking for the Committee for Inclusion and Accessibility office, which is located inside the building in a place with difficult to access.

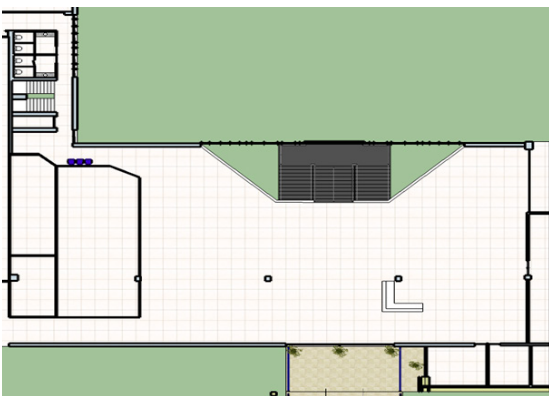

Figura 2 e 3: Esquematic sketch of Hall´s UFPB e UFPB map

Source: Developed by authors from architectural survey and from google view image

EYE TRACKING APPLICATIONS

Eye tracking data consist of records from the positions and time of gaze fixations. Each record includes: user identification, time, position in the display space, and fixation duration. The records may also include others attributes such as stimulus, identifier when are used different visual stimuli. In literature, the order of the temporal sequence of a user looking at a stimulus in the tour is called path of eye or scan path (ANDRIENKO et al., 2012). With minimal intrusion, the eye tracking technology documents eye movements while people viewing information. These eye movements can be used to represent the information processing, and are usually an indication of the spatial focus of attention of the viewer in a particular situation.

Several studies address image-based pupil detection under laboratory conditions. For example, Allison et al. (2010) studied the sensibility of observers to pictures of ecologically relevant image translations of large or complex real-world scenes. Some researchers were centered in identify some of the major trends and findings in skill researchers and their connections to human characteristics (CHARNESS; TUFFIASH, 2008). Various authors perceive a need for integration of the observational tools employed by expert performance researchers (as verbal reports or protocol analysis) into the human factor laboratory. A similar approach was introduced by Colombo, Comanducci, and Bimbo (2007) in their experiment with an iris-tracking single-camera, remapping approach based on passive computer vision is presented. The approach aims to obtain measurements of the iris/pupil position for applications in the area of eye-commanded human-machine interaction systems, employed, in this case, to support severely disabled people in their interaction and communication needs.

Studying eye movements can reveal valuable insights into how people think, especially when performing visuospatial tasks. For example, in project of Dedkova and Popelka (2015) the objective was to create 3D visualization of an extinct village. The researchers created an interactive web application that includes a 3D model to record eye-tracking where data were statistically and graphically analyzed. The results indicate that a 3D model was the most usable type of visualization for respondents.

Some researchers propose methods and compare the results with existing dynamic interaction methods from movement ecology. The sensitivity to method parameters is evaluated on simulated trajectories where the researcher can control the levels of interaction. They execute an research with eye and mouse tracking to produce real data with real levels of interaction, and then apply and test a methodology on a real case (DEMŠAR; ÇÖLTEKIN, 2017).

A similar research describes how the methods work in application to eye tracking data and provide guidelines for method selection depending on the analysis tasks. In the investigation, Andrienko et al. (2012) conclude that the current repertoire of tools and methods is limited and does not meet the needs of eye movement researchers in relation to the variety of tasks and the need to deal with large quantity and variation of data. Additionally, Chen and Chen (2017) proposed a method to use fixations recorded by the eye tracker: they partitioned the fixations into clusters, each of which presents a particular area of interest (AOI). Thus, the authors propose a method of visual attention identification based on random walks, which corresponds to a new approach to indicate the position in a more robustly and correctly way.

In another paper, Chandra et al. (2015) proposes a guidance for developing an eye tracking application, and indicates several opportunities and underlying challenges to develop human-machine interface systems. In their turn, Chynal and Sobecki (2016) used the eye tracking system to recognize how elements of user interface attract user attention and which are not noticed by them. They analyzed the User Experience, focusing especially on a person's perceptions and reactions that result from the intended use or in the use of a product, system or service.

Another interesting topic that was recently aboded by eye tracking experiences is how this device can help in training activities. The objective of the research was to explore the training effectiveness of a feedback method. They utilize eye tracking technology to support trainee assessment and expert demonstration by measuring trainee scan data – which includes diagnostic deficiencies and feedback to the trainee. This research focused individual search strategies and anomaly detection performance, and the eye tracking technology measure and demonstrate visual search of training participants (CARROLL; KOKINI; MOSS, 2013). The experiment suggest those who received the eye-tracking-based feedback method were more effective observing the practical application events than those who received the traditional feedback.

A similar approach is also used in an additional publication (HASANZADEH; ESMAEILI; DODD, 2017), which measures the impacts of training, work experience, and injury exposure on construction workers' attention allocation. In this investigation, researchers show the application of eye tracking for the construction safety practices. The authors design a laboratory experiment for the participants identified safety hazards presented in 35 construction images. This study analyzed how workers search strategies and attention patterns while exposed to see hazardous situations. The authors identified practical safety knowledge and judgment on a job site, which requires the interaction of both tacit and explicit knowledge gained through work experience, injury exposure, and interactive safety training. The study results show that eye tracking can be used to improve worker training and preparedness, which will yield safer working conditions, detect at-risk workers, and improve the effectiveness of safety-training programs (HASANZADEH; ESMAEILI; DODD, 2017).

In the bibliographic portfolio selected in this research was possible to identify some papers focusing on people with motor disability, they are presented in table 2.

KIND OF DISABILITY	PARTICIPANTS	USE	PAPER
Amyotrophic lateral sclerosis	61 patients with ALS and 7 patients with primary lateral sclerosis, compared to 39 healthy age-matched controls	Eye-tracking offering an objective means to assess extra motor cerebral involvement in ALS.	(PROUDFOOT et al., 2016)
Amyotrophic lateral sclerosis (ALS)	20 patients	Eye-tracking assistive device can improve quality of life for ALS patients and relieves burden of their primary caregivers.	(HWANG et al., 2014)
Amyotrophic lateral sclerosis (ALS)	21 ALS patients and 21 age- and education-matched healthy subjects	We assessed language, attention, executive, and social cognition abilities in a sample	(POLETTI et al., 2017)
Amyotrophic lateral sclerosis (ALS) patients unable to speak and write.	46 ALS patients and 50 people (healthy control matched for age)	The eye-tracking, based ECAS version, by assessing cognitive deficits in ALS (people unable to speak or write).	(KELLER et al., 2017)
Amyotrophic lateral sclerosis (people with severe motor impairment)	11 affected by ALS, and 1 affected by Duchene muscular dystrophy	Although bcis could be potentially useful for people with severe physical disabilities, we showed that the usability of bcis based on the visual P300 remains inferior to eye tracking.	(PASQUALOTTO et al., 2015)
Amyotrophic lateral sclerosis (ALS)	35 regular ETCD users	Eye tracking communication devices is used in patients in late-stage ALS with tetraplegia and anarthria can reduce communication disability and improve qol.	(CALIGARI et al., 2013)
Neurodegenerative disorder amyotrophic lateral sclerosis (patients are unable to speak or write)	40 healthy volunteers	A novel eye-tracking version of the trail-making test was compared with performance on the standard written version in a group of healthy volunteers.	(HICKS et al., 2013)

Table 2: Papers focused on people with motor disability

Source: Elaborated by the authors according to the research done

RESULTS

This study corresponds to empirical support for work with people with motor disability of visual search orientation into buildings. In this experiment, it has analyzed the scan paths, heat maps, key performance indicators into AOI, and generated Binning Chart and Line Graphs (presented in the following figures). It has identified the gaze for a set of visual search and selection tasks used by the participants to take visual-spatial orientation into the building (without specific route instructions).

The participants did not know the location of the goal. The assigned task was to find the Committee office, located into the administrations building of UFPB. To get to the site could request information to people who work or were visitors in the building.

It was used the SMI eye tracker glasses in smartphone to record the participant offset by the building in search of the Committee for Inclusion and Accessibility office. In addition, the experimenter held photographs of the areas covered to use in the analyses.

Figure 4 presents the fixations (points) and saccades (lines) of each participant in lobby. Blue color corresponds to participant 1 (wheelchair man) and orange color to participant 2 (prosthesis user). The eye movement is relatively smooth and continuous. Eyes move at high speed, almost discrete, jumps (saccades) interspersed with longer, almost fully stationary, fixations, while eye movement is relatively smooth and continuous.

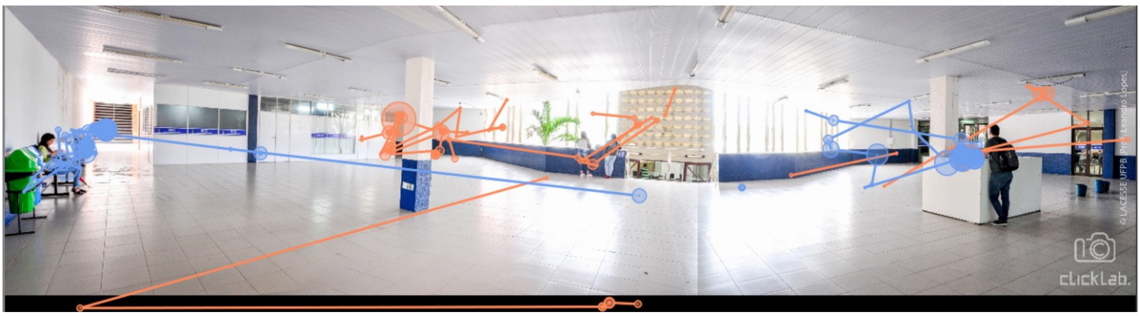

Figure 4: Scan Path both participants in lobby

Source: Developed by authors from BeGaze software

In the first recorded second, both participants concentrated their attention on the reception, located on the right side of the lobby. After that, focus their gaze in the corridor indicated by the receptionist. Curiously, this receptionist indicated different route to each participant, without intervention of experimenter. Analyzing the characteristics of the way the look of the participants of the experiment, it was possible to confirm the height level of the visual field of wheelchair users is less than people who perform the offset in foot, confirming the need to hang the visual identification with height between 1.20 and 1.40 m with respect to the level of the floor.

Figure 5 presents Heat Map of both participants. This analysis uses different color to represents the amount of fixations participants made and how long they fixated areas. Heat maps are color-coded: red was used to indicate a relatively high number of fixations or duration and blue the least, with varying levels in between. Point density is highlighting while participants looking at the hall to take orientation and choose the direction. The reception is immediately noticed by all participants and receives the highest amount of fixations. The dispersion at fixation shows that participants do not set the look at specific points along the route, indicating that the lack of visual identification caused problems of guidance on internal displacement.

Figure 5: Heat Map both participants in lobby

Source: Developed by authors from BeGaze software

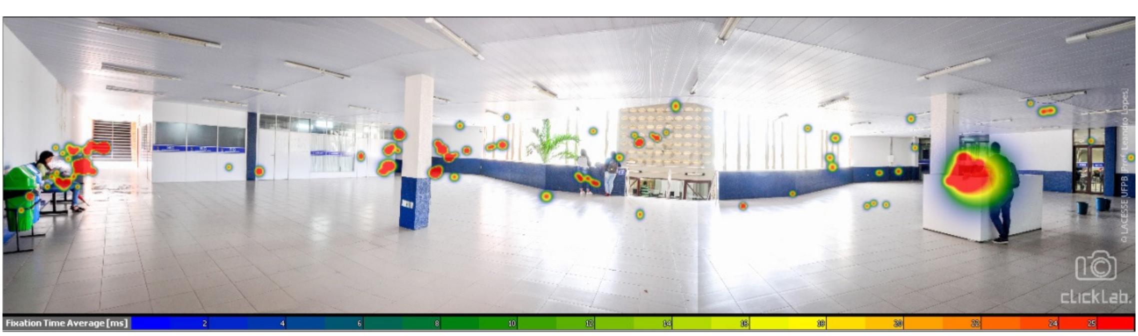

Figure 6 shows Key Performance Indicators (KPI) for both participants. In this local were selected 4 areas of interest (AOI): Hall 1 and 2, Front panel and Reception. Each AOI has description about sequence, entry time, dwell time, average fixation, first fixation, fixation count and revisits. This information permits to identify important aspects of each AOI. And with KPI is possible to understand the order in which particular areas were viewed, how often the areas were viewed, and how long they were viewed.

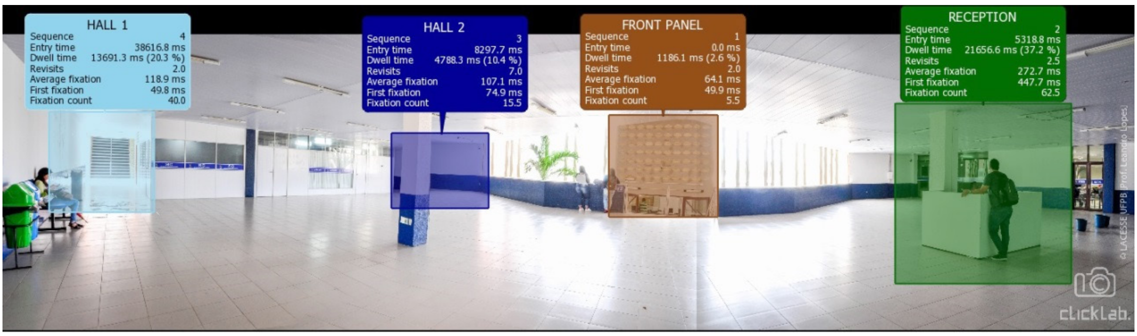

Figure 6: Key Performance Indicators for both participants in lobby

Fonte: Developed by authors from BeGaze software

The AOI sequence chart for both participants is present in Figure 7. This graphic chart denotes where each participant fixes his gaze to each AOI in line time. The AOI Reception is the most focused by each participant in the first second. Then, focus attention on the corridor where they will walk. Identified which AOI, these metrics was gazed upon and for how long.

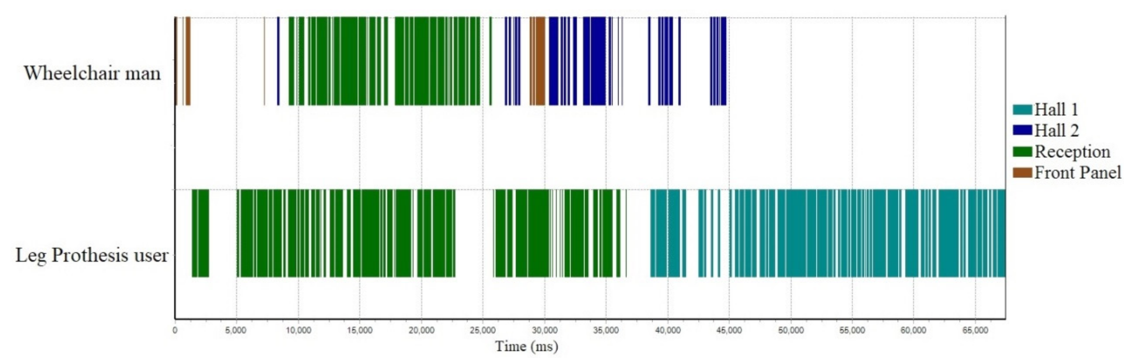

Figure 7: AOI Sequence Chart both participants in lobby

Fonte: Developed by authors from BeGaze software

The relative perceptual that participant fixing in AOI in line time, figure 8. Similar to the previous chart, it is possible to confirm that each participant focuses his attention on the AOI Reception in the initial seconds. Then, focus their attention on the corridor where they will walk.

When the participant recognizes spatial stimuli during the offset inside a building in search of the committee office of cognitive processes generated the movement of the eyes, these movements are captured and analyzed by eye tracking. Whit gaze, scan path, and fixation data analyses, the eye tracking can support in the assessment of perception through measurement of visual attention.

With this experiment was possible to measure the physiological responses to visual stimuli of two inexperienced participants with motor disability, performing an offset in an unknown location.

The route was recorded in real time by SMI eye tracker glasses in the smartphone and later analyzed by BeGaze software version 3.6.

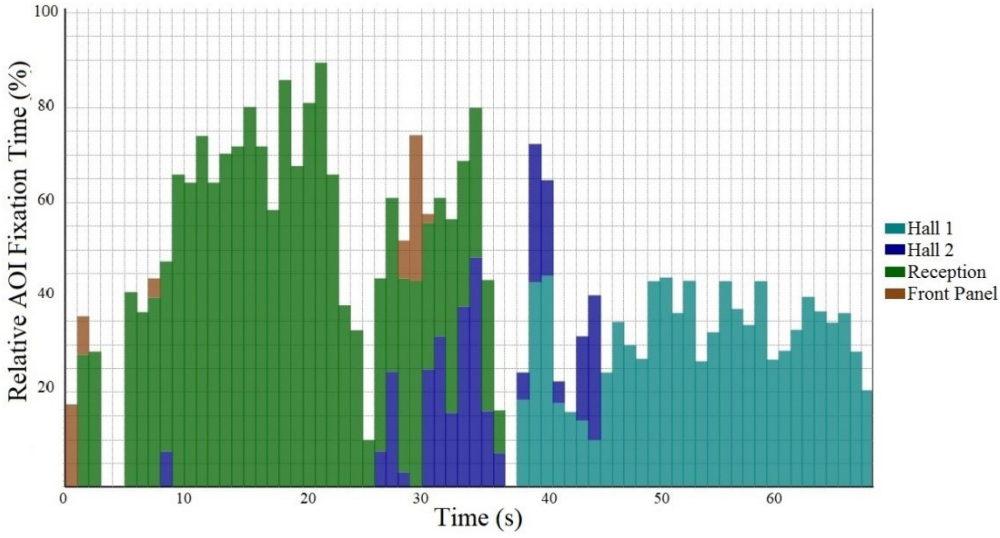

Figure 8: Binning Chart Hall both participants in lobby

Source: Developed by authors from BeGaze software

When calibration of the eye tracker glasses was performed, it must take into account the environmental conditions (humidity, temperature, thermal comfort, impact of rain) to conduct the experiment. During record time, it is necessary to check if eye tracker glasses are blurry because of the participant sweat and if the calibration of device is lost and it is possible interfere to record the video. When photographing the various areas of displacement, it is important to take into account the visibility of AOI chosen.

CONCLUSION

The analyses with eye tracking software should be used to understand the way of people with reduced mobility realize and are inside of a building it is possible to seek to enhance the ability to live normally and enhance independence by reducing the limitations to perform certain activities. The experiment is providing opportunities for greater social inclusion to this population group.

As commented in the literature, eye tracking experiments are costly, time-consuming and complex. They require dedicated devices, and despite the recent developments, reliable eye movement data can only be collected by one person at a time, as pointed by others authors (DEMŠAR; ÇÖLTEKIN, 2017). Despite this, it presents great consistency, and provides a large amount of data that provides a detailed and well-founded analysis. This research was no different. With the direct observation of people with reduced mobility development in buildings, or in other environments built, performing daily activities it is possible to increase the public awareness and understanding of the disabled population.

Supported by the use of assistive technologies and tools such as the eye tracker architects and furniture designers to build environments can improve accessibility for people with disabilities. Also, the uses of assistive technologies are an important support to eliminate subjectivity in decisions and take them with objectivity based on tangible results.

The research limitation related to the experiment characteristics and more specifically, the sample size: this experiment was primarily designed to produce test data of how eye tracking can help to understand the spatiotemporal localization of people with motor disability walking into a building, and were recruited a limited number of participants. The results are therefore still somewhat speculative, but they could be improved by performing larger experiments with more participants. And indeed, we propose that this experiment should serve as a starting point for more detailed future studies about interaction between people with motor disability and Real-World Environments.

For future studies, can be interesting to use SMI eye tracker glasses in smartphone to identify how perception of people with motor disability in escape routes of buildings is. It is possible to make the comparison between inexperienced and experienced users in any area of expertise. Moreover, it is possible to make the comparison between people with motor disability and people without motor disability in built environment. Also, to identify how perception of people with motor disability on street or inside buildings is.

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