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Cognitive disabilities and web accessibility: a survey into the Brazilian web development community

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Abstract

Cognitive disabilities include a diversity of conditions related to cognitive functions, such as reading, understanding, learning, solving problems, memorization and speaking. They differ largely from each other, making them a heterogeneous complex set of disabilities. Although the awareness about cognitive disabilities has been increasing in the last few years, it is still less than necessary compared to other disabilities. The need for an investigation about this issue is part of the agenda of the Challenge 2 (Accessibility and Digital Inclusion) from GranDIHC-Br. This paper describes the results of an online exploratory survey conducted with 105 web development professionals from different sectors to understand their knowledge and barriers regarding accessibility for people with cognitive disabilities. The results evidenced three biases that potentially prevent those professionals from approaching cognitive disabilities: strong organizational barriers; difficulty to understand user needs related to cognitive disabilities; a knowledge gap about web accessibility principles and guidelines. Our results confirmed that web development professionals are unaware about cognitive disabilities mostly by a lack of knowledge about them, even if they understand web accessibility in a technical level. Therefore, we suggest that applied research studies focus on how to fill this knowledge gap before providing tools, artifacts or frameworks.

Keywords: *Accessibility, cognitive accessibility, exploratory survey, GRANDIHC-Br*

1 Introduction

Web accessibility stands for the possibility to people with some limitation, difficulty or disability, either long-term or temporary, to perceive, understand, navigate, interact with and contribute to the Web, independently of their visual, hearing, physical, motor or cognitive abilities, as well as their temporary or situational condition, such as limited internet connection (W3C, 2005). Hence, it means that any person using any technology to access the Web should be capable to visit any website, access the information it offers and interact with the website (Hull, 2004). Still, most websites present critical barriers that prevent users from interacting with them, particularly users with disabilities. A research conducted by WebAIM between 2019 and 2020 analyzing the accessibility of the top one million websites reported that 98.1% of them present accessibility failures (WebAIM, 2020c).

However, the awareness of web development professionals in Brazil regarding accessibility grew in the last decade due to initiatives to democratize the access to the knowledge about the subject. Some of the initiatives include the version 2.1 of the Web Content Accessibility Guidelines (WCAG) released in 2018 (W3C, 2018), the creation of the Accessibility Model in Electronic Government (eMag) based on the WCAG (Brasil, 2014), the increase of scientific research on the subject (de Oliveira Bueno, Ferreira, Ferreira, & Anacleto, 2016) and the efforts of the Great Research Challenges in Human-Computer Interaction in Brazil (GranDIHC-Br)(Baranauskas, Souza, & Pereira, 2012), this one having the Challenge 2 dedicated to approach accessibility and digital inclusion.

The initiatives highlight that the access to the content available on the web for any person regardless disabilities or characteristics goes beyond digital inclusion: it is also social inclusion. In this context, web development professionals have a social responsibility to develop solutions that comply at least with the foundation level of web accessibility and design for all. However, it is possible to note that the most recognizable guidelines of web accessibility, WCAG and eMag, still concentrate most of its recommendations in accessibility for people with visual disabilities, lacking recommendations and best practices regarding cognitive disabilities.

Cognitive disability is an umbrella terminology including a diversity of learning, neurodevelopmental, intellectual and mental disabilities or disorders. The cognitive functions related to these conditions include language, memory, literacy, learning, math comprehension, social and communication skills deficit, attention, problem resolution and even effects of aging (Lewis, 2006; Pouncey, 2010; Seeman & Cooper, 2015; WebAIM, 2020a). Some conditions under this umbrella are dyslexia, dyscalculia, autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), aphasia, Down syndrome, memory disorders and age-related syndromes, among others (WebAIM, 2020a). Autism, dyslexia, dyscalculia, ADHD and related cognitive or learning disabilities are involved in the concept of neurodiversity, which consider such conditions as a diversity of neurological functions rather than a pathology (Dalton, 2013; Disabled World, 2020). Cognitive disabilities differ largely from each other, making them a heterogeneous and complex set of disabilities and disorders (Lewis, 2009; WebAIM, 2020b). Thus, they need a different approaching on the web in comparison to other types of disabilities.

To address cognitive disabilities properly on the web development process, cognitive web accessibility emerged as a research field branched from digital/web accessibility and

inclusive design dedicated to investigate interaction aspects that affect people with cognitive disabilities (Seeman & Cooper, 2020c).

Although concerns about cognitive accessibility has been notably increased in importance in the last 15 years, cognitive disabilities are still the least approached and commented conditions on the subject of web accessibility if compared to visual disabilities (Blanck, 2015; Ferreira et al., 2017; WebAIM, 2013). One reason for that is the fact that such disabilities are considered "invisible" – by not being physically perceivable –, which led technology practitioners to be skeptical to needs of these users. The stereotypes and misinformation mean that they end up receiving insufficient attention compared to other disabilities (Blanck, 2015; Seeman & Cooper, 2020b) and, consequently, they are less understood and discussed (WebAIM, 2013).

Besides, cognitive disabilities lack specific guidelines and technical orientations which consider the complexity of different conditions under this umbrella terminology (Borg, Lantz, & Gulliksen, 2015; Britto, 2016; Ferreira et al., 2017; Friedman & Bryen, 2007). The absence of cognitive disabilities on accessibility guidelines may prevent professionals from approaching those conditions on their projects due to a knowledge gap.

The lack of knowledge about neurodiversity and the difficulty of following international guidelines in practice was also alerted by Lewis (2006) and Poulson and Nicolle (2004), respectively, over a decade before this study, corroborating that we still have a long way to promote cognitive web accessibility. Initiatives like the Cognitive and Learning Disabilities Task Force (COGA) by the World Wide Web Consortium (W3C) (Seeman & Cooper, 2020c, 2020b) are extremely relevant to promote more knowledge about neurodiversity, but they need more disclosure.

Previous research investigated the perception and awareness of web accessibility by information technology (IT) professionals from industry, government and academy (Antonelli, Rodrigues, Watanabe, & de Mattos Fortes, 2019; Ferreira, Santos, Silveira, & Ferreira, 2007; Lazar, Dudley-Sponaugle, & Greenidge, 2004), providing insightful indicators. The studies highlight the challenges to approach accessibility in digital project, such as: lack of awareness, limited usage and knowledge about accessibility guidelines, organizational barriers and misconceptions about people with disabilities. However, these research studies did not perform a deeper inquiry about cognitive disabilities, although presenting high level indicators about the awareness of neurological or cognitive disabilities by web development professionals. A survey focused on cognitive accessibility is necessary to identify specific barriers that prevent IT professionals to consider people with such disabilities in their projects and gather insights to mitigate the gap of knowledge about the subject.

This paper describes the results of an online exploratory survey conducted with 105 professionals that work or teach web development and design to understand their knowledge and barriers regarding accessibility for people with cognitive disabilities. The survey was conducted in 2015 as part of a project related to accessibility guidelines focusing on autism (Britto, 2016). We asked practitioners from industry, government and third sector about their experience approaching people with cognitive disabilities through a set of close-ended and open-ended questions.

The main purpose of this exploratory survey was to investigate the following aspects: (i) how web development professionals from Brazilian community understand accessibility for people with cognitive disabilities; (ii) what are the challenges these professionals face when trying to consider these users; (iii) which type of content or tool can help to increase the awareness of these professionals regarding cognitive accessibility.

This paper is an extended version of the paper entitled "*A survey on the awareness of Brazilian web development community about cognitive accessibility*" published in the 18th Brazilian Symposium on Human Factors in Computing Systems (IHC 2019) (Pichiliani & Pizzolato, 2019).

The paper is organized as follows: Section 2 describes the cognitive accessibility and its importance, as well as a history of accessibility in the GranDIHC-Br; Section 3 presents the related works; Section 4 elucidate the methodological approach to conduct the survey; Section 5 describes the results obtained in our study, while Section 6 discuss the finding along with the literature, proposing strategies to address the barriers emerged from the results and suggesting a roadmap to GranDIHC-Br to mitigate the knowledge gap about cognitive disabilities; finally, Section 7 presents our final remarks and proposal of further works.

2 Cognitive Disabilities and the Web

Web accessibility is commonly associated to programming techniques that improves the user experience for people with visual or physical disabilities, such as alternative text for images, keyboard navigation, compatibility with screen readers and good color contrast.

However, when designing web sites and applications, it is important to have a distinct attention to the needs of people with cognitive disabilities because the impact of an inaccessible solution for this audience may affect how they understand instructions or navigations mechanisms, understand sentences, complete tasks, understand multi-stage processes, keep focus, enter data correctly or how they can simply find the content or feature that they need (Pouncey, 2010; Seeman & Cooper, 2020b).

The barriers faced by people with cognitive disabilities on the web may be considered "invisible", since they are less related only to operational aspects and more related to skills such as memory, attention, language, literacy and perception, for example (Seeman & Cooper, 2020c). Some examples of barriers and how to address them are (Seeman-Horwitz, Montgomery, Lee, & Ran, 2021):

- People with memory-related disabilities may have difficult to remember access codes and passwords. Thus, process should not rely on the memory of the users and need to provide autocomplete, compatibility with password manager or alternative ways of authentications;

- People with deficits on social or communication skills or mild cognitive impairment may lack understanding of metaphors, non-literal phrases, idiomatic expressions and new icons. Metaphors should be avoided and the user interface need to use a clear and unambiguous language or provide explanation to help them understanding terms and expressions;
- People from diverse cognitive disabilities may experience fatigue and cognitive overload with complex and multi-step processes, such as buying a flying ticket, being unable to complete the task. The interface needs to provide information to help users to know where they are in the process, such as the completed steps, the current steps and the pending steps;
- People with learning disabilities related to mathematical concepts may not understand percentages, distance or calculations. Numerical content should present support such as description, pictorial representation, conversion or equivalent concept;
- People with memory or attention disabilities may not complete a task in a webpage if there are distractions and interruptions, such as notifications, moving advertisements and opt-in popups. Adjacent and background distractions should be avoided or the website can provide a reading mode, removing mostly interface elements.

Approaching cognitive disabilities is not trivial, considering they are varied, complex and may be difficult to identify or diagnose (Lewis, 2006, 2009; WebAIM, 2013). Supporting users with cognitive disabilities is mostly about allowing allow them "*to interact with content and to process information in ways that are more usable to them*" (Abou-Zahra, 2017).

Professionals with different roles in a web development process have the responsibility for accessible content and feature development that lead to solutions that reach as many people as possible (Hull, 2004). Nevertheless, there are some misconceptions, especially in the industry, that web accessibility is a technical concern, hard to implement, time consuming and should be approached only when demanded (Antonelli et al., 2019; Freire, Russo, & Fortes, 2008; Friedman & Bryen, 2007; Lazar et al., 2004; Putnam et al., 2012).

When looking specifically at cognitive disabilities, the panorama is even more challenging. As detailed further in this paper, our study identified that some professionals never thought about the needs of people with cognitive disabilities. This is worrisome, considering that people with some sort of cognitive disability represent at least 1.3% (2.5 millions) of the Brazilian population according to the last census of the Brazilian Institute of Geography and Statistics (IBGE, in the original acronym) conducted in 2010 (IBGE, 2010). The percentage of people with cognitive disability may be even bigger than reported in the census, since IBGE category for these disabilities is "mental disabilities", however, the majority of cognitive disabilities do not affect the mental or intellectual abilities. Thus, the results are underestimated. Also, it is worth to consider that data from the census is outdated and may not represent the actual prevalence of all disabilities in the Brazilian population. Unofficial statistics indicate that cognitive disabilities are the most common type of disabilities (WebAIM, 2013). For instance, it is estimate that nearly 2 million Brazilians represents solely people with ASD (Oliveira, 2015).

The Web Accessibility Initiative (WAI) – branch from W3C and maintainer of WCAG – recognized the importance to consider cognitive disabilities with a dedicated attention and founded the working group COGA in 2014, focused on studying aspects related to neurodiversity and cognitive web accessibility (Seeman & Cooper, 2020c, 2020b, 2020a).

In 2015, COGA published the results from their first research conducted with users with cognitive disabilities to address problems and design solutions for accessibility of web content (Seeman & Cooper, 2015), bringing significant and unprecedented results, although requiring further investigation.

2.1 Accessibility in the GranDIHC-BR

Concerns about the importance of accessibility raised prominence in the Brazilian HCI community since the publication of GranDIHC-Br in 2012 (Baranauskas et al., 2012; de Oliveira Bueno et al., 2016), which stablished a challenge dedicated to accessibility and digital inclusion (Challenge 2), aiming to reach the following by 2022 advances in researches about inclusive design and awareness from industry about the commercial potential for the niche of people with disabilities (Furtado, Chagas, Bittencourt, & Façanha, 2014).

In the next three years after stablishing the five challenges for the GranDIHC-Br, the Challenge 2 is the most approached challenge on the Brazilian Symposium on Human Factors in Computing Systems (IHC) and papers related to the topic increased from 2013 to 2015 (de Oliveira Bueno et al., 2016). However, the scenario is not so optimist considered that most of papers published in IHC were not related to any challenge. From 2006 to 2016, IHC had 12% of its papers dedicated to accessibility, being 52% of these papers related to web platform and considering more visual, hearing or motor disabilities rather than cognitive disabilities (de Fátima Granatto, Pallaro, & Bim, 2016).

To follow-up deeper how the challenge was being approached in Brazilian researches, Ferreira et al. (2017) presented reflections and findings five years after the release of GranDIHC-Br, identifying uncovered challenges and questions to be addressed by the Brazilian HCI community.

One of the gaps is related to digital accessibility for neurodiversity, on which the authors concluded that research on people with cognitive disabilities is still incipient in the Brazilian community. Thus, understanding the challenges of cognitive disabilities in web development and correlated fields was proposed as one of the compromises in the GranDIHC-Br (Furtado et al., 2014).

To address the issues related to cognitive disabilities in the HCI field, the authors presented the following questions:

a) What are the difficulties faced by computer science professionals and researchers to consider users with cognitive disabilities in their projects?

b) What actions can be taken to increase awareness about neurodiversity and the specificities of interaction for these disabilities?

Those questions aim to propose reflections for the HCI community and guide a research agenda. Our study focuses on contribute with answers to both questions, publishing and discussing the results of the survey carried in 2015 as a starting point for further research on the subject.

3 Related Works

Investigating and promoting the accessibility awareness for web development professionals has been a recurring concern of the Human-Computer Interaction (HCI) area. Researchers and industry professionals who advocate for inclusive design observe informally how accessibility is an unknown subject for most people in the industry and studies along the years have confirmed this perception (Antonelli et al., 2019; de Fátima Granatto et al., 2016; Ferreira et al., 2007; Freire et al., 2008; Tangarife & Mont'Alvão, 2006).

Previous works usually focus on understanding accessibility awareness of web developers in a broad context, which is also important as a start point to further investigation. We discuss five remarkable works related to the subject in this section (Antonelli et al., 2019; Freire et al., 2008; Lazar et al., 2004; Putnam et al., 2012; Yesilada, Brajnik, Vigo, & Harper, 2015), two of them related to the Brazilian community. However, none of them performed a deeper inquiry about cognitive disabilities, although presenting high level indicators about the awareness of neurological or cognitive disabilities by web developers.

The first large-scale survey on web accessibility was conducted in 2004 by Lazar, Dudley-Sponaugle and Dawn (2004), carried out with 175 webmasters to identify their knowledge about web accessibility and clarify their perception to whether approach or not web accessibility. This is one of the first surveys to research this topic in depth. In contrast with further researches we discuss next, the authors presented a surprisingly scenario where 65.7% of respondents indicated that they had previously created an accessible website, 73.7% were familiar with laws about accessibility and 64% were familiar with the WCAG. Cultural aspects may bias this scenario, since 45% of respondents were from United States. Moreover, respondents also indicated barriers to work with accessibility such as confusing accessibility guidelines or lack of training and managerial support, among others. As a first research about the topic, the authors did not investigate the understanding of webmasters about specific disabilities.

In 2007, Freire, Russo and Fortes (2008) carried out a large survey in Brazil with 613 respondents to compare the perception of web accessibility by professionals from academy, industry and government. In addition of two previous researches performed in Brazil about the topic (Ferreira et al., 2007; Tangarife & Mont'Alvão, 2006), the authors refined the hypothesis of the research in order to identify differences of awareness of web accessibility between sectors. The results from the survey were very distinct from Lazar, Dudley-Sponaugle and Dawn (2004), evidencing a lack of accessibility awareness, starting with the data that 29.7% of respondents from industry had no knowledge about WCAG, while 42.9% from government and 41.7% from academy had no knowledge about these guidelines. Related to the use of guidelines for evaluating websites, they were used only by about 15% of respondents from industry, 9% from academy and 11% from government. Most of respondents did not use any evaluation method. The authors also identified lack of training about the accessibility by the government and academic sectors.

We highlight the data regarding the reasons to consider or not accessibility on organizations. The main reasons by each sector were: addressing more customers (65.9%) by industry, legal factors (70%) by government and personal motivation (69.3%) by academy (Freire et al., 2008). From industry it was worrisome that the main reason to not consider people with accessibility is that it is not a requirement from their customers (71.9%) or organization in general (54.1%).

In 2012, Putnam et al. (2012) conducted a survey with HCI professionals from different nationalities receiving 199 valid responses. The objective was to identify how these professionals consider accessibility when creating computing technologies. Although 87% of respondents pointed out accessibility as an important or very important issue, most of them had limited action in considering accessibility in their projects, mainly due to organizational barriers in the workplace, such as budget, time and not being a customer need. The survey also highlighted that visual disabilities were highly contemplated by the respondents over other disabilities, indicating a potential gap of knowledge that may lead to an underrepresentation of cognitive disabilities.

In 2013, Yesilada et al. (2015) conducted a survey with 300 individuals from 15 countries - including Brazil, but mainly from United States (US) - interested in accessibility who answered questions about their perception on the relation between the following aspects: accessibility vs. usability; accessibility vs. user experience; perception if accessibility is only for people with disabilities or for all; inclusion vs. exclusion; accessibility evaluation; effective of expertise in their perception of accessibility vs. usability vs. user experience. The respondents were presented to 33 statements about web accessibility and should rank them from "strongly disagree" to "strongly agree" or NA in case they did not want to respond. Most of respondents (38%) have a background in computer science, with 31% having specialization in web accessibility and 23% in HCI.

Opposite to Putnam (2012), the study presents positive perspectives on the perception of HCI and UX professionals about accessibility and its relationship with user experience. Participants agreed that accessibility is closely related to usability and user experience and share a perception that it is a quality factor. Also, they consider accessibility not only for people with disabilities, but for all people and share a human perspective about approaching accessibility as a user-centered process and not only source-code inspection restricted

to WCAG compliance. At the same time, there is no consensus if legislation is a persuasive motivation to adopt accessibility in comparison with business cases. There were no questions about the knowledge level of these professionals related to disabilities.

The study provides a relevant understanding on the perception of UX/HCI practitioners about accessibility and inclusive design. However, results may not represent the reality of the industry, since most respondents were somehow already involved with web accessibility and were from US and Europe, which are notably mature markets in terms of accessibility.

In 2018, Antonelli et al. (2019) published the most recent survey conducted in Brazil regarding the accessibility awareness of web development professionals. The survey had a similar structure as Freire, Russo and Fortes (2008) to compare the evolution of web accessibility awareness in Brazil in a span of a decade. The study had a lesser sampling with 404 valid answers, but still representing a relevant amount of responses.

The results presented by authors show that 13.9% respondents had developed an accessible website for people with disabilities, while 34.4% partially developed and 51.7% never developed an accessible website. Regarding the concern to develop accessible solutions, 33.2% of participants were not worried about considering accessibility in their future projects, mainly because most of them lack training about accessibility (61.4%).

However, 51.5% of respondents pointed that one of the challenges to develop accessible websites is that accessibility is not a requirement for customers and 50% indicated that is not also a requirement for the organization, which we found worrisome. This result evidences that the low awareness level may be related to misconceptions about accessibility. A novelty of this study is a question inquiring which disabilities are considered by users who already developed an accessible website. As expected, 86.2% of these participants considered issues related to people with visual disabilities, while 48% considered issues related to elderly and only 12.8% and 5.1% considered issues related to people with neurological/cognitive disabilities and speech disabilities, respectively. Unfortunately, they did not inquire further questions about each disability.

The previous studies presented relevant indicators about the perception of web development professionals, revealing that cognitive disabilities are one the least approached disabilities. However, they did not investigate the reasons why these professionals do not approach cognitive disabilities, considering that such disabilities are likely to be neglected by web development professionals in comparison with visual or physical disabilities. Thus, it is necessary a deeper inquiry to understand and identify the barriers, motivation and biases that prevent IT professionals to consider people with cognitive disabilities in their projects to gather insights and mitigate the gap of knowledge about the subject.

4 Methodology

This research consists of an exploratory survey focused on identifying the problems and motivations of web professionals when dealing with accessibility for people with cognitive disabilities. The survey served as a preliminary study to trace a profile of the Brazilian community, aiming to provide a better understanding of an underrepresented subject about web accessibility.

The study was driven by the following research questions:

RQ1: How Brazilian web development professionals understand accessibility for people with cognitive disabilities?

RQ2: Which are the challenges, barriers or motivation faced by these professionals to consider or not users with cognitive disabilities?

RQ3: Which content type or tools can help to increase their awareness on cognitive web accessibility?

The survey was part of a research project about the development of web accessibility guidelines for people with ASD (Britto, 2016; Britto & Pizzolato, 2016) and provided insightful inputs to the writing of the guidelines.

Following, we describe the structure of the questionnaire and the sampling method.

4.1 Survey design

We structured the survey as an online questionnaire in a survey platform due to the possibility to reach IT professionals from all regions of Brazil and be a non-intrusive way to gather answers from these professionals. The survey received responses from 10/05/2015 to 11/30/2015 and we analyzed the results from December 2015 to March 2016.

Some questions were based on Freire, Russo and Fortes (2008) to enable comparisons with their survey and with Antonelli et al. (2019), which also based some of their questions on the above-mentioned authors. The questions were adapted to match the purpose of our survey.

The survey presented 9 questions about the issues we were investigating plus 6 demographic questions. The 9 questions were distributed in four steps during the questionnaire, as illustrated on **Figure 1.** The flow of the survey, branching according the response to Q1.: (1) the first question (Q1), after the acceptance of the consenting term, inquired if the respondent usually consider people with cognitive disabilities on their projects; (2.a) if the answer to Q1 was “Yes”, the respondents were redirected to a set of four questions (Q2, Q3, Q4, Q5) to understand their motivation to approach this audience; (2.b) if the answers were “No” or “Partially”, the respondents saw a different set of questions (Q6, Q7, Q8) that wondered about their difficulties and what would motivate them to consider this audience; (3) finally, the question Q9 was presented to all respondents to inquiry about their level of knowledge about accessibility content and guidelines. The fourth and final step of the survey addressed demographic and background questions.

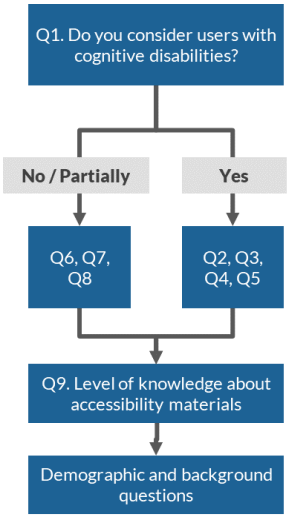

Figure 1. The flow of the survey, branching according the response to Q1.

The survey questions Q1, Q2, Q3, Q4, Q6, Q7 and Q9 were designed specifically to address all three research questions, while Q5 and Q8 – both open-ended and optional questions – aimed at gathering complementary insights for RQ2 (**Table 1**).

It is important to highlight that the following aspects were not included in the survey, as they are out of the scope of the research: knowledge level about assistive technology, knowledge level about specific techniques or programming/markup/styling languages and accessibility statutory laws.

4.2 Sampling

Estimating the population of people involved with web development in Brazil it is still difficult due to the lack of official statistics about the sector. For this reason, it is not possible to apply a probabilistic method for sampling selection. This had been reported as a limitation in previous surveys conducted in Brazil (Antonelli et al., 2019; Freire et al., 2008; Tangarife & Mont'Alvão, 2006). Thus, we adopted a self-selected and non-probabilistic sampling method. To ensure we had a statistically significant number of respondents, we used the estimation provided by SOFTEX (2012), which was 600.000 IT professionals in Brazil. Considering a sampling error of 10% with confidence level of 95%, we should have at least 97 valid responses and we had 105 valid responses.

The target population included the following profiles: web developers, web designers, platform software developers (e.g.: Android, iOS, Windows, etc.), technical team leaders, project managers, educators from technical high school and undergraduate/graduate courses related to IT and people involved with web accessibility in government. To properly select this population and to cover all regions of Brazil the distribution of the survey was made in target groups on social networks, invitation through e-mail lists, direct invitation through e-mail and a call to action on a blog post of a technical website.

5 Results

We present in this section the results of the survey, discussing the insights generated from the collected data. It is important to highlight that some questions can overflow 100% in their responses since the respondents could select multiple options. Regarding the number of respondents, we had 142 participants who answered the survey and 105 of the responses were valid, considering the fulfillment of the questionnaire until the last page and the confirmation that the answers were computed.

Table 1. Relationship between research questions and survey questions.

Research Question	Survey Question
RQ1: How Brazilian web development professionals understand accessibility for people with cognitive disabilities?	Q1. Do you consider users with cognitive disabilities in your projects?
	Q2. In your projects, how do you ensure the accessibility for people with cognitive disabilities?
	Q3. What are the reasons to approach web accessibility for people with cognitive disabilities in your projects?
	Q4. Which cognitive disabilities do you approach in your projects?
RQ2: Which are the challenges, barriers or motivation faced by these professionals to consider users with cognitive disabilities?	Q5. Optionally, please share with us your experience and challenges working with this audience
	Q6. For what reasons do you not address web accessibility for people with cognitive disabilities in your projects?
	Q8. Optionally, please share with us your experience and the challenges that you faced when working with this audience
RQ3: Which content type or tools can help to increase their awareness on cognitive web accessibility?	Q7. What could motivate you to consider people with cognitive disabilities in your projects?
	Q9. Inform the level of ease of understand about the guidelines, recommendations and techniques presented in each of the following materials

Although the number of responses may be considered low in comparison with other surveys about web accessibility, it represents the first iteration to understand issues related to cognitive accessibility in depth, since data about this subject are still scarce, both in the industry and academy.

5.1 Profile of respondents

Most respondents are young web developers and/or web designers, from 25 to 29 years, working on the private sector in the Southeast region of Brazil. Considering the respondents could check from 1 to 3 options about their occupation, the most common combinations were (**Figure 2**): web developer and web designer (N = 23), web developer and platform developer (N = 17).

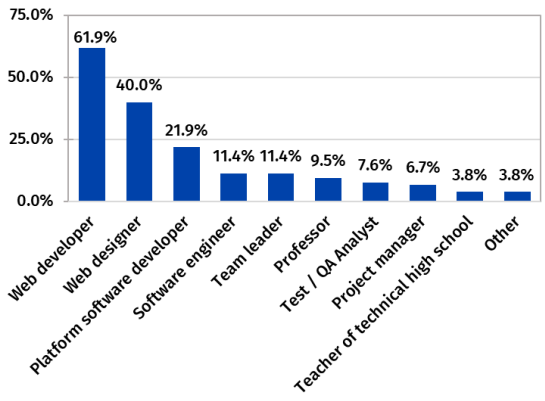

Figure 2. Professional occupation from respondents.

Table 2 presents the distribution of level of expertise by age range of the respondents. We classified the level of expertise as follow: participants who declared to have up to five years of professional experience in IT were classified as Junior; participants with 6 to 10 years of experience were classified as Intermediate; and participants with more than 10 years of experience were classified as Senior. Regarding gender, 69.5% (N = 73) were male-identified participants, while female-identified participants represent 28.6% (N = 30) and 1.9% (N = 2) preferred to not inform their gender.

Table 2. Level of expertise in the IT sector by age range.

	Level of expertise in IT			
Age range	Junior	Intermediate	Senior	Total
16 - 19	0	2	0	2
20 - 24	18	4	0	22
25 - 29	15	22	3	40
30 - 34	8	8	8	24
35 - 39	2	1	7	10
40 - 44	1	0	3	4
45+	0	0	3	3
Total	44	37	24	105

The survey had some undergraduate/graduate professors as respondents (9.5%, N = 10) and a few high school teachers (3.8%, N = 4), most of them also working in the software industry. Nearly 70% of respondents work on the private sector, specially software development companies or digital agencies, while 11% (N = 12) of professionals work autonomously, followed by 16% (N = 17) of respondents who work on the public sector, mainly allocated in the IT department and 4% (N = 4) who work for Non-Governmental Organizations (NGO). **Figure 3** represents the distribution of respondents by sector and **Table 3** presents the detailed industry or department by sector.

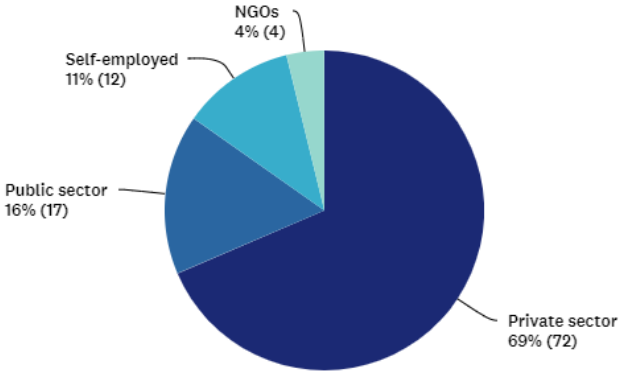

Figure 3. Respondents by their major sector of occupation.

Table 3. Respondents by industry inside each sector.

Sector	Industry / Department	Distribution
Private Sector	IT company, digital agency or telecommunications company	57.1% (60)
	Education (university, college or technical high school)	8.6% (9)
	IT department in a non-IT company	2.9% (3)
Public Sector	IT department in city, state or federal government agencies	10.5% (11)
	Education (university, college or technical high school)	3.8% (4)
	Other municipalities	1.9% (2)
Third Sector	Non-Governmental Organizations (NGO)	4% (4)
Self-employed	Consultant or independent professional	11.4% (12)
	Total	100% (105)

Regarding regional distribution, most respondents are from the Southeast region of Brazil (69%, N = 72), followed by respondents from the South region (16%, N = 17), as shown on **Figure 4**. Only one respondent was from the North region. Considering that the Southeast is the most developed region of the country and concentrate most IT companies and professionals, these data are close to the reality of the industry, however, they may not reflect properly the reality of academy and government.

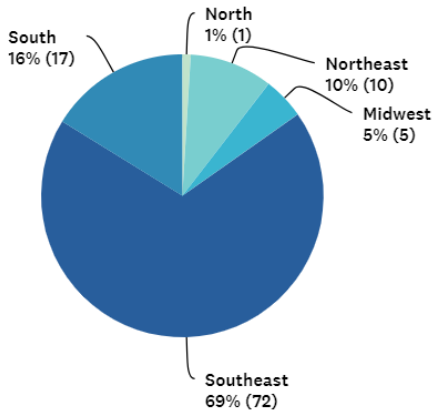

Figure 4. Respondents by regions of Brazil.

5.2 How and why web professionals consider users with cognitive disabilities

The Research Question 1 (RQ1) aimed to investigate the level of understanding about cognitive disabilities from IT professionals and why they consider or not such disabilities.

Therefore, on the first question (Q1), we asked the respondents if they consider people with cognitive disabilities in their web project (**Figure 5**), instead of asking near the end of the questionnaire if they consider people with some sort of disability. The definition of cognitive disabilities was previously explained in the first page of the survey, which presented the consent form. As we expected, 54.3% (N = 57) of respondents answered that they do not consider that audience and 30.5% (N = 32) pointed that they partially consider people with cognitive disabilities. Only 15.2% (N = 16) declared they consider people with cognitive disabilities on their projects.

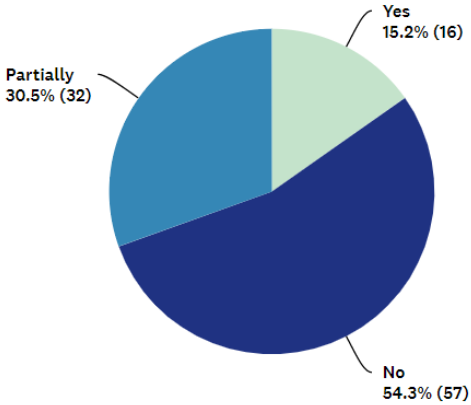

Figure 5. Responses to Q1: Do you consider users with cognitive disabilities in your projects?

The 16 respondents who answered that they consider people with cognitive disabilities in their projects were prompted to answer a specific set of questions to understand their motivation in comparison to the remaining respondents.

Firstly, we asked in Q2 which materials they consume or use to ensure accessibility for people with cognitive disabilities (**Figure 6**). Most of them (75%, N = 12) use WCAG as a support, while scientific papers and technical blog posts were pointed equally by 50% (N = 8) of respondents. Only 1 respondent ensure accessibility through user testing.

In contrast with Q9, which asked for all respondents, the results from Q2 evidenced that professionals who consider people with cognitive disabilities tend to have a higher use and, probably, a higher knowledge about guidelines. However, we do not know for sure if they consider these users because they read more guidelines, papers and blogs or if they read these materials because they already are more aware about the needs of these users.

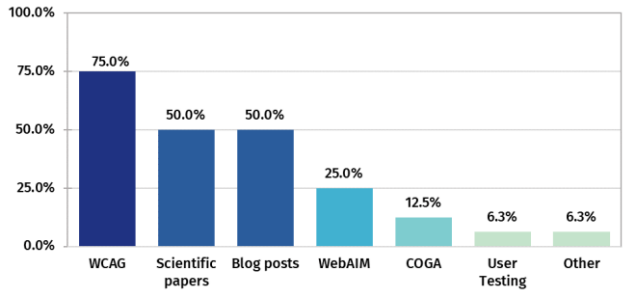

Figure 6. Responses to Q2 related to how they ensure accessibility for users with cognitive disabilities.

Following, we asked these respondents in Q3 their motivations to approach users with cognitive disabilities in their projects. Most respondents (68.8%, N = 11) indicated that they understand these users as part of their audience, while 62.5% (N = 10) pointed that they approach users with cognitive disabilities to allow them to use the product or service and 56.3% (N = 9) had personal motivations.

Regarding personal motivations, it may be related to the fact that some respondents already work with users with cognitive disabilities or have close relatives with some sort of the conditions, specially ASD, which makes these participants more empathic with this audience. Some evidence to these assumptions was answered in Q5, where one participant comment he had a child with ASD and other two participants indicated they had experience working with this audience, specially to meet public policies. **Figure 7** presents the distribution of answers for Q3.

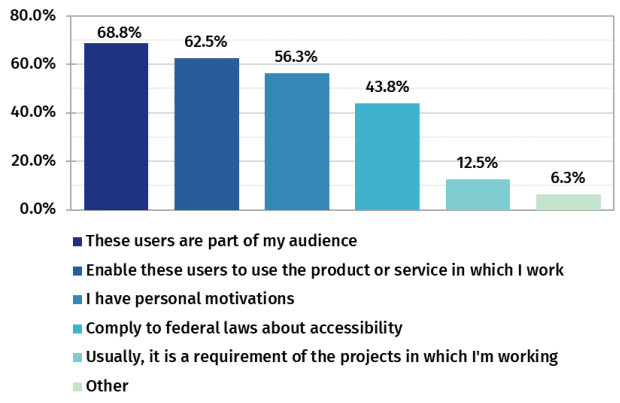

Figure 7. Responses to Q3 related to the motivations to approach users with cognitive disabilities in web projects.

On Q4, the last close-ended question on this set, we wondered which cognitive disabilities the participants usually consider on their project. Although there are far more cognitive disabilities than the eight that we presented as options, we focused on conditions that are currently being approached by COGA. **Figure 8** presents the distribution of answers.

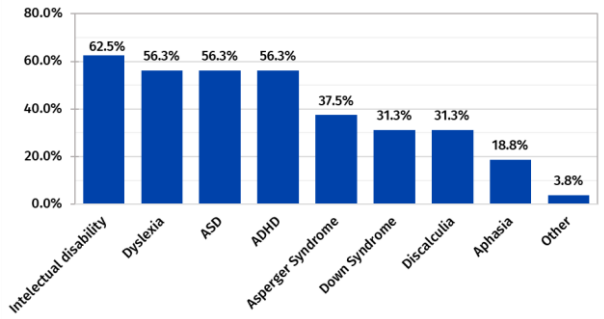

Figure 8. Responses to Q4: Which cognitive disabilities do you consider on your web projects?

Intellectual disability was indicated by 62.5% (N = 10), while Dyslexia, ASD and Attention Deficit Hyperactivity Disorder (ADHD) were checked equally by 56.3% (N = 9) of respondents and only 31.3% (N = 5) consider users with Down Syndrome. On the option "Other", the respondents pointed out visual or physical disabilities, instead of other cognitive disabilities.

5.3 Evidences of challenges and barriers

The Research Question 2 (RQ2) addressed the challenges and barriers that IT professionals may face when trying to consider users with cognitive disabilities in their project.

For the 84% (n = 89) of respondents who partially consider or do not consider users with cognitive disabilities, we presented another set of questions to understand their main reasons for not considering this audience and which resources may help to mitigate this gap. Thus, on Q6 we asked the participants about their reasons for not considering users with cognitive disabilities.

The lack of general knowledge about cognitive disabilities was the main reason, indicated by 75.3% (N = 67) of respondents. However, it was worrisome to note that the second prominent reason is that these users are not considered as part of the audience of their organization according to 53.9% (N = 48) respondents and 26.9% (N = 24) answered that they did not consider users with cognitive disabilities are their audience (**Figure 9**).

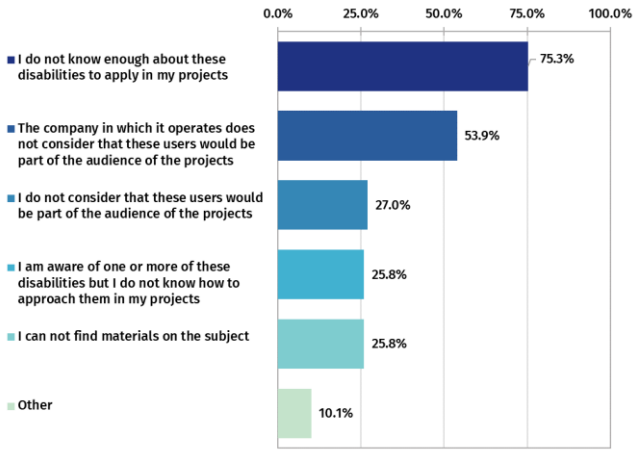

Figure 9. Distribution of responses to Q6: Which are your reasons to not approach users with cognitive disabilities?

This may evidence cultural barriers on organizations, particularly on the private sector. On the option "Other", assigned by 10.1% (N = 9) of respondents, the reasons we could identify when tagging the answers were: a) they never thought about this type of users (3 answers); b) lack of time (2 answers); c) organizational culture that did not prioritize accessibility (2 answers); d) lack of user testing (1 answers).

5.3.1 Reasons to not approach users with cognitive disabilities by sector

The reasons to not approach users with cognitive disabilities change lightly by sector (**Table 4**).

In the public sector, the main reason is the absence of knowledge about cognitive disabilities (83.3%, N = 10). Thus, they may have a concern regarding this audience, even driven by legal motivation, but they do not know what aspects need to consider about these conditions in their projects. However, it is alarming that almost 70% indicated that their department, organization or public bodies do not consider people with cognitive disabilities as part of their audience, which may be conflicting with the legal obligation that public bodies have to provided accessibility for all, independently of disorders or disabilities.

Among respondents from private sector, third sector and self-employed professionals, the lack of knowledge about cognitive disabilities is also the predominant motivation. In the private sector, 55.4% (N = 36) of respondents reported that their companies do not consider people with cognitive disabilities as part of their audience and 22.7% (N = 2) of self-employed indicated the same, while this amount is increased to 66.7% (N = 2) in the third sector. However, we recommend interpreting the results with caution, since the data related to third sector and self-employed professionals presents a small amount of answer that may not be representative with the market reality.

Table 4. Distribution of answers to Q6 by sector. The N refers to the respondents who answered the question, not all respondents from the sector.

	Sector			
Statement	Private Sector (N = 65)	Public Sector (N = 12)	Third Sector (N = 3)	Self-employed (N = 9)
I do not know enough about these disabilities to apply in my projects.	73.8% (48)	83.3% (10)	66.7% (2)	77.8% (7)
The company in which it operates does not consider that these users would be part of the audience of the projects.	55.4% (36)	66.7% (8)	66.7% (2)	22.7% (2)
I do not consider that these users would be part of the audience of the projects.	32.3% (21)	8.3% (1)	33.3% (1)	11.1% (1)
I am aware of one or more of these disabilities, but I do not know how to approach them in my projects.	27.7% (18)	16.7% (2)	33.3% (1)	22.7% (2)
I cannot find materials on the subject.	26.2% (17)	25% (3)	66.7% (2)	11.1% (1)
Other	7.7% (5)	16.7% (2)	0% (0)	22.7% (2)

5.4 Content and tools to motivate and increase awareness of cognitive web accessibility

The Research Question 3 (RQ3) investigated which type of content, tools or materials can potentially be helpful to increase the awareness of IT professionals regarding cognitive disabilities.

On Q7, we asked the participants about which materials, strategies or resources they believe that can motivate them to consider people with cognitive disabilities in their projects. It was surprising that 79.8% (N = 71) indicated that guidelines or recommendations could motivate them, followed by an increase of knowledge about the characteristics of cognitive disabilities, answered by 67.4% (N = 60) and a better understanding of how to apply in practice stablished recommendations to this audience, pointed by 58.4% (N = 52) of respondents. Only 22.5% (N = 20) demanded content translated into Portuguese, which may evidence that language is not a barrier to understand the existent guidelines and materials. On **Figure 10**, it is presented the distribution of answers.

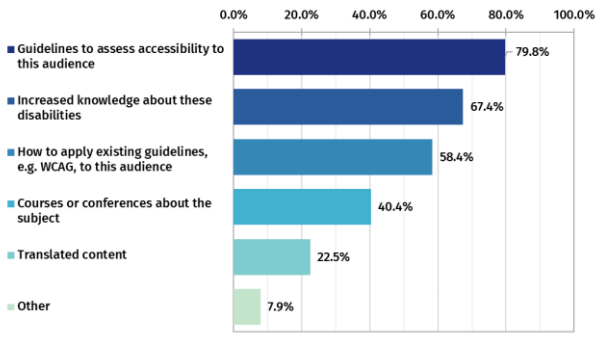

Figure 10. Distribution of responses to Q7: What do you think would motivate you to consider people with cognitive disabilities in your projects?

A factor that may impact how web development professionals consider people with cognitive disabilities is how they understand and consume content related to accessibility in general.

Thus, we asked all participants in Q9 how they understand the following supporting materials: WCAG guidelines (Ferraz & Bechara, 2014), COGA guidelines (Seeman & Cooper, 2015), WebAIM content and guidelines (WebAIM, 2020b), scientific papers and technical posts. Surprisingly, 33% of respondents (N = 35) does not know WCAG at all and 13% (N = 14) never used it, while 21.9% (N = 23) pointed that these guidelines are understandable or easily understandable. The COGA guidelines were barely known for most respondents (62%, N = 65). This result was expected because COGA was a recent task force on W3C at the time of the survey and their material is under development, although the editors have been publishing the content in an open source repository to make the material easily accessible. Similarly, the WebAIM materials and recommendations are unknown by 49.5% (N = 52) of respondents.

The results are more optimist for scientific papers and technical blog posts. For both options, only 8.6% (N = 9) respondents pointed that they did not know this type of content. We could identify that scientific papers are less consumed than technical posts, since that 21.9% (N = 23) of respondents indicated that they never used scientific papers, while 15.2% (N = 16) pointed the same for technical posts.

Regarding easiness of use, the scenario is again more favorable for technical posts, since most respondents indicated they are understandable (31.4%, N = 33) or easily understandable (22.9%, N = 24), while scientific papers are understandable for 22.9%, N = 24 of respondents and easily understandable for only 14.3% (N = 15). We believe that this discrepancy is because scientific papers have a less simplified language than technical posts and because they are not always openly accessible to download. We summarize these results on **Figure 11**.

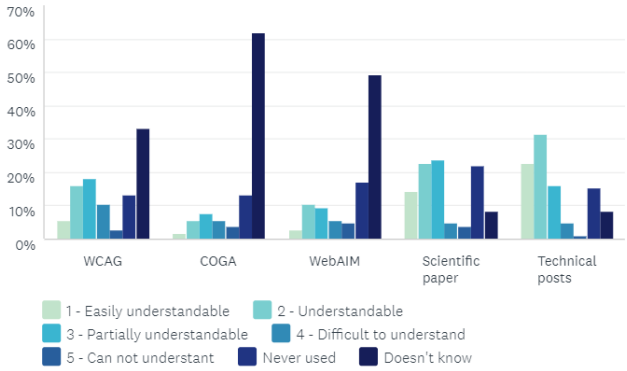

Figure 11. Responses to Q9 related to the level of easiness that participants consider having about guidelines, recommendations and other type of materials.

5.4.1 Motivations by sector

As well as the reasons to not approach users with cognitive disabilities, the possible motivations that could led these professionals to consider these users also differ by sector (**Table 5**).

For respondents from public sector, having access to guidelines to assess accessibility for users with cognitive disabilities was pointed out as the main motivation this audience (75%, N = 9) while understanding how to apply recommendations such as WCAG was indicated by 66.7% (N = 8) of respondents and the need of translated content was reported by 58.3% (N = 7).

The need to have a better understanding of WCAG may be related to the fact that none of the respondents from this sector consider WCAG as easily understandable. It is worth noting that more than half of the practitioners from public sector demand translated materials regarding cognitive accessibility, while only ~17% respondents from private sector indicated this option as one of their motivations.

In the private sector, the majority of respondents (78.5%, N = 51) also indicated as main motivation having specific guidelines related to cognitive disabilities, followed by the need to have an increased knowledge about cognitive disabilities to better understand them (70.8%, N = 46).

In the third sector, guidelines were pointed out as main motivation by all respondents, while both increased knowledge and the need of courses or conferences about the subject represent 66.7% (N = 2) of the responses. Self-employed professionals also indicated guidelines as their primary motivation (88.9%, N = 9) and the need of knowledge and courses as second motivation (66.7%, N = 6).

Respondents from all sector demonstrated they want to have a better understanding about cognitive disabilities. Thus, we can infer that there is a demand beyond technical practices and recommendations, but also related to the context of use and the importance to approach this audience.

5.4.2 Level of understanding about supporting materials by sector

When analyzing the responses to Q9 by sector, we identified noticeable differences in the level of knowledge and easiness regarding the supporting materials.

Professionals from private sector demonstrate an evident unfamiliarity about WCAG. From respondents who possibly used it at some point, only 6% (N = 3) indicated WCAG as easily understandable and 16% (N = 8) as understandable, while 14% (N = 7) consider these recommendations difficult to understand and 6% (N = 3) as a content they cannot understand. While only 10% (N = 5) demonstrated being unaware about technical posts, 33% (N = 17) informed they do not know WCAG. On the other side, technical content, which tend to be specific and present a practical language, were considered easily understandable and understandable by 24% (N = 12) and 29% (N = 15) for respondents from this sector, respectively.

In the public sector, no respondent indicated WCAG as easily understandable neither difficult to understand, and 27% (N = 3) consider it equally as understandable and partially understandable, while only one respondent (equivalent to 9%) pointed it as a content that cannot be understood. We noticed that respondents from this sector may also be more familiar with technical posts as respondents from private sector, since 27% (N = 3) consider such materials as understandable, although 27% (N = 3) indicated them as partially understandable. Scientific papers were considered partially understandable by 45% (N = 5) of respondents from this sector.

In the third sector, besides the low rate of respondents, we noticed a distinct scenario from the previous two sectors. The WCAG was considered easily understandable by half of

Table 5. Distribution of answers to Q7 by sector. The N refers to the respondents who answered the question, not all respondents from the sector.

	Sector			
Motivation	Private Sector (N = 65)	Public Sector (N = 12)	Third Sector (N = 3)	Self-employed (N = 9)
Guidelines to assess accessibility to this audience	78.5% (51)	75% (9)	100% (3)	88.9% (8)
Increased knowledge about these disabilities	70.8% (46)	50% (6)	66.7% (2)	66.7% (6)
How to apply existing guidelines, e.g. WCAG, to this audience	55.4% (36)	66.7% (8)	100% (3)	55.6% (5)
Courses or conferences about the subject	36.9% (24)	33.3% (4)	66.7% (2)	66.7% (6)
Translated content	16.9% (11)	58.3% (7)	33.3% (1)	11.1% (1)
Other	7.7% (5)	16.7% (2)	0% (0)	0% (0)

these professionals (N = 2), as well as technical posts. We hypothesize that practitioners from third sector work specifically with accessibility in NGOs, therefore, they have an increased experience and knowledge on accessibility.

5.5 Comments from respondents

Our survey had three open-ended questions in our survey, Q5, Q8 and Q15 (in the set of demographic and background questions), being Q5 for respondents who consider users with cognitive disabilities, Q8 for respondents who partially consider or do not consider such users and Q15 for all users at the end of the survey. Additionally, Q6 and Q7 had an option "Other" to allow participants to provide answers not contemplated in the set of options and had relevant insights.

We present in this section some interesting comments that caught our attention in some of these questions. On Q5, we only had four answers that we discussed on Section 5.2. As mentioned in Section 5.3, 9 answers on Q6 showed that some participants never thought about accessibility about people with cognitive disabilities. One of the respondents answered:

> "For many times I do not realize that the interface should also be thought for this audience. When we think of accessibility, we think first about physical disabilities, such as blindness."

This demonstrates a genuine lack of knowledge that may be solved by approaching more aspects about cognitive accessibility on guidelines and recommendations such as WCAG. However, when the problem is related to organizational culture, it can be challenging to deal, since it is related to a mindset shared by most people who work on the organization. Some answers to Q9 related to cultural barriers are:

> "Providing web accessibility, in general, is not a culture still present in the institution where I work."
>
> "It is not part of the common culture to consider these people in planning."

When people did not think about users with cognitive disabilities due an environment that do not promote a culture about accessibility, people may be more reluctant to see the value of these users. This was identified on the 7 answers of Q7 to the option "Other". When tagging the answers, we identified the following aspects presented by respondents that could motivate them: a) being proved about the needs of users with cognitive disabilities (4 answers); b) having real contact with these users (2 answers); c) having specific legislation (1 answer). Related to prove the needs, some of the answers were:

> "Being convinced that these people also want to access the content we develop for the general public."
>
> "Access to statistical material presenting the weight that this audience represents."
>
> "[Understand] real needs of this audience and how to recognize that this audience is a potential user for a particular project."

On Q8 we asked optionally if the participants who do not consider users with cognitive disabilities had something more to share about their challenges and personal barriers. We had eight answers and the responses varied. One of the participants reported the thought about the study:

> "I do not know much about this specific public. I can work with the visual and hearing impaired with no problems but at no time did I stop to consider this audience. I found the proposal interesting, but I do not know if there is study material for it."

Another participant commented about the difficulties to approach users with cognitive disabilities and the benefits of using guidelines:

> "Few people really think about this type of audience. But I even understand, because thinking interfaces for all types of audience would give a lot of work and designer is not the person with more time in a company. The idea of the specs would help a lot. Designers follow standards, creating one for accessibility would be great."

And another participant commented about an interesting idea about collaboration:

> "I believe it would be of great value to create a community that can test and give feedback on the correct application of inclusive practices and their outcomes."

Finally, we asked optionally in Q15 the perception of participants about the study. Part of the 35 responses surprised us since some participants pointed out how they wanted to learn more about cognitive accessibility after participating of the survey (4 answers) and how they already had learned something (8 answers). Some of the answers were:

> "[The study] made me think that I really disregard a part of the population."
>
> "It was good to see how much I'm uninformed about it."
>
> "It may seem strange, but the fact that I did not know how ignorant I was on this subject made me a little uneasy. I need to make up for it!"

> "It reminded me of a reality that unfortunately we forgot easily, it was very productive in my case."
>
> "I really liked the theme, I sincerely even aroused my curiosity about it. I will start to research more about this audience and how to include them in the scope of my personal projects and who knows, even in the projects where I work for the company."
>
> "It aroused interest in further study and acquiring knowledge about some disabilities that I did not know could be designed for them."
>
> "Cool. It made me think of things that I did not consider before, from now on I will research more about it while developing websites and games."

Through these responses, we can observe that web professionals may have a low awareness level about cognitive disabilities due to the lack of content that addresses the subject and corrects the misconception that web accessibility techniques are mostly related to visual disabilities. In the following sections, we discuss the results and compare certain information with related works.

6 Discussions

We could identify three biases that potentially prevent web development professionals from considering people with cognitive disabilities in their projects:

a) difficulty to consider people with cognitive disabilities as part of their target audience;

b) well stablished web accessibility guidelines, such as WCAG, are still unknown by many professionals, especially from private sector;

c) organizational culture barriers;

The results of the survey presented in the previous section evidenced the need to raise awareness of the Brazilian web development community about cognitive accessibility prior to provide technical artifacts and computing solutions for cognitive disabilities. Web professionals – from practitioners to educators – not only are unaware about web accessibility in general, but also have a limited knowledge about cognitive disabilities. Some participants reported that the lack of the knowledge or real-life contact with people with these disabilities is something that creates a barrier which prevents them from approaching these users in their projects.

On Q3, we asked the 16 participants that consider people with cognitive disabilities what were their motivation to deal with this audience. Though the most prominent answer was that they understand these users as part of their audience (68.8%, N = 11), we noticed different patterns when segmenting the answers by the sector of the participants.

Respondents from the private sector or self-employed professionals consider people with cognitive disabilities mainly by personal motivation. On the other hand, respondents from the public sector and private educational institutions, pointed as main reason that they understand these users as part of their audience.

Related to the public sector, the respondents from IT department in public bodies also had as motivation the compliance with federal accessibility laws. It was interesting to observe that the motivation differed drastically according the sector.

Considering the technical materials that help web development professionals to consider people with cognitive disabilities, WCAG is still the most used resource. Techniques derived from scientific papers and technical articles, such as blog posts, were indicated in the same proportion (50%, N = 8, for each material), mainly by professionals from private sector who work at software companies, self-employed professionals and from public educational institutions, which is an interesting pattern given this disparity in performance.

When asking the remaining 84 participants in Q5, the major reason these respondents did not address people with cognitive disabilities is the lack of knowledge about these disabilities and their respective characteristics. This issue already was hypothesized by other authors (Friedman & Bryen, 2007; Lewis, 2006, 2009).

However, it is worrisome to see that more than half of respondents, particularly private sector professionals, have indicated that their respective companies do not consider people with cognitive disabilities to be part of the target audience. Next, there is also the fact that 26% of respondents do not personally consider these users as part of the target audience. Misinformation is a barrier to the inclusion of users with cognitive disabilities (Lewis, 2006, 2009; Seeman & Cooper, 2020b), as many developers still perpetuate the stigma that they are not part of their audience.

Our study has shown that, in fact, issues that prevent professionals from specifically addressing people with cognitive disabilities differ in some respects from the motives that prevent them from addressing accessibility in a wider context. That is why there is a need for this type of study and to do it more broadly.

While other studies revelated the lack of time and training as the greatest obstacles to address accessibility (Antonelli et al., 2019; Freire et al., 2008; Lazar et al., 2004; Putnam et al., 2012), our study showed that the greatest difficulty on accessibility for cognitive disabilities is still the lack of basic knowledge about these disabilities and the lack of understanding or perception that these people are part of the audience. This may be due to the absence of specific guidelines or content that addresses the aspects of cognitive disabilities.

6.1 Addressing the challenges

In this section, we present an analysis of each challenge and proposes to mitigate them, both in the industry and the academia.

6.1.1 Lack of knowledge about cognitive disabilities

The absence of knowledge prevents IT professionals, educators and government employees from approaching cognitive disabilities in their projects. Considering that such

conditions are complex, we noticed that professionals lack content that contextualizes the use of accessibility recommendations and which also demonstrates which practical factors impact on a better user experience for this audience.

A prominent issue identified in the study was the difficulty that web development professionals have while trying to understand the guidelines of WCAG (Ferraz & Bechara, 2014; W3C, 2018), WebAIM (WebAIM, 2020b) and COGA (Seeman & Cooper, 2020a), or even the lack of awareness of some participants about these guidelines. Professionals who already have some awareness about cognitive disabilities largely use the WCAG as their main reference, but they still have difficulty in understanding it.

Scientific papers, although better known, according to the respondents, are also not completely understandable if compared to technical articles. Technical articles, which usually are more objective and easily accessible, have proved to be the most popular materials among the respondents as a resource to support the development of accessible web solutions.

As expected, private sector respondents understand better technical articles from specialized sites than scientific papers. However, about 34% (N = 25 of 72 respondents) do not know the recommendations of the WCAG which, as we believed, was a wide known material and points out technical guidelines. However, professionals may also find barriers to use and apply the content of technical posts if they do not have basic knowledge about accessibility.

Most participants also indicated that they cannot find materials about cognitive accessibility neither are aware of how to include users with cognitive disabilities on their projects, even if they have a basic knowledge.

Another factor that prevents respondents from considering users with cognitive disabilities is the unawareness about the characteristics and needs of this audience, as presented in Section 5.3.1.

These results show that there is indeed a scarcity of apprehensible materials and, although HCI researches have advanced to propose specific guidelines on the subject, there is still a gap of knowledge.

Although existing accessibility recommendations, such as WCAG and eMag, have the intention to support the design of accessible websites independently of the disability the user presents, there are situations where specific approaches are needed. And that is the case of cognitive disability, due to their diversity. Each condition under this umbrella may require a specific interaction need with computational systems.

Understand the differences and nuances of cognitive disabilities can led to accurate requirements for web projects, and may aid professionals to anticipate potential interaction barriers, filling a gap in the current accessibility guidelines that may not address the specificities of these users.

This can be supported by results from our study showing that 1 in 4 respondents who do not address cognitive disabilities indicated that they do not do so because they do not know techniques or recommendations to approach these disabilities and could not find materials on the subject.

Interestingly, most respondents that still do not consider users with cognitive disabilities (~80%) indicated that guidelines could motivate them to ensure accessibility for this audience, but they also pointed out the importance of understanding the characteristics of cognitive disabilities (~67%) and to have practical instructions for using established guidelines, such as WCAG, in the context of these users (~58%).

Our results indicate that the gap is not only to understand the materials but also to understand these disabilities. The absence of specific guidelines is not a novelty and has been criticized by some institutions focused on accessibility (WebAIM, 2013). Even having some sort of guidelines currently (Seeman & Cooper, 2020c, 2020b, 2020a), we can infer by our survey that they may still be below expectations or are not reaching properly the professionals of all sectors in Brazil.

Therefore, advances in researches and proposals of design recommendations are necessary to elucidate to web professionals the needs of users with cognitive disabilities and the barriers they usually face when interacting with websites and web applications, providing contextualized recommendations for different conditions.

6.1.2 Access to content and guidelines about cognitive disabilities

A significant number of respondents who do not address cognitive disabilities on their projects rely more on technical posts rather than scientific papers, accessibility guidelines (WCAG and eMag) or studies published by WebAIM and COGA.

Furthermore, contributions by scientific papers may have restricted access through paywalls, present a language of difficult comprehension by practitioners from industry or lack a practical applicability of the proposed recommendations. Although WCAG has as target IT professionals from different roles, its content is a dense material and can be difficult for people who are starting to study web accessibility.

The Web Accessibility Initiative is aware of the complexity of WCAG, especially for people being introduced to web accessibility (Cooper, 2016), and has been working on alternatives to improve the apprehensibility of its guidelines. One of the improvements are the reports published by COGA (Seeman & Cooper, 2020d) describing user scenarios and personas related to different cognitive or learning disabilities, which contextualize the importance of meeting certain accessibility criteria.

The COGA reports are constantly evolving and keep being written by members of the task force. As well as all documents produced by W3C lately, the reports are currently available on Github (an open source repository) enabling people to track changes on the documents and contribute (W3C, 2020a).

However, we still have a language barrier. Most reference materials with robust content and research results are available only in English, which can affect a large number of professionals in Brazil with low proficiency in this language.

So, it is important to invest on official or community translation to such materials to make these content reachable to a larger audience in Brazil.

Thus, the most relevant strategies to mitigate this gap is the development of content materials and technical resources that are easy to access, have intelligible language and that help professionals to understand not only accessibility techniques, but also the characteristics of people with cognitive disabilities, as discussed on Section 6.1.1.

6.1.3 Organizational culture barriers

In addition to the lack of information about cognitive disabilities, the second most prevalent factor that prevent professionals from approaching users with such disabilities is the fact that the company, institution or public body in which they work do not consider these people as part of their audience. This scenario reflects a recurrent misconception in which companies have difficult perceiving people with disabilities as consumers and citizens who have interests and needs in the same way as people without disabilities and this stigma becomes more evident regarding cognitive disabilities.

This situation can also be related to a view of accessibility as mere legal compliance and not as a relevant strategic view or quality criteria of a digital product. Antonelli et al. (2019) identified a similar challenge, where web professionals do not consider accessibility important and demand being "convinced" that they should approach this audience. In our study, some evidences of the same problem can be found in the comments from participants presented in Section 5.4. Moreover, Yesilada et al. (2015) show that UX/HCI practitioners believe that efforts on accessibility are more encouraged by legislation rather than the perception of benefits in business revenue.

However, legal compliance is not enough to ensure a good user experience for people with disabilities. Companies and institutions concerned solely with compliance are still at an early state of accessibility awareness. Regarding cognitive disabilities, having a strict approach of legal compliance related exclusively to WCAG or eMag may not meet properly the needs of users under this spectrum of conditions, as cognitive disabilities are not yet satisfactorily included in these guidelines.

This idiosyncrasy of the IT industry can be explained by the pyramid of WebAIM's Hierarchy for Motivating Accessibility Change proposed by Smith (2013), as shown in **Figure 12**. The pyramid has seven levels, from bottom to top: Guilt, Punish, Require, Reward, Enlighten and Inspire. The lower the level, the more common is the motivation, however, the less effective it is to address accessibility appropriately.

Guilt is presented as the most common motivation and it is usually the starting point to work on accessibility issues by many companies, followed by Punish. These two levels are closely related to legal compliance and drive organizations to work on the bare minimum aspects of accessibility, usually by remediation rather than having an inclusive mindset.

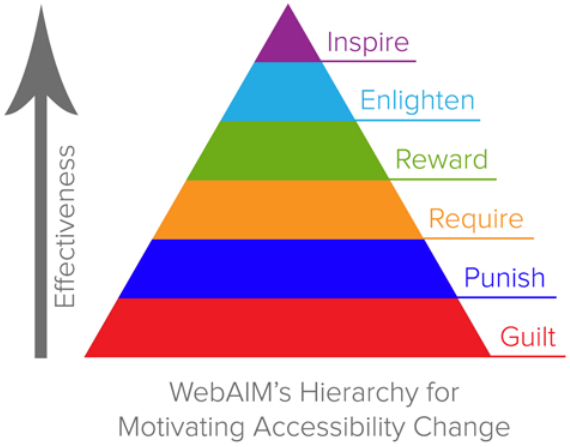

Figure 12. WebAIM's Hierarchy for Motivating Accessibility Change proposed by Smith (2013).

Digital accessibility - in general - is gradually moving from Punish to the Require level in Brazilian companies, in which they are aware of WCAG and legislation plays a supporting role, but the subject is approached as a technical issue restricted to developers, lacking the human factor and multidisciplinary. Evidences of this scenario are pointed by Antonelli et al. (2019). However, when considering specifically cognitive disabilities, our result indicated that we are still in the Guilt level.

Shifting organizational culture is challenging. The topic should be addressed first in the top-level, usually composed by directors, executives and other decision makers of the company. Approaching accessibility in the top-level requires strategic information, such as market analysis, successful business cases and benchmarks. While guidelines, technical posts, use cases and reference guides are key to motivate IT professionals to consider people with cognitive disabilities, data is key to discuss with decision makers.

Strategic information about accessibility and market can be found in relation to global technology companies. However, market analysis focusing on accessibility is scarce in Brazil, as well as official statistics about cognitive disabilities. Some companies and institutions have been working independently on researches about habits of consumers of disabilities (Everis, 2020; Sondery, 2019), but the samples are still misrepresentative and they usually focus on visual disabilities. Thus, partnership between academia and industry is relevant to contribute with further investigations and provide robust results that can be used as reliable reference for every sector.

6.2 Propositions for GranDIHC-Br

To contribute to the next challenges of research in computing and HCI, we summarize our suggestion into the following actions for the roadmap of GranDIHC-Br:

Expand the writing and distribution of learning content in Portuguese about web accessibility to industry professionals, including authorized translations of W3C/WAI (Ferraz & Bechara, 2014) and WebAIM guidelines;

a) Publish results of researches on web accessibility in general and cognitive web accessibility in public repositories or open database, when possible;
b) Develop and promote techniques and recommendations for practical applicability of HCI guidelines in the context of people with cognitive disabilities;
c) Develop specific HCI guidelines, standards and recommendations for Cognitive Web Accessibility;
d) Bring the knowledge about the most common web accessibility guidelines, such as WCAG, to the classroom in undergraduate and graduate courses, making possible the inclusion of this topic in the curricula of courses related to computer science.

6.3 Advances from 2015 to 2020

Although the survey had investigated a perspective not yet studied about web accessibility, there was a significant increase in interest about accessibility from 2015 to 2020 in Brazil due to several milestones, which were not restrict to technology. As the survey was carried in 2015, these events may have an impact on the validity of the results.

The first milestone was the Brazilian Inclusion Law (Brasil, 2015), sanctioned in 2015 with the purpose to ensure and promote the rights of people with disabilities. The law stablished the obligation of accessibility compliance for Brazilian websites on Article 63, thus, it has been since inserted in the agenda of industry and more incisively on government.

In 2016 and 2018, the Brazilian Web Technology Studies Center (Ceweb.br) released the second and third volumes of the Web Accessibility Booklet (Ceweb.br, 2016, 2018), respectively, distributed for free online and on printed copies. The second volume focus on legal aspects, while the third volume focus on best practices on web accessibility considering the particularities of distinct disabilities, including cognitive disabilities, with contributions from members of industry, academia and government, many of them industry experts and researchers on digital accessibility. The booklets focus on a non-technical audience interested in Web Accessibility and, being a content published in Brazilian Portuguese, have a potential to reach a wider audience.

In 2018, the open-source project "Acessibilidade Toolkit" was released in Brazil as a set of tools designed to facilitate the understanding of WCAG (Sales, 2018a; Valerio, 2019). The project translates the WCAG success criteria into cards with an objective language with short sentences and visual organization of the conformance level. The cards can be printed or consulted on the website (Sales, 2018b). The easy language and free availability online may enable WCAG to be better understood by people who are being introduced to web accessibility.

The last remarkable milestone, with a worldwide impact, was the release of version 2.1 of WCAG in late 2018 (W3C, 2018) after ten years since the release of version 2.0, introducing 17 new guidelines related to mobile, touch gestures, rich interactions and aspects about cognitive abilities. Some of the guidelines include concerns about text spacing, motion actuation, identification of input purpose, timeouts, animation from interaction, among others.

In 2020, two books about web accessibility were released in Portuguese. The first one (Pichiliani, 2020) was derived from the master's degree research from which this study is part (Britto, 2016). The book discusses cognitive accessibility and describes a proposal set of web accessibility guidelines with focus on ASD (project GAIA), with adaptations of the content from the dissertation to make it apprehensible for a non-academic audience. The book is associated to a website developed as a reference guide (Pichiliani, 2019), which presents all the 28 guidelines proposed on GAIA, aiding to promote awareness about cognitive web accessibility.

The second one (Ferraz, 2020) presents theoretical content and best practices about web accessibility from planning to testing, also explaining standards and guidelines. Such materials are relevant to reach a wider audience of professionals from different roles in IT and bridge the knowledge gap.

Still in 2020, WAI was actively working in WCAG 2.2 with contributions from the community (Adams, Campbell, Montgomery, Cooper, & Kirkpatrick, 2020; W3C, 2020b). Although in working draft, the proposal additions that benefit users with cognitive disabilities are related to findable help, accessible authentication to reduce cognitive load, redundant entry and avoid hidden controls.

In a span of only five years, we had considerable changes in policies, international guidelines and learning content about web accessibility that embrace cognitive disabilities. Thus, revisiting the study is not only important but it is necessary to identify if web professionals increased their awareness about the subject and what is the impact of these materials.

7 Conclusions

Although the awareness about cognitive accessibility has been increasing in the last few years, it is still less than necessary comparing to the current awareness related to visual or hearing disability, for example. In one hand, researches on human-computer interaction in Brazil have advanced on the development of resources and guidelines about specific cognitive disabilities, such as Autism (Britto & Pizzolato, 2018; Melo, Santos, Rivero, & Barreto, 2017) and Dyslexia (Cascaes et al., 2018; de Santana, de Oliveira, Almeida, & Baranauskas, 2012). On the other hand, professionals involved in the web development industry lack fundamental knowledge about how to design inclusive solutions for people with cognitive disabilities, as we evidenced in the results of the survey. These problems have been perceived by HCI researchers and highlighted in the last GranDIHC-BR forum in 2017, but the reasons were still latent.

This study represents a first step to provide answers to the following questions proposed by Ferreira et al. (2017) in order to contribute with Challenge 2 of GranDIHC-BR: a)

what are the difficulties faced by computer science professionals and researchers to consider users with cognitive disabilities in their projects?; b) what actions can be taken to increase awareness about neurodiversity and the specificities of interaction for these disabilities?

The results evidence that the greatest difficulties are mainly related to misinformation about cognitive disabilities, that led web development professionals to not know properly how to approach the needs of users with these disabilities. Although these professionals have incipient knowledge about the subject, they have interest in knowing more about cognitive disabilities, recognizing their personal limitations. The survey aims to contribute to future researches on cognitive accessibility and neurodiversity by indicating the perception and awareness level relative to this subject, as well as evidence knowledge gaps, suggesting emergent research topics and encouraging researchers to work on fulfilling this gap in the Challenge 2 of GranDIHC-Br.

Despite the study had been conducted in 2015, the results are still valid and have been used to perform a follow-up of the challenges identified as the authors are involved in web development industry. This follow up led to the writing of instructional content on our main project (Britto, 2016), as well the writing of technical articles (blog posts) intended to mitigate the lack of awareness about cognitive accessibility, approaching the pain points identified through the survey.

Besides, no further survey about cognitive accessibility was found until the date, a scenario we expect to change in a short-term period. As a further work, we intend to redesign the survey to ask fewer and better questions without reducing the scope of our investigation. We also plan to work on a rigorous sampling and increase the number of participants, so that we can perform statistical analysis and verify possible correlations.

7.1 Limitations

The major limitation of our study is that we could not ensure if that the number of participants represents the community. Defining the sample size in computer science surveys in Brazil is challenging since there is no official statistics about the number of professionals. However, as a first study about cognitive accessibility in Brazil, we focused less on rigorous sampling number and more on the quality of answers we could gather, specially from professionals in the industry. In a further application of this survey, we plan to do an accurate sampling and expand the number of participants to have more statistical relevance of answers.

Another perceived limitation is the length of the survey, that may be too long and presented redundant questions. Additionally, there was an unbalanced use of open-ended and close-ended questions. In the next survey, it is interesting to have more open-ended questions to gather more qualitative data about the reasons to not consider people with cognitive disabilities.

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