

DM

Designing Accessible Web Interfaces for Autistic People

MASTER DISSERTATION

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INTERNATIONAL MASTER OF INTERACTIVE MEDIA DESIGN



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Resumo

Viver na era digital faz com que o uso da internet e das suas vantagens sejam essenciais no nosso quotidiano. O desenvolvimento de tecnologia tem progredido diariamente e com este, em simultâneo, as necessidades dos utilizadores. Embora tenha havido um progresso significativo na compreensão das necessidades dos utilizadores neurotípicos, há espaço para melhorias na compreensão das preferências de design de interfaces e dos requisitos de acessibilidade para pessoas neurodivergentes, especificamente para aquelas com diagnóstico de autismo. Esta tese focou-se no grupo-alvo de pessoas autistas, uma vez que a internet é considerada um ambiente recentemente adequado ao autismo e oferece às pessoas com autismo uma variedade de possibilidades, tais como interagir com outras pessoas que partilham dos mesmos hobbies e interesses. Também permite a exploração de diferentes fóruns e blogs online, ajudando centros médicos, organizações autistas, comunidades online e tecnologias digitais e ferramentas disponíveis. trabalho teve como objetivo aumentar a acessibilidade digital das interfaces de utilizadores da web para pessoas autistas, de modo a tornar estas plataformas mais fáceis de explorar e de obter informação. Começa por recolher práticas e orientações atuais de design para pessoas com deficiência para, posteriormente, inferir técnicas que designers e desenvolvedores possam utilizar especificamente para o utilizador alvo mencionado anteriormente. In-

cluiu o design e teste das interfaces de utilizador para reunir diretrizes adequadas. Como resultado, fornece uma visão geral das melhores práticas adquiridas ao longo das sessões de teste com este público-alvo. Inclui de igual forma, recomendações de alto nível sobre a criação de conteúdos utilizados nos protótipos digitais para fins de teste, uma vez que, para este grupo-alvo, alguns dos conteúdos podem ser considerados sensíveis.

Palavras-chave: Autismo, neurodiversidade, acessibilidade digital, diretrizes de acessibilidade, recomendações de acessibilidade, design centrado no ser humano

Abstract

Living in the digital era makes using the Internet and its advantages becoming essential in our daily lives. Technology development is progressing daily, and users' needs are changing accordingly. Although there has been significant progress in understanding the neurotypical users' needs, there is room for improvement in understanding the interface design preferences and accessibility requirements for neurodiverse people, specifically those with an autism diagnosis. This thesis focused on a target group of autistic people since the internet is considered a newly autism-suitable environment, and it offers autistic people a range of possibilities, such as engaging with others who share the same hobbies and interests. It also allows for exploring different online forums and blogs, helping medical centers, autistic organizations, online communities, and available digital technologies and tools.

This work aimed to increase the digital accessibility of web user interfaces for autistic people to make these platforms easier to explore and obtain information from. The initial stage of this work collected current practices and guidelines for designing for people with disabilities to infer later techniques that designers and developers can use specifically for the target user mentioned previously. This thesis describes the design and testing process of user interfaces to gather adequate guidelines. As a result, it provides an overview of best practices gained

during the testing sessions with the target audience. It also includes high-level recommendations on creating content used on the digital prototypes for testing purposes, as for this target group, some of the content might be considered sensitive.

Keywords: Autism, Neurodiversity, Digital accessibility, Accessibility guidelines, Accessibility recommendations, Human-centric design

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List of Acronyms

AASPIRE Academic Autism Spectrum Partnership in Research and Education

ADHD Attention-deficit/hyperactivity disorder

AHAT Autism Healthcare Accommodations Tool

App An application

ASD Autism spectrum disorder

AUS Accessible Usability Scale

COGA Cognitive and Learning Disabilities Accessibility Task Force

CSS Cascading Style Sheets

CTA Call to action

Custom. Customization

DSM-5 Statistical Manual of Mental Disorders

etc. et cetera

N. Number

PCS Personal Communications Service

pt Points

SIDE Semiotic Interface sign Design and Evaluation

SUS The System Usability Scale

UI User interface

UX User experience

U.S. United States

WAI Web Accessibility Initiative

WCAG Web Content Accessibility Guidelines

Web. Website

W3C World Wide Web Consortium

Chapter 1

Introduction

1.1 The autism spectrum condition

Around 15% of the world's population, meaning more than one billion people, live with some disability. For example, in the U.S., around one in six kids has one or even more disabilities [14]. Neurodiversity refers to the diversity of all populations, but it is usually used in the context of autism, learning disabilities, and ADHD [15]. Neurodiversity affects up to 7% of the population and impairs individuals' memory, executive functions, cognition, and communication skills [16]. Autism is a neurological disability defined by impairments in social relating and communication, uncommon responses to sensory stimuli, and stereotypical and repetitive behaviors. People who have an autism diagnosis might face difficulties in learning, communication, and behavior. Autistic people also have various abilities and strengths [15]. Some neurodiverse individuals are creative and have visual-spatial skills, innovative thinking, and attention to detail [16]. Some autistic people have a standard or above-average intelligence quotient and can communicate verbally and live independently. Vice versa, some people might struggle in communication, are more dependent on others, and may have impairing behavior, but it can differ individually [15]. This disability affects both genders, females and males, influencing people's understanding of what is happening around them and their world. Autism is a lifelong disability. [17].

Statistical Manual of Mental Disorders (DSM-5) defines the following three cat-

1.1 The autism spectrum condition

egories, described in table 1.1, for autism spectrum disorder based on the extent of support that the autistic person needs [12].

Table 1.1: Overview on categories for autism spectrum disorder [12]

Description	Category 1	Category 2	Category 3
Support	Support is required.	Substantial support is required.	A very substantial support is required.
Social communication	Difficulties initiating social interactions, and without support, they face a deficit in social communication, which causes noticeable impairments [12].	Considerable deficits in verbal and nonverbal communication, even with support, there are marked social impairments and limited initiation of any social interaction [12].	A very limited initiation of any social interactions with a limited response to social initiations of other people. There is a severe deficit in verbal as well as nonverbal communication [12].
Restricted, repetitive behaviors	Difficulties with organization, planning, and switching between different activities [12].	Repetitive behaviors are apparent to the casual observers due to their frequent appearance during the interactions. Difficulty coping with change and difficulty changing action or focus [12].	Extreme difficulties coping with change, great difficulty and distress changing action or focus, and inflexibility in behavior [12].

Autism might be identified around 18 months in childhood [18]. Due to the medical tests during general medical appointments and increased awareness about autism spectrum conditions, adults have been diagnosed with autism earlier. Since the middle 1980s, the number of autistic people has risen worldwide, from 1 child out of 2000 to 1 in every 54 children in the U.S. who have autism (Based on the U.S. Federal Centers for Disease Control, March 2020) [18].

1.1 The autism spectrum condition

Lawson [19] defines the following cognitive processes informing the experience of autism spectrum condition: literalness, monotropism, non-generalized learning and thinking in closed pictures, non-social priorities, difficulties with motion and time, and difficulties with the theory of mind. These aspects are detailed in Appendix A.

Autistic people tend to prefer monotony in their routines and environment. Supportive social networks, such as friends, family, and social services, are essential factors in the quality of their lives. Nevertheless, they are usually not prioritized or accommodated by the supporting services, which can lead to a lack of sufficient support and underestimation of their needs [20]. Assistive technology can be a helpful and valuable tool for people on the autism spectrum. Assistive technology tools can help autistic people with routine tasks, learning, communication, greater independence, and support with everyday activities [21]. Some useful assistive technologies are software for voice recognition, screen readers, or augmentative and alternative communication systems that support autistic people with communication. These systems can be simple picture exchange systems or include more advanced speech-generating devices that can vocalize symbols or text by users' input [22]. Additional assistive technologies autistic people use are speech-to-text tools, eye-tracking communication systems, visual timers, audiobooks, etc.[23].

Strengths of autistic people

Autistic people have many abilities, strengths, and skills. For example, some autistic people are good at playing instruments, programming, solving complex problems, art, and other activities [24].

Everyone is different, but some standard abilities and strengths of autistic people are:

- Thinking about things clearly and rationally. Having attention to detail.

1.2 Usage of the Internet by autistic people

- Having potential for academic excellence, especially in complex fields of study, due to their ability to solve complex problems. Having an ability to absorb and hold information.
- Being very honest, punctual, loyal, truthful, and reliable.
- Having good expertise and detailed knowledge in different topics which interest them.
- Having a high level of creativity. Bringing new innovative approaches to learning. Having great methodical approaches and skills in science, music theory, physics, or math.
- Having emotional, mental, and physical strength and resilience.
- Having a concentrated focus, for example, on the activities they like, they can spend a long time [24].

1.2 Usage of the Internet by autistic people

The Internet offers autistic people a range of possibilities, and it is considered a newly autism-suitable environment, which has the potential to influence the lives of autistic people positively [25]. It brings people on the autism spectrum the opportunity to engage with others who share the same hobbies and interests since they usually have specific and more systematic interests than non-autistic people. The Internet may offer autistic people an opportunity to explore all of these special interests and a chance to explore different online forums, blogs, discussion boards, help medical centers, autistic organizations, online communities, and available digital technologies and tools. Through Internet surfing, autistic people could learn about neurodiversity and participate in different events and

organizations that view autism as a valuable and unique aspect of human diversity and empower autistic people to challenge the societal conceptions of autism. [25]. Another research suggests that different digital technologies can benefit people with disabilities; for example, for people with cognitive impairments, it can increase their ability, independence, and quality of life [1]. The Internet has motivated autistic people with high support needs to communicate with each other [20]. “Chatting on line allows me to use the best parts of my social skills; my intellect, and my deep sense of empathy; without having the anxiety of talking to someone face to face. Without the anxiety, my communication is much clearer” [26]. “I do love the Internet, because at least I get SOME social contact this way. For whatever reason I’m much less scared with it than in real life” [26].

People on the autism spectrum are generally aware of their challenges during social interaction, and the Internet can allow them to contact a peer group, which they might find challenging under the usual circumstances [20].

1.3 Research questions

During the software creation, there is a need to design and develop solutions that meet users’ needs and goals. Additionally, these solutions should consider accessibility to ensure that tools are accessible, easy to understand, and satisfactory, regardless of user limitations [14]. There is limited empirical evidence about the web accessibility requirements for autistic people. Most studies generally focus on the accessibility and usability of websites for disabled people, mainly for color vision deficiency and visual impairment. Still, only a few are considering specifically people on the autism spectrum. These are a few ongoing initiatives about designing accessible websites for this target group [27]. Another challenge was found among the professionals working with website design and development.

1.3 Research questions

There needs to be more knowledge and understanding of the website accessibility guidelines and the needs of the target group, people with disabilities [1]. The Internet is one of the critical tools for autistic people since it allows them to find information about different organizations and seek help. There are several questions regarding the topic of accessibility, which this dissertation will focus on, explained in Table 1.2.

Table 1.2: Research questions

Questions	Explanation
Are the current websites with autistic content accessible and usable for people with an autism diagnosis?	Chapter 2 provides an introduction to website accessibility and an overview of the available research on website accessibility and usability, focusing on websites with autistic content. Unfortunately, some websites with autistic content are not accessible.
Are there already existing digital tools, such as websites or Apps, following accessibility recommendations?	The positive news is that there are already existing initiatives, but the autism spectrum condition is the area with the potential to create more specific guidelines for this group of users. Some of these initiatives are explained in Chapter 3.
Are there existing guidelines about web accessibility for people on the autism spectrum? What do these target users want?	It is crucial to include the target audience in the testing process to understand the competence of the website and future usage.
How can we design web platforms that will be accessible to people on the autism spectrum?	To answer these questions, the following dissertation objectives were stated.

Dissertation objectives:

- Collect and understand current web accessibility practices for people with an autism diagnosis.

- Design and test web user interfaces according to guidelines that improve accessibility for this target group.
- Summarize the most successful and adequate guidelines for the target audience.

Relevant stakeholders can use these guidelines as a basis for designers and developers to understand the preferences of autistic people and help them adjust or develop websites that are accessible and usable for people on the autism spectrum.

1.4 Structure of the document

Chapter 2 describes digital accessibility and its importance. It explains possible cognitive barriers for people with cognitive disabilities and their potential consequences. This chapter also includes information about the accessibility and usability of websites with autistic content. Chapter 3 describes projects related to the accessibility of digital tools. Chapter 4 describes already existing accessibility guidelines for people with cognitive disabilities. These guidelines will be used as a base for designing the prototype, as explained in Chapter 5 - Methodology. Furthermore, Chapter 6 explains the design thinking process framework and its results in detail. Chapter 6 also describes the testing process using two different testing methods. Chapter 7 discusses the main findings from the testing sessions. Chapter 8 provides an overview of design recommendations for autistic people, and Chapter 9 concludes this research paper.

Chapter 2

Digital accessibility

2.1 Web accessibility and usability

Web accessibility is how technologies, tools, and websites are designed and developed so that people with different disabilities can use these products to understand, perceive, interact, and navigate through the website [28].

Accessibility addresses possible discriminatory conditions for equal user experience for persons with disabilities. In other words, web accessibility means that users can equally interact with the tools and websites and similarly contribute without facing barriers [28].

Usability is about designing efficient, effective, and satisfying products. It includes user experience design, consisting of general conditions that impact everyone and not only the effect on persons with disabilities [28].

The website might be accessible but not usable since accessibility does not signify usability [29]. The combination of accessibility and usability is considered usable accessibility, and it produces design, which is also called universal design, or in other words, design for all. Universal design includes designing products that everyone uses, and there is no need for additional adjustments. Generally, usability concerns website and other applications' satisfying, effective, and efficient design. Accessibility is focused on the condition related to equal user experience on the website for people with different disabilities [29].

People with cognitive disabilities might face cognitive barriers while searching

2.1 Web accessibility and usability

the Internet, especially websites. Still, it was found that even people without any cognitive disabilities can benefit from cognitively accessible websites [1]. For example, a third of participants in the survey, who considered themselves as not having a cognitive disability, found the website either complex or even complicated to use. This group of people was experiencing similar issues as people with cognitive disabilities. There is no straightforward relationship between distinct barriers on the website and particular cognitive diagnoses. For example, two people with the same cognitive disability could have different preferences and needs when using the Internet. Sometimes, people with and without a cognitive disability can face the same accessibility barrier [1].

There were identified several usage needs that are recommended to take into consideration when creating design guidelines, which include the following cognitive functions: reading, directing, focusing, and shifting attention, writing, recalling from short-term and long-term memory, managing time, making choices, comprehension, tasks completion [1].

Figure 2.1 displays how one of the common reasons for websites being not accessible is a lack of awareness about the importance of accessible websites, which leads to the lack of knowledge among web professionals and people who need to make this decision. This means a lack of accessible services and websites, which causes people with cognitive disabilities to be unable to use the websites. This can lead to the feeling of invisibility, which can cause a feeling of even further exclusion [1]. The good news is that the topic of software accessibility and its importance is supported by some initiatives, including education, where some of the courses and modules include accessibility in the course curricula, for example, in courses such as human-computer interaction, web design, mobile app development, software engineering, and others. The room for improvement is accessibility for neurodiverse people since neurodiversity is often not included in

2.1 Web accessibility and usability

the mentioned initiatives. Some surveys suggested that neurodiversity has the lowest inclusion rate in the courses focused on accessibility. [30]

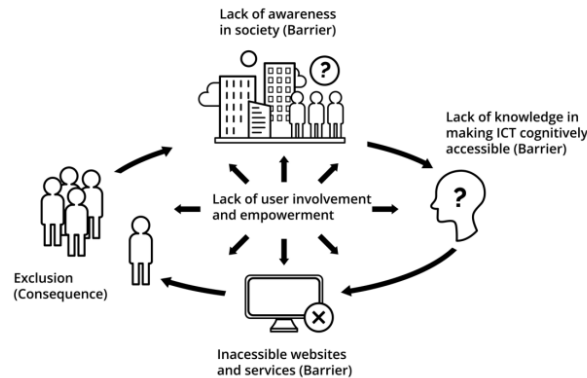


Figure 2.1: Cognitive barriers and consequences [1]

Some of the available standards, for example, standard EN 301 549, pointed to by accessibility legislation, have only partial coverage regarding cognitive user needs. Other EN 301 549 and WCAG 2.1 standards include these users' needs at the AAA (nonnormative) level. The W3C has a particular COGA Task Force group working on the requirements for people with cognitive disabilities. There is no official agreement on what specifically users with cognitive disabilities can be covered through web accessibility requirements meaningfully [1].

The following overview shows disability prevalence and current web accessibility indicators in specific countries:

United Kingdom: 1 in 5 people have a disability. Less than 1% of websites' home pages are accessible.

United States: 1 in 4 people have a disability. Around 30% of websites are considered to have critical accessibility issues.

Canada: 22% of the population have a disability. Approximately 3% of websites are accessible.

Australia: 1 in 6 people have a disability. Around 1% of websites are accessible.

2.2 Accessibility and usability of websites with autistic content

France: 1 in 5 people have a disability. Around 2% of the websites are accessible.

Germany: 1 in 6 people have a disability. Around 3% of the websites are accessible.

Spain: 8.5% of the population have a disability. On average, there were around 51 accessibility errors on each web page [31].

There exists an official requirement from The European Union Directive on the accessibility of mobile applications and websites, which requires European Union member states to ensure their mobile apps and websites meet common accessibility standards. It uses the four principles of the Web Content Accessibility Guidelines (WCAG) 2.0.: perceivable, operable, understandable, and robust. Each country has particular laws that conduct private and public sector web accessibility in more detail [31].

There was identified as the most important recommendation for improving the usability and accessibility of the information and communication technologies, including targeted user participation in the design and development process and creating the personas that are used in UX design processes, which would help with the fictional representation of the targeted user for which the website will be developed [1].

2.2 Accessibility and usability of websites with autistic content

As mentioned in the previous chapter, autistic people might face communication, behavioral, and social challenges [2]. Apart from that, autistic people might face different challenges during their interaction with websites. For example, sensory (related to visual and auditory processing) or information overload can lead to problematic behavior or even meltdowns. It can be a daunting experience for

2.2 Accessibility and usability of websites with autistic content

autistic people to access information with distractive content, such as blinking, flashing, and flickering information interfaces. There is a need for website data to be presented adequately for people with cognitive disabilities. There were established guidelines for website design focused on people with disabilities, including people on the autism spectrum, that should help this target group understand, navigate, and interact with the website. Nevertheless, it is still challenging for designers to create a user-friendly website for people with autism spectrum condition without knowing the most influential features and their configuration [2]. Autistic people tend to have exceptional attention patterns and experience difficulties in reading comprehension. An eye-tracking study investigated if there are some differences between autistic people and non-autistic control participants when it comes to the proportion of time spent while looking at the images included in thirty-nine texts and image pairs. The results of the study are below [32]:

- Autistic people spent more time on images than non-autistic people, confirming a different attention pattern for this group. People on the autism spectrum spent around 20% of their time looking at the pictures and almost 80% reading the text. The non-autistic group spent about 13% of their time looking at the images and 87% reading the text.
- Symbols and photographs were equally appropriate for easy-to-read documents for people with autism spectrum condition.
- Autistic people faced more difficulties reading chosen texts and showed more diverse answers on the difficulty levels.
- Almost 59 % of autistic people preferred including images in the text. Almost 24% of these preferences used photographs, and around 35% preferred texts, including symbols [32].

2.2 Accessibility and usability of websites with autistic content

In another eye-tracking study [33], researchers tested eight chosen websites with the participants' group consisting of nineteen people on the autism spectrum, who are highly independent and verbal, and nineteen neurotypical people. This study focused specifically on the autism spectrum condition because it is one of the least discussed disabilities within the cognitive disabilities group. It was found that these two groups of participants have differing patterns of visual processing for the browsing tasks and the synthesis. It was observed during synthesis tasks that autistic people make more transitions and have higher fixation times, which influences imposing a heavier cognitive load. People on the autism spectrum tended to look at less relevant elements (when considering the factors unrelated to the specific tasks asked) during task completion. These tasks viewed the pages with not easily distinguishable features and the visually complex pages. When autistic participants were asked to browse the web pages freely and focus on the aspects they found interesting, the number of transitions and fixations was similar to that of the non-autistic group. The only difference was that autistic people had longer fixations. Compared to neurotypical people, they tend to show different behavior when searching for specific elements on websites or when they freely browse sites without a particular time limitation. This confirms the need for web accessibility manuals and guidelines for people with an autism diagnosis. This study showed that low distinguishability and the high visual complexity of web page elements influence autistic people during task completion [33]. In another study [34], researchers focused on understanding if website users with an autism diagnosis experience barriers when searching for different website information. The researchers compared eye tracking data gained during several defined tasks for participants' whole searching on the website, for example, asking the user to find a contact number for further support and assistance. Thirty-six people participated in the study (18 non-autistic people and 18 people with an autism

2.3 Comparison of the websites' accessibility and usability for websites with autistic content

diagnosis, adults who are regular web users). The results of this study show that there are existing accessibility barriers for people with autism diagnosis. There is a difference between the suggested two groups of participants. Non-autistic participants were more successful in locating the information they were asked for. In contrast, the autistic participants were less successful, with a higher variance of the scan paths when searching for the specific answer within the website. Non-autistic users followed the exact directions to find requested information on the web pages. This study suggests that autistic people may face difficulties when searching for information on websites under a time limitation. One of the reasons for this heterogeneity found among the autistic participants could be due to the speed at which they tend to focus more on irrelevant details, which could potentially cause higher complexity when searching for contact information and other requested information, even if not required for completion of the task [34].

2.3 Comparison of the websites' accessibility and usability for websites with autistic content

Dattolo et al. [29] systematically compared the usability and accessibility of the websites for autistic people. In this research, 21 websites were chosen, and the authors aimed to follow the distinctive accessibility standards of the World Wide Web Consortium (W3C). Most of these websites contained autism-related topics and were websites of autism conferences and associations with a target group of autistic adults, parents, and researchers. They found that some of the stated websites had similar or the same features, for example:

- Navigation was consistent on all websites but not simple.
- Some sections used simple language, but in some website sections, many

2.3 Comparison of the websites' accessibility and usability for websites with autistic content

links led to external sources and included a massive amount of information.

- Some websites included many secondary, not simplified content without any feedback option.
- Some websites included many pictures but did not lead to external sources. The other websites lacked images to support the text information.
- The text was usually long, including much information, except for a few examples.
- Some of the websites included even moving text features.
- On some websites, the design layout was complicated and should have been simplified [29]

Only two websites followed most of the accessibility and usability guidelines, but they did not include engagement parts on the website, and the tasks were not divided into sub-tasks. Two websites fulfilled the graphical design layout requirements, but in some parts, their text content was very long and should be simplified. The navigation was generally consistent, but it would be recommended to use more buttons. These websites excluded any user engagement. Apart from some exceptions (websites that included broken links), most websites were available. Sometimes, the websites needed resizing and working correctly on mobile devices [29].

In another conducted study [2], there were evaluated six hundred autism-related websites. There were created four main website categories:

Autism Focused: this part included fifteen websites from the comparative study mentioned in the previous section [29].

U.S. Federal: included 287 federal websites, which met the minimum regulatory requirements for people with disabilities.

2.3 Comparison of the websites' accessibility and usability for websites with autistic content

Google Autism Search: included 120 websites shown in the Google search when searching for the keyword "autism-friendly websites."

Alexa Ratings: included the top 178 U.S. websites, generated based on Alexa web traffic in October 2017 [2].

The researchers' hypothesis was as follows: The most autism-friendly website would be the autism-focused category, followed by the U.S. Federal, followed by an Autism search on Google, and the most autism-unfriendly would be an Alexa Rating category. This would be based on the average website autism spectrum condition rating per each group. The total number of tested websites was six hundred. Figure 2.2 displays a pie chart to understand better the number of websites and the percentage of websites by category [2].

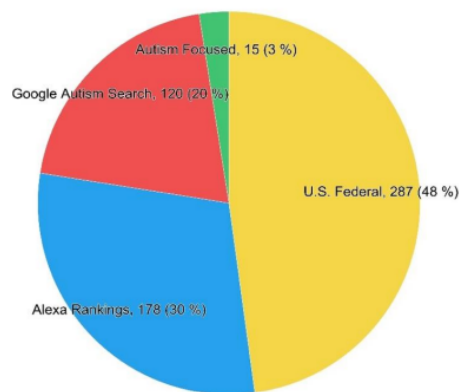


Figure 2.2: The number and percentage of websites by category [2]

There were grouped user requirements into three main categories: image metric, animation metric, and font value, which scores are a uniformly weighted average of their defined component metrics (they measure the proportion of property's friendliness ranging from 0 for the most-friendly score to 1 for the least friendly score). The final autism spectrum condition website rating can be seen in Figure 2.3: [2].

Based on this rating score, the distribution of all six hundred tested websites is

2.3 Comparison of the websites' accessibility and usability for websites with autistic content

	Most Friendly -----> Least Friendly				
ASD Website Rating	1	2	3	4	5
ASD Proportion	0.0–0.19	0.20-0.39	0.40-0.59	0.60-0.79	0.80-1.00

Figure 2.3: Websites' rating score [2]

displayed in Figure 2.4.

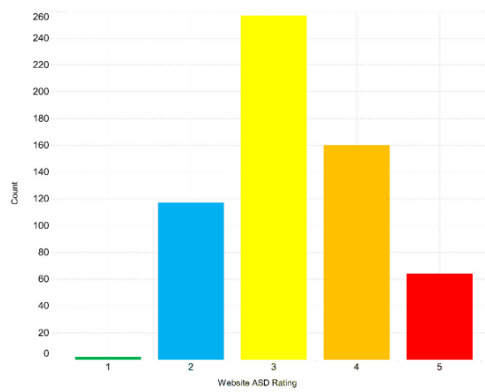


Figure 2.4: Histogram displaying six hundred tested websites on the defined scale for website autism spectrum condition rating [2]

Figure 2.4. shows that only 20% of tested websites are considered autism-friendly (1 to 2 on the autism spectrum condition rating score). 37% of the tested websites are deemed not autism-friendly (4 to 5 on the autism spectrum condition rating score). The rest of the websites belong in the middle of the autism spectrum condition rating score. The researchers' hypothesis was not confirmed since the Autism focused category was expected to have the best score. The results show that these websites have the lowest website autism spectrum condition rating (3.07) with a 95% confidence interval, which falls between ratings 2-3. The other three websites have a 95% confidence interval of rating 3. Researchers mentioned that the relationship between website autism spectrum condition ratings and website categories is not statistically significant [2].

Chapter 3

Related work

3.1 AASPIRE Healthcare Toolkit

AASPIRE, Academic Autism Spectrum Partnership in Research and Education, designed and implemented the Healthcare Toolkit project, which consists of a website with informational content [3]. It consists of AHAT, the Autism Healthcare Accommodations Tool. This tool is an online survey tool that is accessible and collects information, based on which it generates a customized report for the health care providers. This tool is based on the community participatory research approach to improve the accessibility of websites for people with an autism diagnosis. This tool might be used as a living laboratory and help develop the AASPIRE Web Accessibility Guidelines for Autistic Web Users. These accessibility guidelines (which consist of recommendations for increasing the intellectual, physical, and social acceptability of websites) are available in a theoretical way, have been tested with targeted users, people with autism spectrum condition (170 autistic people evaluated this website), and were empirically evaluated, using the evaluation surveys and usability study. The learnings from the AASPIRE Healthcare Toolkit project were compiled in the AASPIRE Web Accessibility Guidelines, which are included in Chapter 4.

Figure 3.1 displays the website's home page [3]. In Figure 3.2 is displayed the personalization panel [3].

The results show that almost all autistic users (97 %) found the website easy to

3.2 A tourism website

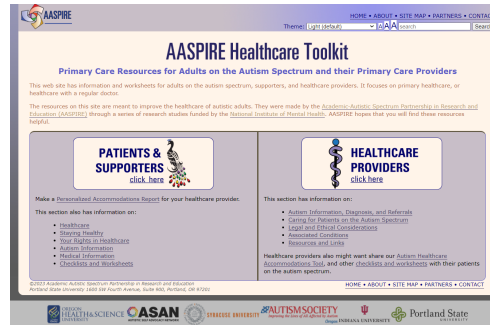


Figure 3.1: Website's homepage [3]

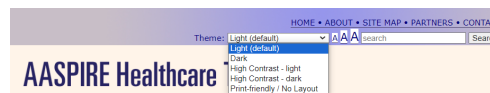


Figure 3.2: Personalization panel [3]

use, 97 % of participants found it meaningful, 95 % found it easy to understand, and 96 % found it helpful. 95 % of participants would recommend this website to healthcare providers, and 92 % of users would recommend this website to a friend [3].

3.2 A tourism website

Dattolo et al. [4] followed in their study World Wide Web Consortium (W3C) general website usability and accessibility guidelines and designed a tourism website accessible for people on the autism spectrum. This project was done in collaboration with the therapists and center, which helps people with different neurological and physical disabilities, including autism, Asperger syndrome, and mental retardation. The graphical layout of the website is shown in Figure 3.3. It is simple and understandable, with enjoyable elements. The background color is white, with orange and blue colors used on the simple bars. A simple font with a big size was used, with various uppercase letters, to make reading the text more accessible. Content is written in simple language, with short sentences, without

3.2 A tourism website

any abbreviations or acronyms. Photos and pictures relevant to the content are included on the pages to support the content's comprehension. The pictures show practical experiences or actions familiar to the user so the user can visually prepare for the occasion. If the users click on the logo or the back command, which is included on some web pages, they can return to the home page. Following the general recommendations and guidelines, pop-up messages, dynamic content, images, and background sound were excluded from the design layout. A simple question is placed on the homepage to support users with more straightforward navigation: "Cosa ti piace?" - "What do you like?" The user can choose from the four displayed pictures that lead to the respective page. There were chosen four main itineraries, which were nature, sport, history, and religion, which fit the target audience since, in general, autistic people prefer more relaxing places, with the possibility of doing a sport and meeting people with the same interests. Users have different ways to navigate to the next page: through the navigation menu, which is placed in the header part, by clicking on the images, or the green emojis placed under the pictures [4].



Figure 3.3: Homepage [4]

Following psychologists' recommendations, the website pictures are symbolic and sketchy. The idea behind this choice is that when the autistic user sees a picture in nature with a person driving a bike, they can relate it to practicing this sport

experience. Different pages include images, links to videos, additional pictures, information about the destination, how the trip group will reach the place, and what to bring to help users prepare for this trip by visualizing different elements [4].

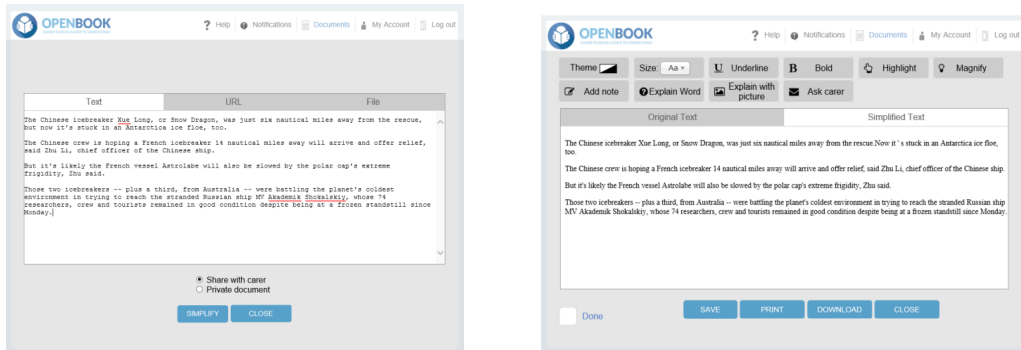
Some website sections include games to engage with the users and to make them pay attention. These games are based on simple questions like "Have you already seen this image during your itinerary?" The user can choose between the two following options: yes or no [4].

Website was tested by nine users, out of which four users (18-19 years old) had an autism diagnosis and mental retardation, and 1 had an autism diagnosis and psychosis (22 years old). The feedback from the users' testing was positive and engaging. Participants appreciated the pictures on the pages and tips on packing their backpacks and games. They felt motivated and wanted to try itineraries. The user test was done using the mouse, which facilitated the navigation through the website. Trying to test the touch screens caused some complications for the users. Some users had difficulty searching for the location of some pictures, which could be improved in the future [4].

3.3 The Open Book tool

Pavlov [5] designed and implemented a user interface for the assisting tool - the Open Book tool for autistic people. This tool is a distributed software system that assists autistic people in reading different documents. This tool helps to simplify the text, which improves reading comprehension for this target group. It consists of an easy-to-read user interface and possible personalization, where the users can choose, for example, different colors, font styles, line spacing, and font typeface according to their preferences. It also includes assistive tools, such as

3.4 The Easier system



(a) Home page

(b) Personalization panel

Figure 3.4: Interface of the Open book [5].

access to dictionaries and images and interaction with helpers and intermediaries. The design of this tool follows guidelines and best practices from different studies regarding accessibility for people with an autism diagnosis and preliminary feedback from the target group and clinical specialists [5].

Figure 3.4 shows several design recommendation concepts in practice, such as using a single toolbar and simple buttons, including text and icons, which do not use bright colors. Personalization is included in this tool as well [5].

3.4 The Easier system

Lourdes Moreno et al. [35] presented in their study cognitive accessibility design patterns and also their possible application while designing the Easier web system's user interface, which provides a tool used to assist in the readability and understanding of the different text for people with intellectual disabilities. This tool can detect more complex words and suggest a word definition or a replacement by suggesting an easier-to-understand option. This tool was tested by older people and people with intellectual disabilities who had a satisfactory experience. For designing the user interface of the Easier, the most important requirements

3.4 The Easier system

were defined as simplicity and accessibility of the user interface. The user interface was designed to be understandable, using explicit content and explanation of the necessary instructions in easy-to-understand language. On the home page, users can find explanation text that describes the purpose of the system and instructions on how to use it. This page includes one box where the user can enter the word he wants to simplify and submit it by clicking the available button. The results page uses plain language and includes two parts - two boxes, one placed on the right and one on the left side of the page. Users can enter the text displayed in the left box and highlight the complex words. Users can interact with the highlighted words and use a synonym, definition, or pictogram that will appear in the box on the right side [35].

Figure 3.5 displays the system interface, which shows the main design pattern applied to every website section. It provides a consistent visual design layout, making it easy for users to navigate the system.



Figure 3.5: Home page and the results page [6]

3.5 An Accessible Evaluation Tool to Detect Easy-To-Read Barriers

Morato et al. [6] proposed implementing a web tool to help text editors improve text comprehension following easy-to-read guidelines for cognitive and learning disabilities. This tool will detect different elements within the text that might make it difficult to understand. This tool will suggest guidance and recommendations within the editing process. The tool would measure the text readability, detect and indicate possible readability issues, and provide recommendations that follow the easy-to-read guidelines. A prototype was implemented on the platform - Comp4Text, displayed in Figure 3.6. This application is accessible and follows the WCAG 2.1 guidelines. It has a simple design interface and includes three different input buttons. It uses colorful warning and error icons to help users easily identify errors.



Figure 3.6: Comp4Text [6]

Chapter 4

Accessibility and usability guidelines for autistic users

4.1 General accessibility recommendations

Andy Budd [36] defined heuristic evaluation for modern website development, which includes analyses of the website usability compared to the set of general usability principles. During the heuristic evaluation, one or two experts will analyze the websites based on the pre-defined set of scenarios. This evaluation is considered more objective than the usual expert view as the results are based on the agreed scenarios or guidelines rather than on subjective personal opinion. There are included the following recommendations:

- The website should be designed based on the users' expectations and goals, which include helpful information and features with the appropriate complexity for the targeted audience.
- The content should be explicit and use meaningful and helpful icons, labels, etc.
- Make the website and task completion efficient by using quick links, removing unnecessary steps, pre-checking standard options, etc.
- Make it easier for users to understand what part of the website they are currently on by highlighting the section in the navigation, providing visual

4.1 General accessibility recommendations

clues, for example, progress indicators, etc.

- The website content and structure should be consistent. Hence, using the typical naming convention is recommended, placing items in the standard places, creating a system that behaves predictably, etc.
- Avoid errors on the website. Include clear, straightforward, and easy-to-understand and notice error messages.
- Create an attractive design with positive website interaction [36].

When designing for neurodiverse users, it is essential to understand what they find important and meaningful in their lives and design and develop solutions that can be situated in their daily lives [37]. Developers and designers should focus on understanding the meaning of "be in the world" as a neurodivergent individual rather than developing the tool to "help," which may, compared to researchers themselves, represent the people with disabilities worse off in some way. Different technologies have been designed and developed for neurodiverse people in the past years, which benefit the target group. However, there are many challenges connected to it for researchers and designers. For example, understanding what the users prefer and the personalization of these tools [37].

Kletenik et al. [30] suggest the following accessibility recommendations for autistic people:

- Sans-serif font should be used.
- Font size and a color contract should be customizable.
- Software design should not include visual clutter, for example, multiple colors and fonts, and distracting or overwhelming audio and visuals.
- White space should be adequately used to support users' attention.

4.1 General accessibility recommendations

- The content organization should be logical, and the design structure should be consistent.
- To support users in managing their attention, concise information, clear directions, graphics, and visual cues should be added.
- Users should have enough time to think to avoid possible cognitive overload.
- Language should be direct and plain, excluding idioms [30].

There has been an ongoing initiative from the World Wide Web Consortium (W3C) since 1994, which is an international community, including multi-stakeholders worldwide [38]. It consists of member organizations, full-time employees, and the public, and the goal of this initiative is to work together to develop open web standards, including creating technical standards and guidelines for web technologies. Their vision is “To make the web work for everyone.” Web Content Accessibility Guidelines are detailed recommendations on the different areas of accessibility. These guidelines are meant to support designers and web developers to create websites (taking into consideration other devices, such as tablets, mobile devices, laptops, and desktops) that are more accessible for people with disabilities, such as neurological, language, physical, learning, auditory, cognitive, speech, visual disabilities [38].

The guidelines are created around four main principles, which are considered necessary for people to access and use website content. These four main principles describe that everyone who wants and needs to use the web must have available content, which is:

- **Perceivable:** It must be possible for users to perceive the presented information. Hence, the user interface components and information must be presentable so that users can perceive that information.

4.1 General accessibility recommendations

- **Operable:** Website users must be able to operate the website's interface, including the navigation and user interface, and there can not be required interaction that the user can not perform.
- **Understandable:** The operation of the website interface and information must be easy for users to understand.
- **Robust:** The content should stay accessible even if the user agents and technologies evolve.

If any of the criteria mentioned above is not valid, it is considered that people with disabilities will not be able to access and use the web [38].

W3C [39] suggests the following criteria for creating usable content for people with cognitive and learning disabilities:

- Icons, terms, symbols, and different design patterns, which the user is familiar with, should be used to help easier understanding of the website content. Users should not be asked to learn new ways to understand it.
- Use an easy-to-follow design layout for your navigation bar. It should include clear visual cues, headings, regions, and boundaries.
- Use straightforward content, including short sentences, easy words, images, other media, and short blocks of text.
- Users should be asked to take only the necessary steps. Make sure to avoid making mistakes and errors on your website. If such a situation happens, users need to be able to correct it quickly.
- Users should not be distracted from doing their tasks. Breadcrumbs and headings benefit users when they get distracted to restore the context if they lose it. Linked breadcrumbs are helpful for users to undo mistakes.

4.1 General accessibility recommendations

- The process should not rely on memory; hence, avoid using long passwords to log in.
- Support and help must be provided on websites, including the opportunity to get human help as efficiently as possible. The contact information should be visible on the websites. Designers can add it to several pages. Added icons to links and headings, alternatives for numbers, summaries of long documents, and graphics can all help the user.
- Website should support the personalization.
- When designing and developing the tool, the target group should be involved in the different phases of the implementation: research, design, and development process [39].

AASPIRE Web Accessibility Guideline recommends the following three attributes, physical, intellectual, and social accessibility, to be considered when designing and developing an accessible website for autistic people [3].

Recommendations on physical accessibility:

- For users with sensitive vision, at least one low-contrast palette should be included in the options.
- The user should be able to select the preferred color palette. The options should include light and dark background colors and one of the options should be a no-style, which excludes CSS (cascading style sheets).
- Website navigation should be simple and consistent, and site behavior should also be compatible on each page within the website.
- It is not recommended to use a background with moving images, textures, ornamental elements, and different visual and audiovisual elements without additional value and information.

4.1 General accessibility recommendations

- Users should be able to choose between large and smaller font sizes since some of the large font sizes might make the website content challenging to read and cluttered.
- It is recommended to use sans-serif font styles, for example, Arial, to make reading for the users easier [3].

Recommendations on intellectual accessibility:

- The user interface should be simple, allowing easy understanding.
- The choice of images and icons should be concrete and straightforward and support the text's context for easier comprehension.
- Label website elements should be used that are clear and make the website and navigation more straightforward.
- In the parts that could cause difficulties with understanding the text, concrete examples should be included.
- It is recommended to minimize scrolling to avoid users' unnecessary assumptions about the content that should follow.
- Site navigation and essential features should be shown for the user to avoid having assumptions and guessing where the item might be hidden and how the user should access it. It is not recommended to use combo box drop-down areas but to use visible radio buttons or list boxes instead.
- To reduce possible cognitive burden, content should be specific, short, and precise [3].

Recommendations on social accessibility:

- The language used in the texts should be precise. The precision of the used language should be enhanced. For example, be as specific as possible: instead of “contact,” specify if it is email or phone (email us/call us).
- The usage of ambiguity, colloquialisms, and idioms should be avoided.
- If the website included unusual information or nonstandard instructions, additional pragmatic context and the reason behind it should be included.
- To reduce possible frustration for the user, alternative responses are recommended on the forms and surveys, such as “I do not wish to say” or “I do not know,” etc.
- Use frequently asked questions (FAQ), which would help you organize complex information and clarify to the user how this information can be connected and valuable in their daily life.
- If the content includes some parts, which understanding could be determined by social content or some specific field, these terms should be defined for a user to understand the context.
- When designing and developing a website for people with an autism diagnosis, consider their preferences, culture, history, and symbols since it might influence perception and the website’s credibility [3].

4.2 What do autistic users want?

Results from an anonymous online survey focused on what autistic users want from the software and technologies designed for them summarize the concerns

4.2 What do autistic users want?

and goals of this target group, understanding a user experience, and their interests [40].

Researchers asked participants, including children and adults with cognitive disabilities, about their interests:

- 46% of the respondents mentioned being interested in computers, video games, and related technologies.
- 36% of the respondents, mostly women, were interested in the artistic field, including art, music, and writing.
- 31% of the respondents were interested in academics, math, and reading.
- 29% of the respondents were interested in comic books, animations, and movies.
- 7% of the respondents mentioned having an interest in science fiction [40].

Additional common interests that designers might consider were a desire to understand electrical and mechanical devices, transportation, and animals [40].

When asked about the user's goals when choosing the technology, 32% of respondents expressed interest in improving social and communication skills and, for example, designing a tool that would teach the user with an autism diagnosis social skills through simple examples and the possibility of learning it quickly and engaging the user to communicate more. Other goals mentioned by participants were:

- A tool helping with reading, writing, and general academic help (for example, with math, to develop a tool with visual and audio explanations).
- A tool helping to generate, organize, and write the user's thoughts, the technology supporting the handwriting.

4.3 Detailed recommendations for accessible website design for autistic users

- A tool to support the user with time organization and schedule.
- Another suggestion was to design a tool to help the user develop critical thinking [40].

There are already existing tools to support people on the autism spectrum with different language tasks, such as communication software PCS, the APP VAST-Autism¹, Mind Reading², iPad application, Stories About Me³, or the tool Open-Book 4 [32]. Additionally, participants mentioned in the survey that they lacked access to technology and suggested some design improvements, such as hardware design, portability of the product, and easy-to-use design of the product, including voice activation. For a software product, one of the suggestions was to allow the user to set the sounds and colors of the tool and include a fun element in the design, for example, when developing educational games [40].

4.3 Detailed recommendations for accessible website design for autistic users

Friedman et al. [13] created a table overview of top design recommendations for website users with cognitive disabilities. This overview is based on the frequency with which these specific design recommendations were cited. This overview can be seen in Table 4.1.

For this analysis, twenty different published design manuals and guidelines created by web accessibility experts, including advocacy and government organizations, were compared with 86 design recommendations. Different design recommendations were ordered based on the percentage of times these specific recommendations were included in the mentioned twenty studies. The recommendations cited less than 15% were included in a separate table, which is not included in this

4.3 Detailed recommendations for accessible website design for autistic users

Table 4.1: Overview on the frequency of top design recommendations [13]

Frequency	Design recommendations
75%	Using icons, pictures, and symbols next to the text.
70%	Using straightforward text content.
60%	Navigation and design should be consistent on each page within the website.
50%	Using the titles, prompts, and headings.
35%	Using alternate text tags to support screen reading.
30%	Using larger fonts, starting at a minimum of 12pt. Designing a simple screen layout.
25%	Using wide margins to maintain white space. Allowing the website’s customization, the user should be able to choose the placement of navigation (left or right side), sound, large print, contrast, and type size. Use the “home, help, exit, next page” buttons on each page.
20%	Using sans serif fonts, for example, Helvetica, Verdena, Tahoma, or Arial. Using consistent and large navigation buttons. Using instead of bullets numbered lists.
15%	Possibility to enlarge the font. Supporting contrast by using color. Using lowercase rather than using all capitals. Using the “back” or “undo” button to help the user get back if needed [13].

dissertation [13].

Another study suggests when designing the application for people with an autism diagnosis, the content and layout should be predictable, with a reduced number of features available at any given time. The website interface should allow users to find the tools immediately without the need for any further investigation. Paying attention to the choice among photographs, symbolic pictures, and images is recommended [29].

Following other studies related to this topic, there were collected and listed the following main areas for accessibility and usability features:

4.3 Detailed recommendations for accessible website design for autistic users

Graphical design layout: It includes, for example, images, text, content, and the responsivity of the website. The connection should be fast, and it should be possible to resize the windows [29]. The following guidelines are recommended:

- The design layout should fulfill the following criteria: simplicity, clarity, predictability, and distractive content should be avoided. A limited number of different features should be available anytime during the user's interaction with a website [29].
- The content should provide feedback and should be predictable.
- Pictures should be combined with the redundant representation of information [29]. The proper number of pictures on the page should be considered since the interface with rich multimedia could potentially cause a negative user experience [5].
- Used pictures should be easy to understand, with a sharp focus and no dynamic background. It could be, for example, photographs, drawings, or symbolic images [29]. Images, menu labels, and icons should use the theme of the natural world, for example, daily activities, which the user easily recognizes [41].
- Using horizontal scrolling, moving text, background sounds, moving text, and blinking images should be avoided [29].
- Pictures should support the informative text. A general rule is to have simple, straightforward, and short text (it is recommended to have one sentence on a line). The text should use a large font and plain Sans-serif style, for example, Verdana, and the color should be mild. It is recommended to use titles and headings [29].
- The interface's responsibility is essential [29].

4.3 Detailed recommendations for accessible website design for autistic users

Additionally, an appropriate contrast between objects in the foreground and background should be chosen for easier differentiation of the items and content and for relating similar information within the website's content. Writing long paragraphs should be avoided. Markups, such as heading titles and lists, should be used to support the reading flow [41]. It is recommended to use the design layout with soft, mild colors and to avoid using bright colors. Text and transparent images should not overlap, and it should be avoided to use any pop-up distractions and elements and separate clear boxes from the rest. The text should be presented in a single column. Only a few elements should be included on the page; simplicity is key. One toolbar is sufficient, and using large buttons, including text and icons, would benefit the user. The controls should not include only icons without text (the popular buttons such as "back" might be an exception), and the icons should not have many colors [5].

A study focusing on the empirical investigation of the effects of animations (for example, animated logos) on the user interface suggests avoiding using irrelevant animations on the website [42]. Participants in this study were autistic adults as well as non-autistic people. For this experiment, a certain number of tasks and distracting animations were designed and included on the web application.

The findings of this study showed that tasks including animations compared to non-animated tasks had a significant influence on the tasks performed by both participant groups. Participants reported animated tasks as more stressful, mentally demanding, annoying, insecure, etc. Autistic people were more affected. For example, they were even more distracted than the non-autistic group, which caused frustration and greater mental exertion to finish the task. They needed more time for animated task accomplishment compared to the non-animated tasks, and they had more errors and were more likely not to complete these tasks [42].

4.3 Detailed recommendations for accessible website design for autistic users

Website's navigation and structure: They are considered fundamental features for users with cognitive impairments when it comes to accessibility and are also crucial for users' satisfaction when it comes to usability. In the case of websites, the navigation inside the site should be limited to three clicks. Any links within the website should be working correctly and not be broken. There are recommended the following guidelines for the website's navigation and structure [29]:

- Consistency of navigation on every page and section.
- The website layout should be designed with a logical and simple structure.
- During the 1st visit, the user should easily navigate through it and be able to remember the navigational information when visiting and using the website later.
- The navigation information and buttons should be added at the page's top and bottom.
- The website design layout should be available and efficient [29].

Additionally, to support the user's attention on particular content and separate different scopes, the blank spaces between the content modules on the web pages would be used. Navigation must be consistent and simplified across all pages, and progress and location indications are recommended. Global navigation buttons, help, back to the home page, and exit should be available on each page. There should be avoided automatic page redirects and time limits for different tasks [41]. Navigation should be clear and straightforward; avoid using complex menus. Page load should be fast and indicated on each page where the user is [5].

4.3 Detailed recommendations for accessible website design for autistic users

Website’s interactivity: It is considered a crucial aspect, and it includes customization, adaptivity, and user engagement, which are essential features and supports users to focus on a specific topic. The following guidelines are recommended for the website’s interactivity:

- Possible customization to be added to the website. Autistic people benefit from personalized interfaces [43]. The elements that could be customized are text size, font, color, sound, images, arrangement of the components within the pages, and features personalization. Enabling a reading or printing mode would be helpful for activities requiring reading and concentration [41]. Regarding personalization, Pavlov [5] recommends focusing primarily on the font type and its size, spacing between lines (line-spacing), and the colors for foreground and background.
- User’s engagement. It is recommended to add some games on the website since it can result in a broad engagement between the autistic users of the website and the website itself [29]. During the testing sessions of designing and implementing the tool, which supports adults with an autism diagnosis, the researchers observed that some participants who were asked to test the system in an unstructured way enjoyed playing game [44]. One of the games was called “expression hunt,” which showed the participants people with specific facial expressions, and the users needed to identify them. Participants, who usually face challenges with socializing, preferred a game named “Movie Actor and Director,” where two people play it. These people will take turns deciding who is in the role or the actor and director. An actor will make some expressions, and the director needs to capture these expressions. This game had a positive influence on interactions between the participants [44]. To motivate, engage, and stimulate the user, precise orientation and instructions about different tasks should be included to

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support understanding of the content [41].

- The interaction with users on the website should be adaptive. It should consider their preferences, needs, requests, and interaction history [29].
- Tasks should be divided into easy sub-tasks to simplify the experience [29].
- There should be none or a minimal number of errors on the website [29].

Additionally, a website should rely on more than just the text for content presentation [41]. Alternative options, such as audio, image, and video, should correspond to the text. Audio instructions and subtitles for the text should be provided. Feedback should be provided to alert the potential mistakes and confirm the correct actions. For feedback, images, text, and audio, which represent the message, it should be avoided to use icons with facial expressions or emotions. Elements on the web pages that are related or similar should produce consistent, matching, and predictable actions/results. Components must look clickable, and more oversized buttons, form controls, and icons, which provide users with appropriate clicks, should be used [41].

One example of a complex area for people with cognitive disabilities is authentication and passwords [1]. A study identified a considerable obstacle for people with mental impairments: the website requiring a password to log in and see the website content. It is challenging for people with cognitive disabilities due to the mental effort needed to manage logins, and it is considered challenging to overcome. There is also seen potential stress between accessibility and security requirements since there is often imposition on the user to create sophisticated passwords due to security reasons. Another challenge is the arrangement around consent and its understanding and safety about beginning their information online. Some people with mild cognitive impairments faced challenges with size activation and sight of the clickable areas. For example, suppose the user presses

4.3 Detailed recommendations for accessible website design for autistic users

the button or area too long or misses the clickable area. In that case, the function is not switched on, or another function is being activated, which was not intended. Another challenge was found regarding audio speed, which could make understanding the text and instructions more challenging [1].

Language: Is a crucial aspect while designing a website for users with cognitive impairments. The following guidelines are recommended:

- Simplicity and precision are the keys [29].
- It should be avoided to use abbreviations, non-literal text, jargon, and acronyms [29].
- There should be used names, expressions, terms, and symbols that are familiar to users' backgrounds [41].

An eye-tracking study [32] suggests considering the following list of recommendations regarding text accessibility for adult readers with an autism diagnosis:

- It is recommended to include relevant images in the text paragraphs that illustrate these paragraphs' main ideas and meanings.
- In case of unavailability of the relevant image, it is recommended not to put any image rather than a non-relevant one because it could affect reading speed and comprehension.
- The text should not include any visual information (advertisements or logos) irrelevant to the text's context.
- The images should be inserted closely to the related sentence or a text group.

4.3 Detailed recommendations for accessible website design for autistic users

- The text should be written in plain English, and using different guidelines for easy-to-read materials is recommended.
- Due to the extended time needed for reading compared to the general population, it is recommended to let the reader skip through the web pages at their own pace.
- If the videos are used on web pages, it is recommended to leave a longer time for reading the captions and text to process the visual information [32].

Pavlov [5] summarizes in his study the following recommendations:

- One sentence should be on one line; if this is not possible, separating clauses on separate lines might be a solution, or the sentence at the parts where the natural pause happens might be divided into separate lines.
- Web pages should not include much information, and each new idea should be included on the new page. The text should have a logical flow and should avoid links which are leading to the next pages or to be continued on the following pages.
- It is recommended to use a maximum of two type cases, one for the headings and one for the text.
- If there is a need to emphasize some information in the text, it should be avoided using italics in the text and block capital. Instead, underlining or bold text should be used [5].

The good news is that some existing web software already supports users with cognitive and physical disabilities, which makes reading comprehension easier and mitigates sensory overload. One of these extensions is BeerLine, a Google Chrome

4.3 Detailed recommendations for accessible website design for autistic users

web extension that offers a more comprehensible rendition of a website, eliminating advertisements, remarks, and other potential disturbances. The functionality of this tool is in applying the color gradient to the content on the website to guide and support a user's eyes when reading from one line to another. A disadvantage of this tool is not following autistic people's color preferences, which can lead to distraction when reading the website content [2].

Another acceptability software is Recite Me [45], also used by the UK National Autistic Society. It is a cloud-based technology with a unique assistive toolbar, which provides a range of benefits to users with disabilities. For example, language translators, screen readers, reading aids, customization and styling, and more. This toolbar can be customized by the customer and the website's content and accessibility needs, making the website digitally inclusive. Recite Me offers a free accessibility scanner that gives the customer an overall web accessibility score and evaluates various regulation and compliance issues, including Web Content Accessibility Guidelines [45].

On the other side, even though there is already existing accessibility software, and it was shown in several studies that the usage of computer technologies has a positive impact and can be supportive for autistic people, there is only a limited part of the already existing websites that is usable and accessible for people on the autism spectrum [29].

Chapter 5

Methodology

This chapter will describe the methodology adopted to answer the research questions in Chapter 1. The methodology followed the design thinking process framework [46]. Design thinking framework is an iterative, non-linear process with a user-centered approach to problem-solving. It is based on understanding the users, challenging the possible assumptions, redefining the problem, and creating innovative solutions that will be prototyped and tested. The work process for this dissertation is divided into several main milestones, following the design thinking process: empathize, define, ideate, prototype, and test [46]. Because the test phase included an extended amount of information, it was included separately in Chapter 6.

5.1 Empathize

The first stage of the design thinking process framework is Empathize. It consists of research to understand the target users' needs. It is important that the designer sets aside assumptions, becomes fully objective, and tries to see through the eyes of the users as much as possible since the users are experts. Based on the research and possible interviews, before starting the next phases of the process, the designer should understand the users' tasks and the motivation to complete them. Designers should adopt a beginner's mindset to view and analyze situations with users objectively. [46].

5.1.1 Objectives

This phase aims to understand the problem the researcher is trying to solve and gain insights about the target users. This can be done through research on the defined topic. The goal of this phase is the concept definition, including research about autism spectrum condition, writing about related work, and research on accessibility and usability guidelines for people with an autism diagnoses.

Deliverables are defining the research questions and writing the theoretical part of the dissertation [46].

5.1.2 Methodology

The literature review was used and summarized to accomplish the objectives of the Empathize phase. The research included information about autism spectrum condition, digital accessibility, accessibility guidelines for people with cognitive disabilities, and an overview of related projects. One of the findings was that during the software creation, there is a need to design and develop solutions that meet users' needs and goals. Additionally, these solutions should consider accessibility to ensure that tools are accessible, easy to understand, and satisfactory, regardless of user limitations [14]. Another study suggests limited empirical evidence about the web accessibility requirements for people with an autism diagnosis. Most studies focus on the accessibility and usability of websites for disabled people, mainly for color vision deficiency and visual impairment. Still, only a few are considering specifically this target audience. These are a few ongoing initiatives about designing accessible websites for people with an autism diagnosis [27]. Another challenge was found among the professionals working with website design and development. There needs to be more knowledge and understanding of the website accessibility guidelines and the needs of the target group, people with disabilities [1].

5.1.3 Main results

The following research questions were defined in Chapter 1:

- Are the current websites with autistic content accessible and usable for people with an autism diagnosis?
- Are there already existing digital tools, such as websites or Apps, following accessibility recommendations?
- Are there existing guidelines about web accessibility for people on the autism spectrum? What do these target users want?
- How can we design web platforms that will be accessible to people on the autism spectrum?

Below are explained key findings of each question.

5.1.3.1 Are the current websites with autistic content accessible and usable for people with an autism diagnosis?

Chapter 2 compares the website accessibility and usability for websites with autistic content.

Dattolo et al.[29] systematically compared usable and accessible websites for people on the autism spectrum. Most of these websites contained autism-related topics and were websites of autism conferences and associations with a target group of adults with an autism diagnosis, parents, and researchers. They found that some of the stated websites included consistent but complex navigation, leading to external sources with a massive amount of information; some websites lacked pictures or icons to support the text information; some websites included moving features and had a complicated design layout. Only two websites followed most of the accessibility and usability guidelines, but they did not include

engagement parts on the website, and the tasks were not divided into sub-tasks. [29].

In another conducted study [2], there were evaluated six hundred autism-related websites. The total number of tested websites was six hundred. The study showed that only 20% of tested websites were considered autism-friendly, 37% of the tested websites were deemed not autism-friendly, and the rest of the websites were in the middle of the autism spectrum condition rating score.

5.1.3.2 Are there already existing digital tools following accessibility recommendations?

The positive news is that there are already existing initiatives, but autism is the area with the potential to create more specific guidelines for this group of users. Some of these initiatives are:

AASPIRE: Academic Autism Spectrum Partnership in Research and Education, designed and implemented the Healthcare Toolkit project, which consists of a website with informational content [3]. It consists of AHAT, the Autism Healthcare Accommodations Tool. This tool is an online survey tool that is accessible and collects information, based on which it generates a customized report for the health care providers. This tool is based on the community-based participatory research approach to improve the accessibility of websites for people with an autism diagnosis. This tool should be used as a living laboratory and help develop the AASPIRE Web Accessibility Guidelines for Autistic Web Users. These accessibility guidelines (which consist of recommendations for increasing the intellectual, physical, and social acceptability of websites) are available in a theoretical way, have been tested with targeted users, and were empirically evaluated using evaluation surveys and usability studies. The learnings from the

AASPIRE Healthcare Toolkit project were compiled in the AASPIRE Web Accessibility Guidelines, which are included in Chapter 4 [3].

A tourism website: Dattolo et al. [4] followed in their study World Wide Web Consortium (W3C) general website usability and accessibility guidelines and designed a tourism website accessible for people on the autism spectrum. This project was done in collaboration with the therapists and center, which helps people with different neurological and physical disabilities, including autism spectrum condition, Asperger syndrome, and mental retardation.

The Open Book tool: Pavlov [5] implemented a user interface for the assisting tool - the Open Book tool for people with an autism diagnosis. This tool is a distributed software system that assists people on the autism spectrum in reading different documents. It consists of an easy-to-read user interface and possible personalization, where the users can choose, for example, various colors, font styles, line spacing, and font typefaces according to their preferences. It also includes assistive tools, such as access to dictionaries and images and interaction with helpers and intermediaries. The design of this tool follows guidelines and best practices from different studies regarding accessibility to the target audience and preliminary feedback from the target group and clinical specialists [5].

The Easier system: Lourdes Moreno et al. [35] presented in their study cognitive accessibility design patterns and also their possible application while designing the Easier web system's user interface, which provides a tool, used to assist in the readability and understanding of the different text for people with intellectual disabilities.

An Accessible Evaluation Tool to Detect Easy-To-Read Barriers: Morato et al. [6] proposed implementing a web tool, which will help text editors improve the comprehension of the text following easy-to-read guidelines for cognitive and learning disabilities. This application is accessible and follows the WCAG 2.1 guidelines. It has a simple design interface and includes three different buttons for inputs. It uses colorful warning and error icons for easier identification of these errors [6].

5.1.3.3 Are there existing guidelines about web accessibility for people on the autism spectrum?

There were established guidelines for website design focused on people with disabilities, including people on the autism spectrum, that should help disabled people to navigate, understand, and interact with the website. Nevertheless, it is still challenging for designers to create a user-friendly website for people on the autism spectrum without knowing the most influential features and their configuration [2]. W3C [39] suggests a list of criteria for creating usable content for people with cognitive and learning disabilities. Friedman et al. [13] created a table overview of top design recommendations for website users with cognitive disabilities. This overview is based on the frequency with which these specific design recommendations were cited. There are also existing initiatives for creating accessibility guidelines, particularly for target users, for example, The Open Book tool from Pavlov [5]. The design of this tool follows guidelines and best practices from different studies regarding accessibility for people with an autism diagnosis and preliminary feedback from the target group and clinical specialists. These design recommendations follow the guidelines from W3C through the WAI and focus on improving web access for people with disabilities. These recommendations aim to improve the accessibility and usability of digital tools. The findings

described in the study enabled defining the specific requirements for UI for the target audience [5].

Another study, AASPIRE Web Accessibility Guideline, recommends the following three attributes: physical, intellectual, and social accessibility, to be considered when designing and developing an accessible website for people with an autism diagnosis [3]. Chapter 4 lists available accessibility recommendations with detailed descriptions. Below is a high-level overview of some of the recommendations for website design layout:

- The user interface should be simple, which will allow easy understanding[3].
- Use wide margins to maintain white space [13].
- It should be indicated on each page where the user is [5].
- It is recommended to minimize scrolling to avoid users' unnecessary assumptions about the content that should follow [3].
- Avoid using background with moving images, textures, ornamental elements, and different visual and audiovisual elements without additional value and information [3].
- Icons, terms, symbols, and different design patterns, which the user is familiar with, should be used to help easier understanding of the website content. Users should not be requested to learn new ways to understand it [39].
- The choice of images and icons should be concrete and straightforward, and it should support the context of the text for easier comprehension [3].
- The images and icons should be inserted closely to the related sentence or a text group [32].

- It is not recommended to use a picture as a background for the paragraph or any text within the page [5].
- Use the titles, prompts, and headings [13].
- Use larger fonts, starting at a minimum of 12pt [13].
- Use lowercase rather than using all capitals [13].
- Use sans serif fonts, for example, Helvetica, Verdena, Tahoma, or Arial [13].
- Use numbered lists instead of bullets [13].
- Support and help must be provided on your websites, including the opportunity to get human help as efficiently as possible. Make sure the contact information is visible on your websites. You can add it to several pages [39].
- One toolbar is sufficient, and using large buttons, including text and icons, would benefit the user. [5]

5.1.3.4 How can we design web platforms that will be accessible to people on the autism spectrum?

People on the autism spectrum might face different challenges during their interaction with websites. For example, sensory (related to visual and auditory processing) or information overload can lead to problematic behavior or even meltdowns. It can be a daunting experience for people with an autism diagnosis to access information with distractive content, such as blinking, flashing, and flickering information interfaces. There is a need for website data to be presented adequately for people with cognitive disabilities such as autism. There were established guidelines for website design focused on people with disabilities, as mentioned previously [2].

Based on the research, we would suggest the following focus areas while designing accessible digital interfaces for this target audience:

- Understanding the target group, their needs, and wants.
- If possible, interview target users to understand their challenges while using digital tools.
- Researching already existing initiatives and projects.
- Using already existing accessibility guidelines for this target audience.
- Including people with an autism diagnosis or UX experts designing for this target group in the design process.
- Testing with the target audience, using the proper testing tool and doing several iterations.
- Creating the final accessible design interface following the results from the previous iterations.

The second phase, which follows after collecting information in the Empathize phase, is the Define phase.

5.2 Define

During this phase, the designers analyze the information collected from the empathize phase, and by synthesizing them, they define the core problems, also named problem statements. Problems statements are brief descriptions of possible design challenges. During this phase, the team focuses on the most important information gathered during the previous phase and defines the user target group [46].

5.2.1 Objectives

This phase aims to analyze the gathered insights from the Empathize phase and, based on the characteristics from conducted research, define the target group. In this stage, the information gathered during the empathize phase will be accumulated. It is recommended to create a persona to follow the human-centered approach [46].

Deliverables: Persona creation [46].

5.2.2 Methodology

A persona was created based on the PersonAut model. The PersonAut is a specific Personas Model for autistic individuals. It presents an alternative technique that can be used to create user personas for people with an autism diagnosis. It includes demographic and general characteristics, soothing and stressful activities, stereotypes, and social aspects. There are two PersonAut Models, types 1 and 2, shown in Figure B.1 and Figure B.2 in Appendix B [47].

During the persona creation process, we took a user-centric approach, incorporating the characteristics we gathered from our research and online interviews with the target users. This approach ensures that our personas are not just theoretical constructs but accurate representations of the diverse neurodiverse community we aim to serve.

When interviewing neurodiverse users, it is recommended to use accessible and clear instructions and include multimodal feedback in the output responses. For maximizing the participant's attention and focus, it is recommended to use customized settings based on individual preferences, for example, multimodal feedback, sound level, screen brightness, etc. [16] Following this recommendation, the accessible survey, from the Accessible Surveys, created in collaboration with the International Disability Alliance, that follows the individual preferences and

needs of people with disabilities, was used. The questions can be presented in different ways that suit the person answering the questionnaire best. The user can choose from various languages and formats, a sign language using videos, or the possibility to read the questions louder, or to change the interface to an easy-to-read format, which includes side illustrations for easier understanding of the questions [11]. For the online survey, participants needed to be 18 or older and have a medical diagnosis of autism with any level of support needs. There was no residence specification, but possible communication in English was needed. We recruited one participant through a word-of-mouth method.

The Accessible Survey includes an accessibility page, which is shown in Figure B.3 in Appendix B. This is the 1st page after the consent part, where the user can personalize the survey. Users can choose from different color themes and contrast, adjust the text size, and activate the "Easyread" option by displaying the pictures next to the questions, as shown in Figure B.4 in Appendix B, or activate the read-aloud feature [11].

The rest of the survey included the questions following the PersonAut, which suggests including in the questionnaire demographic (table B.1), general characteristics (table B.2), soothing and stressful activities (table B.3), stereotypes, and social aspects (table B.4) [47]. The questions and answers are listed in the above-mentioned tables in Appendix B.

5.2.3 Main results

Figure B.5 in Appendix B shows the final persona created based on the research about people on the autism spectrum from the empathize phase with the combination of online interviews with the target user. The user persona includes the following information:

General characteristics

- Autism level: Level 1
- Language: Verbal

Demographic characteristic

- Name: Jane
- Age: 32
- Gender: Male
- Nationality: Austria

Social/family aspects

Studying and working. Going to work five times per week. Not a member of an autism community yet, but interested in it.

Soothing activities

Motorcycling, sauna, walking in the nature.

Stressful activities

Working, phoning, socializing, waking up early, loud music, planning and organizing.

Stereotypes/manias

Reduced social use of eye contact.

Hobbies

Motorcycling, online games, reading books.

The next phase follows the Ideate phase.

5.3 Ideate

This phase is about designers bringing ideas in the form of different questions and possible solutions. It can be done via various techniques and activities,

such as brainstorming, brainwriting, mind mapping, storyboarding, sketching, etc. It is about generating as many ideas as possible, which can also inspire better and different ideas, which brings creative solutions. It is about diverse thinking, where the team usually focuses on the variety and quantity of ideas. The focus is on exploring as many possibilities and options as possible without any restraints. After the ideation session is done, it is followed by collection, categorization, refinement, and narrowing down of the ideas. It helps the team to select the best ideas, strategies, and solutions from this list. Some possible methods for choosing the best final ideas are an affinity diagram, six thinking hats, four categories method, etc. [46].

5.3.1 Objectives

This stage is about brainstorming ideas and finding alternative ways to solve the problem with innovative solutions. It aims to find new, creative ideas on how to solve the problem [46].

Deliverables: Affinity diagram.

5.3.2 Methodology

For collecting ideas, a digital visual workspace tool called Miro was used. It can be used for brainstorming as well as for the execution of ideas. Brainstorming is a method that is used to generate innovative and new ideas. It can be executed in a group or alone, and the goal is to think outside of the box and try to find answers to the defined problem while the participants develop and bring new creative and innovative ideas. During this session, any ideas should be criticized or judged. It is based on free thinking, which allows everyone to bring their creative ideas on how to solve the problem [48]. The affinity diagram, an affinity chart or affinity map, is a visual tool for organizing the information gathered

during the brainstorming session. It starts with sorting the ideas based on their relation into different categories and groups. The design team will group similar ideas to help represent the possible steps to solve design challenges and display them visually. After clustering the ideas, the most relevant ideas that can help reach the goal should be prioritized [49].

5.3.3 Main results

Figure C.1 and Figure C.2 in Appendix C display the results of the Ideate phase. The following priorities from the affinity diagram were defined:

- **Explore other accessible websites:** To learn the best practices and design ideas for accessible panels.
- **Follow accessibility guidelines:** To ensure the website will be accessible to the target group.
- **Personalization panel:** It is one of the most mentioned recommendations for designing accessible tools for the target audience.
- **Consistent navigation and design on each page:** It is recommended to use consistent navigation while designing accessible tools for the target group.
- **Accessible survey:** To use an accessible survey with a customization panel.
- **Testing with autistic users with any level of support needs:** To ensure users with every level of support needs can give feedback and participate in the study.

- **Simple website design layout:** It is recommended for designing accessible tools for people with an autism diagnosis to use a simple design layout.
- **Avoid using moving elements:** It might distract an autistic audience when using moving elements on the website.
- **Pictures next to the paragraphs for easier understanding:** Use pictures or icons to support understanding of the website content.
- **Using sans-serif font:** for example Verdana.

The next phase is the Prototype phase.

5.4 Prototype

This phase is an experimental phase that follows the Ideate phase, during which the main ideas were prioritized. Based on these ideas, designers will design early versions of the proposed solution during the prototype phase. This phase is a good way to detect how the target audience and users think about the solution, and it can help resolve any possible uncertainties connected to the selected idea. It is not recommended to create multiple solutions but rather to focus on one which can be improved. Designers can choose from different prototyping methods, such as paper prototypes, storyboarding, wireframe prototypes, etc. It is essential to consider selecting the relevant method for the designed solution, depending on whether it is a digital service, website, or physical product. The prototypes should be functional and easy to use [50].

5.4.1 Objectives

The Prototype phase aims to produce an inexpensive, scaled, and early version of the designed solution based on the ideas gathered in the Ideate phase. It helps

designers visualize their abstract ideas, test the practicability of the solution, and understand what the users think about the product. This phase allows the designers to determine if the designed solution can successfully solve the defined problem [46].

Deliverables: Based on the brainstorming and the affinity diagram, a wireframe and accessible website design will be created [46].

5.4.2 Methodology

Based on the recommendations listed in Chapter 4, the design layout and structure recommendations for designing the accessible website were considered while creating the wireframe. They are divided into three main parts: website design layout, navigation, and customization:

Website design layout

- The user interface should be simple, which will allow easy understanding[3].
- Wide margins should be used to maintain white space [13].
- It should be indicated on each page where the user is [5].
- It is recommended to minimize scrolling to avoid users' unnecessary assumptions about the content that should follow [3].
- It should be avoided using background with moving images, textures, ornamental elements, and different visual and audiovisual elements without additional value and information [3].
- Icons, terms, symbols, and different design patterns, which the user is familiar with, should be used to help easier understanding of the website content. Users should not be requested to learn new ways to understand it [39].

- The choice of images and icons should be concrete and straightforward, and it should support the context of the text for easier comprehension [3].
- The images and icons should be inserted as close to the related sentence or a text group [32].
- It is not recommended to use a picture as a background for the paragraph or any text within the page [5].
- The titles, prompts, and headings should be used [13].
- It is recommended to use larger fonts, starting at a minimum of 12pt [13].
- It is recommended to use lowercase rather than all capitals [13].
- Sans serif fonts, for example, Helvetica, Verdena, Tahoma, or Arial, are recommended [13].
- It is recommended to use numbered lists instead of bullets [13].
- Support and help should be provided on websites, including the opportunity to get human help as efficiently as possible. The contact information should be visible on the websites. It can be added to several pages [39].
- Using large buttons, including text and icons, would benefit the user. [5]

Navigation

- Consistency of navigation on every page and section [29].
- The website layout should be designed with a logical and straightforward structure [29].

- Site navigation and essential features should be shown for the user to avoid having assumptions and guessing where the item might be hidden and how the user should access it [3].
- Use an easy-to-follow design layout for your navigation bar. It should include clear visual cues, headings, regions, and boundaries [39].

Additionally, it is recommended for target users to include possible customization on the website since this target group benefits from personalized interfaces [43].

Customization

- Allow website customization, and the user should choose sound, large print, contrast, and type size [13].
- Users should be able to choose between large and smaller font sizes since some of the large font sizes might make the website content challenging to read and cluttered [3].
- The elements that could be customized are text size, font, color, sound, images, arrangement of the components within the web pages, and features personalization. Enabling a reading or printing mode would be helpful for activities requiring reading and concentration [41].
- In terms of personalization, [5] recommends focusing primarily on the font type and its size, spacing between lines (line-spacing), and the colors for foreground and background.

Since the customization panel is one of the most mentioned accessibility recommendations for people with an autism diagnosis, the mockup includes examples of accessibility panels on different websites, as shown in Figure 5.1.

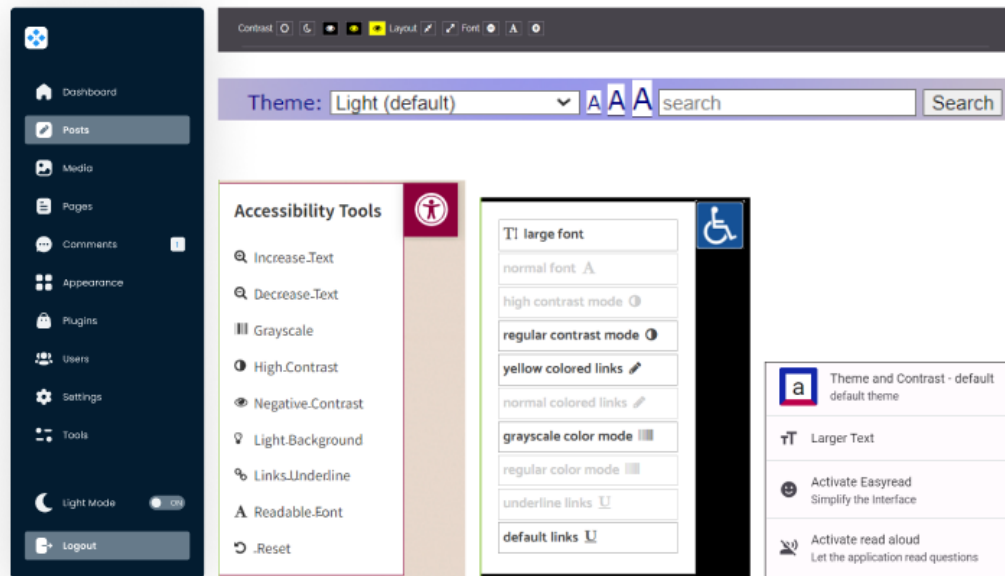


Figure 5.1: Mockup [7] [8] [3] [9] [10] [11]

Following the best practices from other websites, including the customization panel displayed in Figure 5.6, the customizable components on the accessible websites are the following:

A website template including customization option [7]:

- Light and dark mode [7].

A website template including customization option [8]:

- Contrast: the default mode, night mode, high contrast black/white mode, high contrast black/yellow mode, high contrast yellow/black mode.
- Layout: the fixed layout, the expansive layout.
- Font size: 7 font size adjustments available [8].

A website template including customization option [10]:

- Large/regular font.
- High/Regular contrast mode.
- Yellow/Normal colored links.
- Grayscale/Regular color mode.
- Underline links/Regular links [10].

A website with autistic content [3]:

- Light-dark theme.
- Contrast: high contrast light, high contrast dark.
- Print-friendly/no layout.
- Font size: 3 font size adjustments available [3].

A website with autistic content [9]:

- Increase/decrease text.
- Grayscale.
- High contrast.
- Negative contrast.
- Light background.
- Links underline.
- Readable font.
- Reset [9].

Accessible surveys [11]:

- Theme and contrast: 8 available options.
- Font size: 4 available font sizes.
- Easyread option.
- Read aloud.
- Voice speed: 4 available levels. [11]

5.4.3 Main results

5.4.3.1 Wireframe

The initial wireframe proposal is displayed in Figure D.1, Appendix D.

For autistic audience, it is essential that the navigation is simple and consistent. If possible, a sitemap should be shown. Hence, the primary navigation bar is placed on the left side. The left-side navigation allows enough space to include all available pages on the website.

Some of the websites have customization options hidden under an icon. Other websites have it visible above the main navigation bar. Since customization is a significant feature for autistic audience, the customization panel is placed on the most common primary navigation placement - horizontal navigation and it includes the most used customization options following the best practices listed in the 5.4.2 Methodology part - Customization: theme, contrast, font size and underline links.

The UX expert who designs online tools for neurodiverse users provided feedback on the wireframe design proposal, color palettes, and font options:

- “In the customization panel: include icons that suit the action here; this will significantly help users with cognitive issues.”

- “For the content text modules: try not to centralize text, which makes reading the text difficult. Keep all text left aligned; don’t center text if possible - it makes it hard to read.”
- “Customization panel: Nice. I really like your idea of these settings.”
- “CTA: Back to home: try not to change the navigation; this would be unexpected to the user and may confuse them. Keep the buttons the same across all pages; don’t change the navigation for specific pages.”
- “Color palette: these are all very muted colored themes; you may want to consider high-contrast colors (black and white) to help low-vision users.”
- “Verdana is an awesome, free, accessible font; Roboto is not very good. I would consider Atkinson Hyperlegable, it’s free to download.”

Figure D.2 in Appendix D displays the final website wireframe design proposal.

5.4.3.2 Accessible website design

For designing the website, Figma was used since it is one of the standard tools used for online application design [51]. This sub-subsection is divided into five main milestones following the website implementation process: customization panel, site map, accessible content, website color palette, and prototype.

Customization panel

The following customization options were defined based on the accessibility recommendations about including a customization panel in interfaces designed for people with an autism diagnosis.

Theme: two options are available: light theme (default theme) or dark theme.

Contrast: two options are available: high-contrast light or high-contrast dark.

Font: two options are available: big font (default font) or small font.

Underline links: two options are available: yes underline or don't underline (default setting). Figure 5.2 displays the proposed design of the customization panel on the accessible website. Different options can be combined except for theme

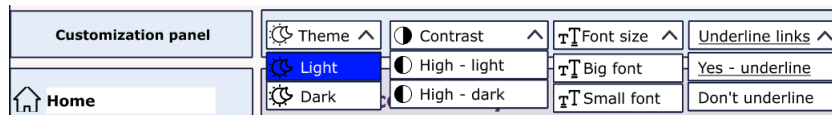


Figure 5.2: Customization panel

and contrast. The user can choose only one color theme or contrast option, which is combinable with a font size and links underlining.

Site map

The site map was created based on common pages used on websites with autistic content, which were seen during the Empathize phase. Since the purpose of this dissertation is the accessible website design and not the content, the number of pages was limited to 12. The purpose was to give participants options to go through the website, find information that might interest them, and try different features available on the website, but not overload them with too much content. Figure D.3 in Appendix D displays the site map of the accessible website.

Accessible content: The content created on the website combines the research from the Empathize phase and fictively created content inspired by content from other websites. The content is a placeholder for the website prototype's design testing purposes. The content of the actual website should follow the content accessibility guidelines.

The national autistic society [52] produced the guidelines that provide recommendations on how to talk and write about autism, created based on the preferences of people with an autism diagnosis and their families, supporters, and professionals. These guidelines were followed while creating content on the website. The guideline includes the following recommendations:

- Ask the particular person or a group what their preference is for being described. Use “identity first” language instead of “person first” language. It is recommended to say autistic person/people/child/adult instead of saying person/people/child/adult with autism.
- Say they are autistic or have an autism diagnosis instead of saying they suffer from autism, they are victims of autism, they have/are living with autism, or are an aspie/autistic/autie/autist.
- Refer to autism as autism is a spectrum condition, and a person/people/child/adult is on the autism spectrum.
- If you are explicitly referring to terminology in the medical manuals, it is acceptable to use “autism spectrum disorder”; otherwise, it is not recommended to use “disorder.” Condition is more preferred compared to disorder.
- Autism is a lifelong disability, not a handicap, illness, mental illness, or disease. Use non-autistic, not autistic, or neurotypical instead of using “normal” people. People find it offensive since it suggests some sort of hierarchy, where only one “right” way of being exists.
- People on the autism spectrum are neurodivergent, and autism is a form of neurodivergence. Do not say that autism is a neurological disorder.
- Use terminology for people with an autism diagnosis with low or high support needs and people with an autism diagnosis without or with learning disabilities. Do not use terminology as low or high-functioning and severe or mild autism.
- It is recommended to use terminology such as adjustments, support, needs, and access requirements and avoid terminology such as cure and treatment.

- Use terminologies such as common autistic characteristics and traits and avoid saying signs or symptoms of autism.
- It is recommended to say that an autistic person has unreliable, limited, or no speech or who speaks few or no words. [52].

Website's color palette

The below listed recommendations were considered:

- For users with sensitive vision, there should be at least one low-contrast palette from the options [3].
- The user should be able to select the preferred color palette. The options should include light and dark background colors [3].
- For easier differentiation of the items and content and for relating similar information within the website content, an appropriate contrast between objects in the foreground and background should be chosen [5].
- It is recommended to use the design layout with soft, mild colors and to avoid using bright colors [5].
- The icons should not have many colors [5].

Appendix E includes a detailed explanation of the color palette and how different color versions are displayed on the website's prototype.

Website's Prototype

After defining the site map, content, customization panel, and color palette, the final website's prototype was created. The proposed design can be seen in the Appendix F.

Chapter 6

Test phase

The last and final phase in the design thinking process is the Test phase. During this phase, designers thoroughly test the product-best solution defined in the Prototype phase. This phase is about understanding the user's interaction with the proposed solution. During this phase, more iterations of solution improvements are usually created until the final product is produced. During the iterative process, the user's feedback is essential; otherwise, it will fail without it. Users should test and provide feedback on the solution, which helps the designer understand what users like and what they do not like about the product. Receiving the input allows designers to provide solutions that will be wanted and used by users [46].

6.1 Objectives

This phase aims to give designers a proper understanding of the design solution and how the users interact. During this phase, designers observe how the users interact with the designed product, behave while using it, their feelings about the suggested solution, and what they think about it [46].

Deliverables: The final accessible website design proposal [46].

6.2 Methodology

6.2.1 Usability testing with target audience

Valencia et al.[55] reviewed existing literature focused on designing and developing different products and systems for people with an autism diagnosis. Different evaluation methods were used to evaluate the usability of the products and systems designed for this target group. Some researchers used the complete or simplified versions of SUS (System usability scale) to evaluate their systems. The simplified versions of SUS include, for example, reducing the scale, using emoticons, and using simplified language. These modifications were used while evaluating the system directly with people on the autism spectrum. For the testing with tutors or experts working with the target audience, they used reduced or complete versions of SUS. In some of the studies, the researchers used sets of heuristics, such as Nielsen's heuristics, or SIDE, the Semiotic Interface sign Design and Evaluation. Some of the studies used the questionnaires. In another study, the system was tested by direct observation while users interacted with the digital product. Some researchers proposed their versions of questionnaires, usually based on different defined categories. Some investigators used several methods to evaluate systems, such as SUS, a heuristic evaluation, and a virtual reality sensitivity scale. Another study used SUS, questionnaires, and interviews. Additional evaluation methods were the think-aloud protocol or cognitive usability scale [55].

There are some limitations to the methods used while conducting testing sessions with people with an autism diagnosis. Nielsen's set of heuristics and SUS are used to find the usability problems in the systems and help to provide an overview of the participant's satisfaction with the product or system. This method might lack the details needed to understand the particular wants and needs of people

on the autism spectrum while evaluating the system. Cognitive walkthroughs and think-aloud sessions can help to receive feedback directly from the testing participants, although it should be considered that some people with an autism diagnosis might have unreliable, limited, or no speech, and it might be inclined to frustration. In general, not each literature includes empirical evidence from the researchers, nor provides proper details about the evaluation details [55].

Valencia et al. proposed in their study a three-stage methodology, which can be used to evaluate user experiences for people with an autism diagnosis, particularly for people on the autism spectrum with level 1 of autism based on the DSM-5 definition [55].

6.2.2 Recruitment process

Participants needed to be 18 years old or older with an autism diagnosis and any level of support required. There was no residence specification, but there was a need for possible communication in English since the survey was handled in English language. Participants could participate directly or with help from a supporter in case of need and preference. Participants were recruited via forums, word-of-mouth, developmental disabilities agencies, autistic organizations, online recruitment channels, and social media. It was aimed to require between 5 and 10 users.

6.2.3 Evaluation method

When choosing the proper evaluation method, it was considered that when interviewing neurodivergent users, it is recommended to use accessible and clear instructions and include multimodal feedback in the output responses. For maximizing the participant's attention and focus, it is recommended to use customized settings based on individual preferences, for example, multimodal feedback, sound

level, screen brightness, etc. [16].

It was also considered that some people with an autism diagnosis might use an assistive technology. Assistive technology tools can help with routine tasks, learning, communication, greater independence, and support with everyday activities [21].

The additional considerations:

- Some people on the autism spectrum might not feel comfortable having a think-aloud session and would like to be anonymous. This consideration is based on the feedback from the interviewing the autistic person for prototype creation.
- Some people with an autism diagnosis might have unreliable, limited, or no speech and might face challenges during social interaction [12].
- The accessible options, including a read-aloud option, should be available during the testing.
- No limitations to the specific geographic area.
- No limitations to the specific level of autism.
- Possible testing in an environment where the participants feel comfortable at any time and within their preferred period. There should be a possibility of starting and continuing/finishing the testing later.

Based on these considerations, it was decided to proceed with the Accessible Surveys, which were already used for persona creation, and the questions were created based on the accessible version of SUS. The System Usability Scale (SUS) was used in several studies to evaluate users' feedback, as previously mentioned. The System Usability Scale (SUS) is a tested and proven online questionnaire. It

consists of a 10-item questionnaire, where the participant stands on some affirmations (from “Strongly Disagree” to “Strongly Agree”) [54].

For evaluating the usability systems for users who rely on assistive technology, it is recommended to use the Accessible Usability Scale (AUS), which is an easily understanding psychometric survey that complements the System Usability Scale scores and is modeled on the ten questions from SUS, where the questions are slightly modified or identical. Some of the questions were changed to fulfill accessibility needs. The differences between SUS and AUS questions are displayed in Table G.1 in Appendix G. AUS scale is displayed in Table G.2 in Appendix G [56].

For counting the AUS score, each response gets assigned a scale position in positively worded statements (including the following questions: 1,3,5,7,9), and the scale position is taken and subtracted by 1. This result is multiplied by 2.5.

In negatively worded statements (including the following questions: 2,4,6,8,10), the number five subtracts the scale position. This result is multiplied by 2.5.

The final questionnaire included the following main parts:

Consent,

Accessibility options,

Questions about general characteristics:

- What country are you from?
- What do you do for a living?
- What is your gender?
- What is your age category?
- What is your level of autism?

Additionally, the questions about the website’s prototype based on ten questions from AUS.

Every question that included “assistive technology” had additionally the following explanation: In case you did not use any assistive technology, you can give feedback for using the website on your device, for example, a desktop. Note: assistive technology for people with an autism diagnosis can include different tools that might help someone carry out daily functions, learn, and communicate.

The overall data collection process was approved by the university ethics committee to make sure all the methods used were according to the unique characteristics of this user population (request number P.120).

6.3 Main results

This section explains the iterations, which are explained in sub-sections named User testing 1 and User testing 2.

6.3.1 User testing 1

For the first testing session, neurotypical users were recruited from friends and acquaintances. This testing session aimed to understand if the website’s prototype is usable and appealing before sharing it with the target audience.

For consistency, Accessible Surveys and AUS were used. Table G.3, Appendix G, displays the participants’ general characteristics. Table G.4, Appendix G, displays the results of the testing.

Overall, the usability score of the website’s prototype was high, 95 from the highest possible score of 100, which shows that the website was usable.

Since this first testing session aimed to improve the design of the interface as well, the UX expert was interviewed regarding the website’s design.

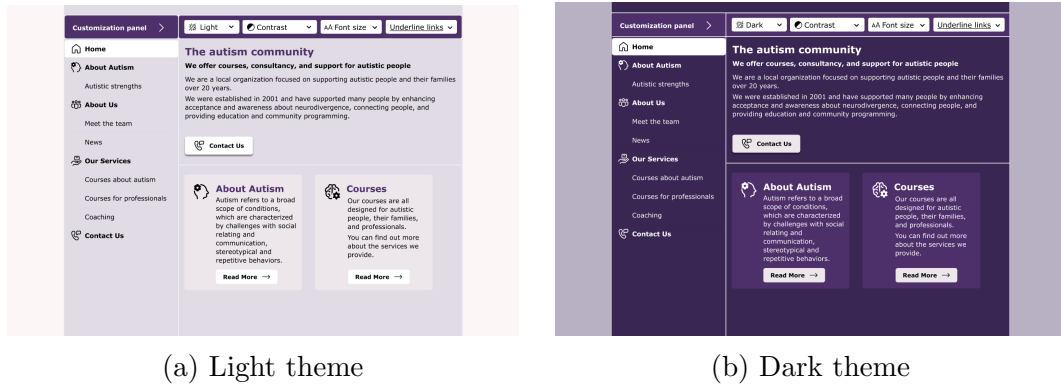
There were shared the following recommendations on how to improve the design

of the website:

- “The website’s interface is easy to navigate, and overall, it looks nice, but it looks like a wireframe rather than a prototype ready for testing.”
- “I like a lot the accessibility panel and its visible position. It is a good idea and highlights its importance for the target group.”
- “I also like the navigation on the left side; it can improve the navigation of the websites.”
- “A couple of suggestions to improve the website design: I would decrease the number of blocks from three to two on the home page. It will simplify the user’s readiness. I would unitize the icons, change the color of content dividers from black to grey, highlight the buttons (you can use two different sizes), and decrease the number of color combinations. Also, the yellow color in the light contrast does not look appealing. Hence, I suggest using another color palette. Adjusting these few parts will make the website look good and ready for testing.”

Following the feedback from the UX expert, the website’s design was adjusted. The website’s structure remained the same. These were only small changes that improved the design visually:

- The grey color content dividers replaced the black borders (Figure 6.1 and Figure 6.2).
- For the buttons, a slight shadow was used, which highlighted them. Also, two sizes of buttons were used - A bigger size for Contact Us and a smaller size for additional Call to Action buttons (Figure 6.1 and Figure 6.2).
- The icons were used from the same library (Figure 6.1 and Figure 6.2).



(a) Light theme

(b) Dark theme

Figure 6.1: Updated theme color palettes

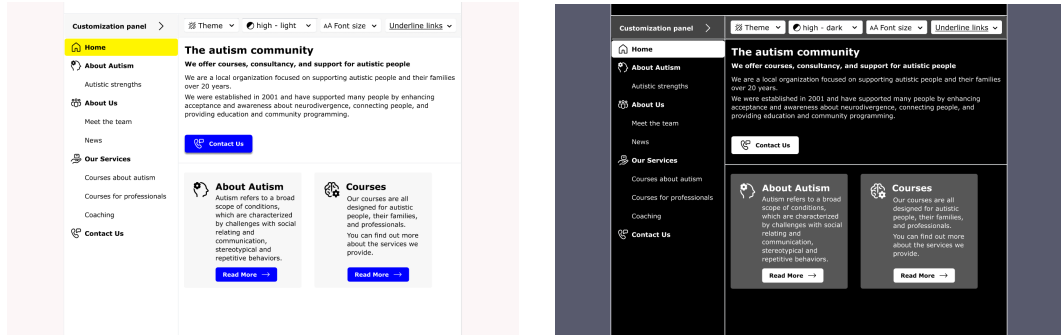
- The number of different color combinations was decreased (Figure 6.1 and Figure 6.2).
- Three blocks on the home page were changed to two blocks (Figure 6.1 and Figure 6.2).
- High-contrast light color palette was adjusted from yellow to white for the background, including blue and yellow colored contrasted buttons (Figure 6.2).
- Button “Back to home” was deleted since the navigation is always visible on the left side (Figure 6.2).
- Next to the title “Customization panel” was added an icon with an arrow for more straightforward navigation (Figure 6.1 and Figure 6.2).

Figure 6.3, Figure 6.4, and Figure 6.5 display the final design of the website’s prototype, which was used for the second testing with the target group.

6.3.2 User testing 2

The second testing session was planned with the target group, the people with an autism diagnosis. Since there is no digital method for testing with the autistic

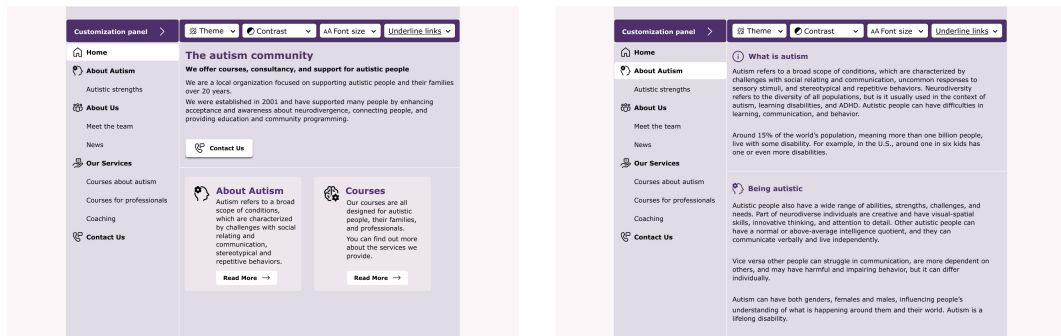
6.3 Main results



(a) Light contrast

(b) Dark contrast

Figure 6.2: Updated contrast color palettes



(a) Home page

(b) About autism

(c) Autistic strengths

Figure 6.3: Updated prototype - Home page, About autism, Autistic strengths

6.3 Main results

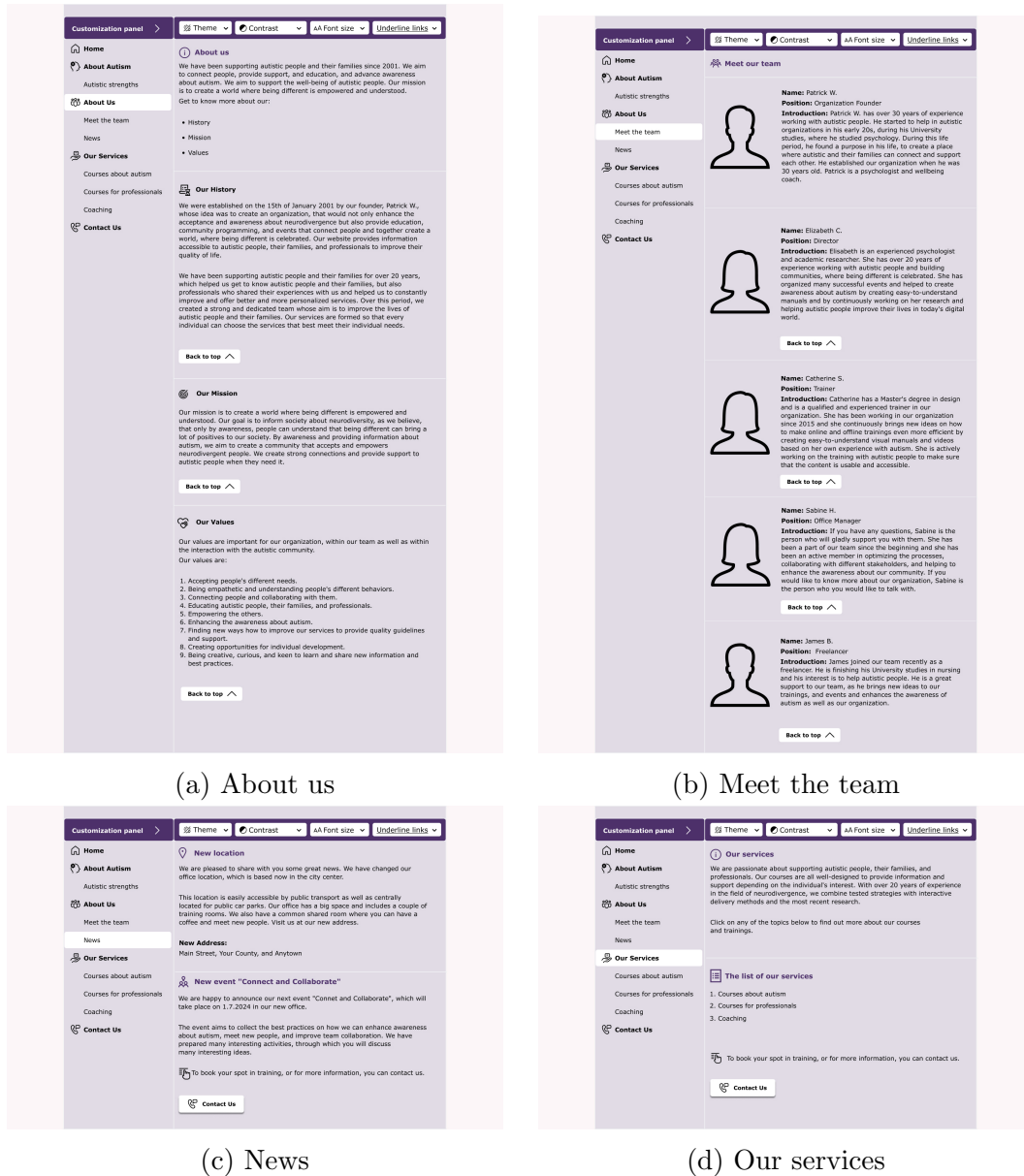


Figure 6.4: Updated prototype - About us, Meet the team, News, and Our services.

6.3 Main results

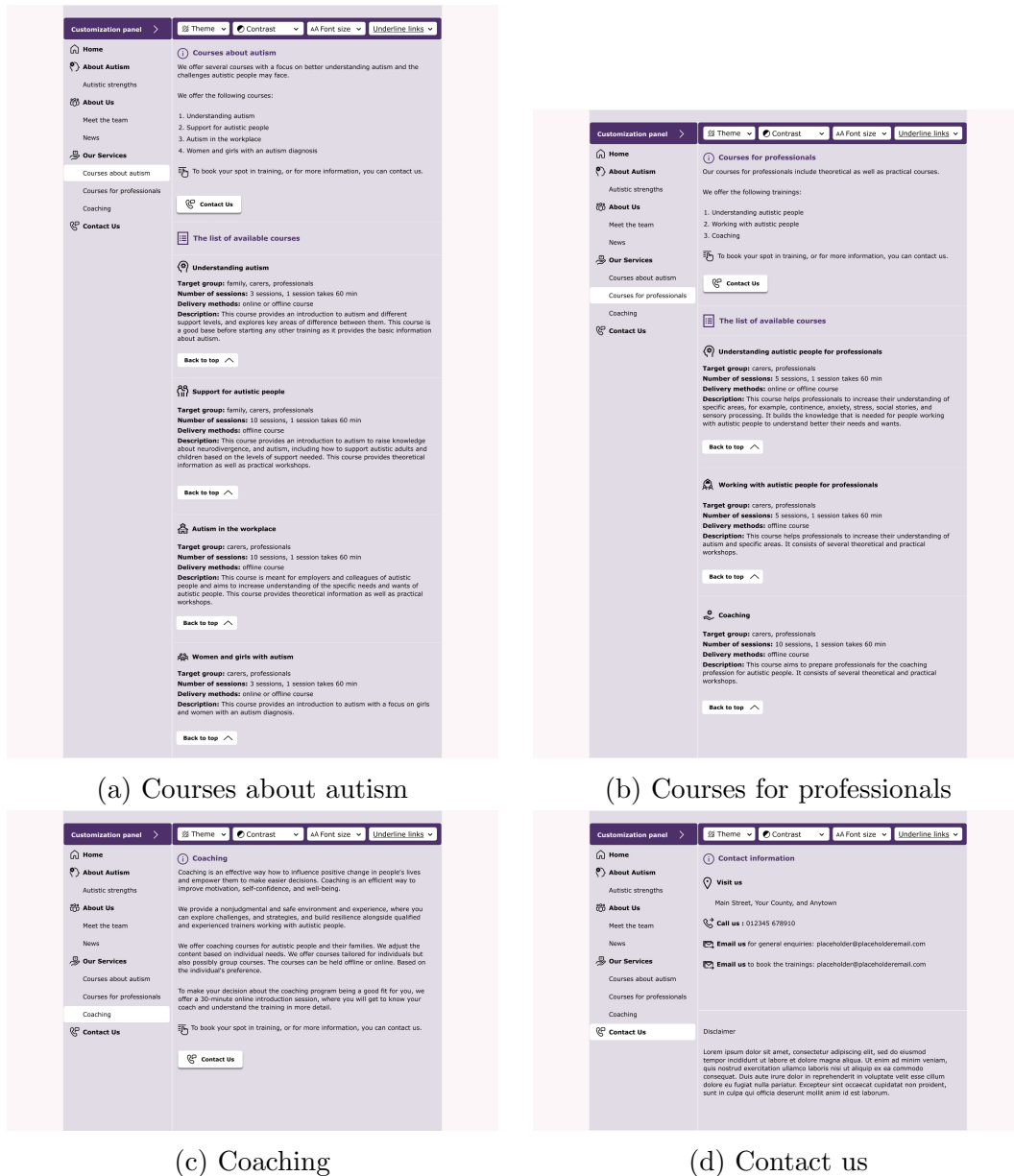


Figure 6.5: Updated prototype - Courses about autism, Courses for professionals, Coaching, and Contact us page

audience, two different methods, the questionnaire, and a think-aloud protocol, were applied to collect feedback. These two methods are described below.

6.3.2.1 Questionnaire

This testing was done online by sharing the links for the Figma prototype and the questionnaire. The participants had to be at least 18 years old and have an autism diagnosis. It was possible to do testing with the supporter in case of need and preference. The testing could be done anytime and in the user's preferred environment. The advantage of the online survey is that participants could start the testing one day and continue another time or day. The only additional requirement was that participants should speak the English language, as the website and survey were in the English language. The participants were recruited via word-of-mouth and social media and contacted by some of the autistic organizations that shared the links with the target group. The recruitment message included the introduction text with the poster. Based on the best practices from the first testing session, the questionnaire was slightly adjusted. A mandatory field named "Please specify your chosen option" was added under each of the 10 AUS questions to ensure the feedback would be as detailed as possible.

Each AUS question included the following note: "Specify please your chosen option in the text field below. Your detailed explanation will help us to improve the website's accessibility." Every question that included "assistive technology" additionally had the following explanation: "In case you did not use any assistive technology, you can give feedback for using the website on your device, for example, a desktop. Note: assistive technology for autism can include different tools to help someone learn, communicate, and perform daily functions."

On top of the AUS questions, two additional free-text questions were added: "What did you like the most about the accessible website?" and "Where do you

see room for improvement on the accessible website?” An example of the questions in the Accessible surveys is displayed in Figure H.1 in Appendix H.

Table 6.1 displays an overview of users’ demographic information. Appendix H, Table H.1, and Table H.2. display the participants’ general characteristics per user.

Table 6.1: Users’ demographic information

Country (6)	Czech Republic (2), Austria (1), Slovakia (2), Germany (1)
Occupation (6)	Translator (1), Data analyst (1), IT (2), Process expert (1), Marketing (1)
Gender (6)	Male (4), Female (1), NB (1)
Age (6)	30-39 (4), 40-49 (2)
Level of autism (6)	Level 1 (4), Level 2 (1), Level 3 (1)

Table H.3, Appendix H, displays the results from the second test using a questionnaire.

As mentioned in the introduction of this section, each of the AUS questions included a mandatory field, “Please specify your chosen option,” to understand participants’ feedback better. Appendix H, Table H.4, Table H.5, and Table H.6 display a detailed overview of the participant’s comments.

As previously mentioned, two additional free-text questions were added on top of the AUS questions: “What did you like the most about the accessible website?” and “Where do you see room for improvement on the accessible website?” Table H.7 in Appendix H displays the responses from the participants.

6.3.2.2 A think-aloud session

A think-aloud protocol is a usability test in which users are asked to think out loud while performing a set of defined tasks and verbalize their thoughts while using the interface. To perform this usability test, it is recommended to recruit the users, define the tasks they will perform during the testing session, and listen

properly to users' feedback. [57].

This usability test has some advantages; for example, users can provide an honest opinion and share their thoughts on the interface. Designers can usually detect easily if the participants face challenges while interacting with the system. The participants can share many good ideas and recommendations for improving the design interface. [57].

Recruitment process

Participants needed to be 18 years old or older with a medical diagnosis of autism with any level of support required. There were no residence specifications, but there was a need for possible communication in English. Participants could participate online directly or with help from a supporter in case of need and preference. The requirement of participants was done via social media. It was aimed to require between 5-10 users. A reimbursement in the form of a voucher for 15 euros was offered to the participants.

Table 6.2 displays an overview of users' demographic information. Appendix I, Table I.1, and Table I.2 display the participants' general characteristics per user. Six users participated in the think-aloud session. The average time for one session

Table 6.2: Users' demographic information

Country (6)	Austria (1), Scotland (1), United States (2), United Kingdom (2)
Occupation (6)	IT (1), Student (2), Website designer (1), Data analyst (1), Unemployed (1)
Gender (6)	Male (4), Female (2)
Age (6)	18-29 (3), 30-39 (3)
Level of autism (6)	Level 1 (2), Level 2 (3), Level 3 (1)

was around 45 minutes.

A general setup of the think-aloud session

The think-aloud session was organized as follows:

- The session was via an online tool. Participants were asked about preferred tools, such as Skype and ZOOM, and all of the participants preferred ZOOM.
- Once the date and time were agreed upon, participants received a confirmation email including the following information: time and date of the session, link to ZOOM meeting, recommendations on using a desktop device rather than mobile, and preferred browser - Google Chrome. It also included information about the link for the prototype, which will be shared directly during the session. Two days before the session took place, a gentle reminder was sent.
- At the beginning of the session, the participant was provided an introduction to the study and what the session would look like as clearly as possible, including the number of questions (for an interview and the tasks) and estimated time for the session. Participants could ask any additional questions.
- After the introduction, participants were asked about consent to proceed with the testing and additionally were asked about consent to proceed with recording. It was explained to the participants that recording helps collect all feedback they provide. All participants provided consent.
- The next part was an interview of the participant, including the five questions shown in Table I.3, Appendix I.

- The next part was sharing the link to the prototype and asking the participant to share their screen. It was explained to the participants in the example how the think-aloud session works, and participants could ask any additional questions. The participants were also informed that the prototype uses fictive content, and the purpose of the study is to provide feedback for an accessible website interface rather than content.
- Then, participants would perform defined tasks that were decided before the session. Tasks for the think-aloud session are displayed in Appendix I, Table I.3.

Results from the User testing 2 - A think-aloud session

Detailed feedback from the participants is listed in Appendix I, section I.1. Below is a summary of the feedback received during the think-aloud session.

Table 6.3: A summary of feedback from the think-aloud session

Task	Feedback
Please share your 1st impression of the website.	All participants found the website clear, explanatory, and easy to navigate.
Find a customization panel and test it.	All participants liked the customization panel and the personalization it brings. They found it an excellent addition to the website. One additional font size was suggested.
Find information about autistic strengths.	All users found this page quickly and felt familiar with the navigation bar. Most users mentioned that they liked how the information was listed, one after another, using the bullet points. Some users mentioned they liked the simplicity of the website, not including too many elements and text.
Find information about the values of the autism community.	Users appreciated a table of contents included at the beginning of the pages leading to the history, mission, and values. These users who activated the underline links feature from the customization panel liked that these clickable titles were highlighted. Users also liked the button “Back to top,” which made navigation on the website even easier.
Find information about available services.	Users liked that the list of the available services was listed below each other and led to a separate page. Some participants mentioned the “Contact Us” placement, as they found its placement perfect and easy to contact the team.
Find out how you could book a course you would like to attend.	All participants found a way how to book the service quickly.
Find information about Sabine H - Office manager	Most participants liked the page; they would only appreciate including the pictures of the team members except for the placeholder icons and every team member’s email and phone numbers.

Chapter 7

Discussion

This chapter describes and interprets the user test session results. It includes a comparison, best practices, and possible limitations of the two methods used in testing with the target group. It also contains the final customization panel proposal following the feedback from the testing session and future work suggestions.

7.1 User testing 1 - Neurotypical participants

The first user testing was done with neurotypical participants, and it aimed to understand if the website's prototype was usable and appealing before it was shared with the target audience. For consistency, accessible surveys and AUS were used.

Overall, the website prototype's usability score was high, 95 from the highest possible score of 100, which showed that the website was usable.

This method would generally be recommended for usability testing with neurotypical users, but additional methods of providing more detailed feedback and conducting interviews with some participants might also be recommended.

7.2 User testing 2 - Autistic participants

Twelve participants with an autism diagnosis participated in the second testing session. Six users provided feedback via a questionnaire, and six users participated in an online think-aloud session. Both sessions are described in more detail in separate subsections.

7.2.1 Questionnaire - AUS

This testing was done online by sharing the links for the Figma prototype and the questionnaire directly with the target audience, autistic organizations, and on social media.

Based on the best practices from the first testing session, the questionnaire was slightly adjusted to ensure the participants could provide more detailed feedback on the prototype.

Results and learnings from the User testing 2 - Questionnaire

The questionnaire was created based on the AUS score, including a mandatory field for specifying the chosen option and two additional questions that allowed participants to provide more detailed feedback on the website's prototype.

Overall, the usability score of the website's prototype was high, with an average score of 82 from the highest possible score of 100, which shows that the website was usable. The additional field, "Please specify your chosen option," helped researchers understand some feedback. Based on the comments provided, it looked like some users did not like this field was mandatory, some users did not understand the questions asked, some answers were general, not specific to the tested prototype, and some comments would need further clarification. The two additional free-text questions allowed users to provide feedback on what the users liked about the prototype and where they saw room for improvement.

The results from the questionnaire lacked detailed input on some of the chosen options. Also, some of the responses indicated that the participants did not feel comfortable with the questions. Based on the comments received, one user suggested including a read-aloud function, and another suggested hiding a customization panel. Most of the feedback was positive, but some would need further clarification.

Using a questionnaire for this target audience has some advantages; for example,

7.2 User testing 2 - Autistic participants

it can be created in the tool, as was, in our case, Accessible surveys, allowing participants to customize the questionnaire, which is primarily for this target group. Users can test at any time, in their preferred environment, and divide testing into several sessions. Questions from the Accessible usability scale consider that some participants might use an assistive technology. Nevertheless, from the feedback in the comment fields, some questions might not be clear to participants, and some users did not like how the questions were defined.

To receive more detailed feedback on the website design and interface and to understand if there might be some potential accessibility barriers, it was decided to try another method for testing with the target group: a think-aloud session.

7.2.2 A think aloud session

Six users participated in the think-aloud session. The average time for one session was around 45 minutes.

Results from the User testing 2 - A think-aloud protocol

The feedback was overall very positive. The navigation and interactive website's prototype were evaluated as easy and intuitive. The room for improvement was seen mostly in the customization panel. Hence, the following adjustments were made:

- Customization panel - this title was deleted. This place would be a placeholder for the logo.
- Theme and Contrast color options were included in one drop-down menu.
- Word "default" was included next to the light theme and small font since these options were default settings.
- One additional font size was added, the medium font size. The font sizes were increased for the body text as follows: small font size 18pt, medium

7.2 User testing 2 - Autistic participants

font size 20pt, and big font size 22pt.

- Adding a reset button, which changes the customization panel settings to default.

For the content, the following adjustments were recommended:

- Renaming “Coaching” to “Coaching for autistic people.”
- Using bullet points instead of numbers.
- Where possible, substitute the full-text paragraph with bullet points.

Figure 7.1 displays the final customization panel design proposal. The rest of the website design layout was as explained in Chapter 6, Figures 6.3, 6.4, and 6.5.

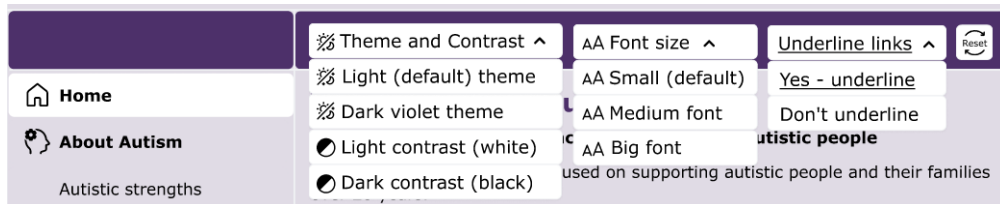


Figure 7.1: Customization panel - final design proposal

Learnings from the User testing 2 - A think-aloud protocol

This testing session provided a more precise and detailed overview of what could be improved in the design interface. It was also an excellent opportunity to get closer to the target audience and understand how the users interacted with the website.

As the best practice for planning a think-aloud session with people on the autism spectrum, the following suggestions would be recommended:

Before the session: Provide a clear overview of the session, including the date, time, recommended devices, and other relevant information.

During the session: Provide an introduction and clearly explain the purpose

7.2 User testing 2 - Autistic participants

of the study. Try to create a positive and welcoming atmosphere. Let participants know what task they are currently proceeding with and how many tasks are remaining. Ensure the participants have enough time to complete the task and provide feedback. If the participant is silent for extended periods, ask them what they think. If the participant does not provide feedback, you can ask some follow-up questions, for example: how do you like the color, left navigation, and customization panel used on the website? You can also provide feedback to users after performing tasks, for example, thank you for your feedback, say if you would like to mention something additional, etc. Even though the participants were told that the website's content was fictive, they provided feedback. We did not want to interrupt their thoughts, so we collected and included this feedback in the recommendations, as it was an essential part of the interface testing.

Ending the session: Show participants your appreciation by thanking them for their time and mentioning that their feedback is very valuable and will improve the tool's interface.

This method would be recommended for this target group overall, but proper preparation is recommended. If possible, we suggest including a supporter, therapist, or a professional working with the target audience in the session.

7.2.3 Comparison of both methods

Both usability testing methods used for this target group have pros and cons.

Using the AUS score allowed all people with an autism diagnosis to provide feedback; it did not exclude any level of support needs. Participants could test in their preferred environment. The accessibility questionnaire tool would be strongly recommended for this particular group of users. Some people on the autism spectrum might have limited speech or could not prefer calling, as provided in some of their comments. This needs to be considered while choosing the

7.2 User testing 2 - Autistic participants

correct testing method. Also, the questions should be defined for people with and without using assistive technology and should be defined directly for this audience.

We saw a lack of usability testing scores for this target audience, which we see as an opportunity to create in future work.

A think-aloud session provided a better understanding of how the users interacted with the tool. The researchers got closer to the target group and could better understand their wants and needs, which is considered an advantage of this method. As already mentioned, some people with an autism diagnosis did not prefer calls and did not feel comfortable participating in such sessions; hence, it should not be limited only to this method.

To sum up our learnings from both testing methods and considering the available tools, we would not recommend using only one of these methods but combining them. A questionnaire using AUS allowed all target audience to participate in the testing and provide feedback. A think-aloud session provided a valuable experience of talking with the target audience and seeing the interaction process, which an online anonymous questionnaire could not provide.

We see room for improvement in creating usability and accessibility methods, particularly for this target group. These methods should also consider online testing and all levels of support needs and not be focused only on one level of autism.

7.2.4 Limitations and future work

This work was focused on understanding how to design accessible website interfaces for people with an autism diagnosis. Two major limitations of this study could be addressed in future research.

First, there is a limited amount of testing data available due to the low number

7.2 User testing 2 - Autistic participants

of users participating in the testing sessions. Many autistic organizations were addressed to recruit more participants, but we were successful in recruiting 12 altogether target users. The suggestions for improving the design layout were based mostly on the qualitative data collected from the participants' feedback written in the questionnaire or mentioned during the think-aloud protocol. Although the designs followed some of the already existing accessibility guidelines, generalizing the additional recommendations would require testing with a higher number of users from the target audience.

Second, during the design process and testing, it was found that no usability testing method was designed for this target audience, which would include all autism levels and different preferences for providing feedback. Our research found no method focusing on usability and including accessibility testing scores. Hence, the first recommendation for future work would be to create a usability and accessibility method, particularly for people on the autism spectrum. This method should include a detailed explanation and preparation for the testing since many stakeholders do not have a background in working with people on the autism spectrum. Even if the testing is only for the design of the product or service, it is recommended to pay attention to the content included on the website, as some naming conventions might be considered sensitive for this target group. Some high-level recommendations are listed in Chapter 8. During the testing sessions, one user mentioned including a read-aloud function, which might be tested and implemented in future work. The rest of the users were satisfied with already existing customization options. More color palettes and combinations could also be tested and included in the customization panel, but they should not be too complex. Apart from that, simplicity was a preference, and this should be considered in any further work on designing accessible interfaces for people on the autism spectrum.

Chapter 8

Design and content recommendations

8.1 Design recommendations

Following already existing accessibility guidelines for people with cognitive disabilities, neurodiverse people, and people with an autism diagnosis, the website's prototype was created and tested. We suggest considering the following recommendations when designing a website for people on the autism spectrum.

Navigation bar

Based on the learnings from the testing sessions, we suggest the following:

- A simple design interface excluding pictures in the background, moving elements, advertisements, pop-up messages, and blinking text.
- Consistent navigation on all pages.
- Left-side navigation is recommended.
- The number of pages should be limited and display only quality information.
- Highlighted clearly which page the user is currently on.
- A site map should be displayed in the navigation bar. Titles of the main pages should be in bold and should include related icons.

The design proposal for the navigation bar is displayed in Figure 8.1.

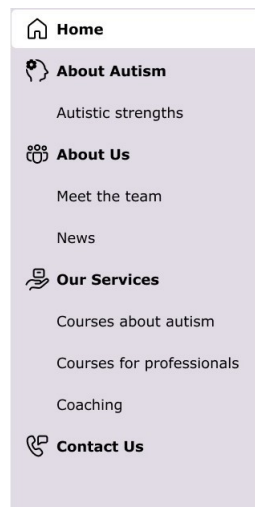


Figure 8.1: Left-side navigation bar

Customization panel

Specifically for this target audience, personalization on the website is essential. We recommend positioning the customization panel clearly on the website so the audience can see it after visiting it and does not need to search for it. We recommend that the customization panel includes the following areas to customize:

- One drop-down for Theme and Contrast. It should include at least one mild color theme, a dark color theme, and light and dark contrast.
- It should clearly state what color palette and font are default settings.
- The drop-down menu should include icons that should be clickable.
- It would be recommended to use at least three levels of font sizes, starting at the minimum font size of 16pt, ideally 18pt for plain text. Titles and buttons should be around 2 points higher.
- Most participants liked the underline feature, which we recommend adding to the customization panel.

- A reset button should be a part of the customization panel.

Additionally, we would recommend adding a read-aloud functionality, if possible.

Figure 8.2 displays the design proposal for the customization panel.

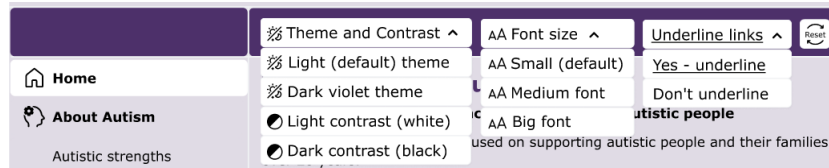


Figure 8.2: Customization panel

Text on the website

In the best scenario, the text block would be substituted with shortened, straight-forward text using bullet points. In some cases, scrolling is necessary; we would recommend the following:

- Using only vertical scrolling. The horizontal scrolling might be unexpected for the user.
- At the beginning of every page, which requires scrolling, a clickable table of contents leading to the dedicated parts of the page that should be added. Users found this very helpful.
- Bold text for the titles and primary information should be used in the text.
- Bullet points instead of numbers were preferred by the target audience.
- Text paragraphs should be divided by lines, which helps better understand that the following content might be focused on a slightly different topic.
- Pictures or icons for better comprehension of the text should be placed next to the relevant title or paragraph.

8.1 Design recommendations

- A maximum of two different sizes of buttons. The bigger-sized buttons should be for the “Contact Us” primary CTAs, and the smaller-sized buttons, for secondary CTAs.
- Buttons should include related icons suggesting the action; for example, the “Contact Us” CTA should include an email or phone icon, the “Read more” CTA should include an arrow, etc.
- Longer pages that require scrolling might include a “Back to top” button leading to the page’s table of contents.
- If the “Meet the Team” page is included on the website, an email and phone number should be placed next to each team member.

Figure 8.3 displays the design layout of the page, including a table of contents, paragraph dividers, a primary “Contact Us” CTA, and a secondary “Back to top” CTA.

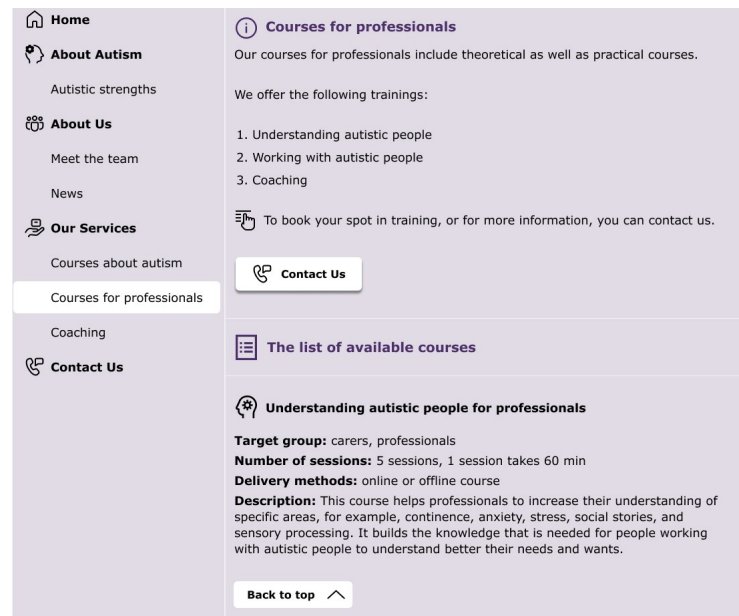


Figure 8.3: Page design layout

8.2 Content recommendations

The recommendations on the content were not initially planned to be included in this document. Still, based on the learnings we gained during the testing with the target group, we appreciate its importance and recommend high-level suggestions that can be used for testing purposes while designing the interface specifically for people with an autism diagnosis. We would like to mention that regarding the content on the website for this target audience, there is already separate literature on this topic that is recommended for review.

The content on the websites was fictive content, including some information from the empathize phase and some ideas about pages and courses based on already existing websites with autistic content. A general recommendation would be to keep the content as simple as possible. It should aim to provide important information or summarize the content, allowing users to read more if needed. For this target group, some of the content might be considered sensitive; hence, it is important that the content is reviewed before the testing sessions. Some of the specific feedback we received during the testing with the target audience was to include the page about autism and the strengths of autistic people since these pages were greatly appreciated.

Participants also found it essential to include the “Meet the Team page,” which should consist of pictures and contact details of the people. Participants mentioned that they felt connected while seeing this page and would feel more confident and comfortable to contact the team. Additionally, users mentioned that contact information should include phone as well as email information since some of them might find it uncomfortable to call and would prefer writing an email instead.

Some participants mentioned they would be interested in the page, including the news, not only about the organization but also about the achievements of people

8.2 Content recommendations

on the autism spectrum, research about autism, digital tools, etc. They would like to keep informed about the news related to autism. One user mentioned that they would like to see some recommendations on proven social media accounts that provide quality information about autism. Another recommendation was about factful content on the website. Including information about years of experience in the field was appreciated and valued by some of the participants. They mentioned it gave them confidence to work with the organization. Some users mentioned that they enjoyed the various courses offered on the website. We would not recommend using placeholder text on any parts of the websites, but instead, we recommend writing a note that this part of the website is a placeholder. We strongly recommend paying attention to the content displayed on the prototypes and ensuring it is user-friendly and follows at least high-level guidelines. Some of the guidelines we followed are mentioned below:

- Ask the particular person or a group their preference for being described. Use “identity first” language instead of “person first” language. It is recommended to say autistic person/people/child/adult instead of saying person/people/child/adult with autism.
- Say they are autistic or have an autism diagnosis instead of saying they suffer from autism, they are victims of autism, they have/are living with autism, or they are an aspie/autistic/autie/autist.
- Refer to autism as autism is a spectrum condition, and a person/people/child/adult is on the autism spectrum.
- If you are explicitly referring to terminology in the medical manuals, it is acceptable to use “autism spectrum disorder”; otherwise, it is not recommended to use “disorder.” Condition is more preferred compared to disorder.

8.2 Content recommendations

- Autism is a lifelong disability, not a handicap, illness, mental illness, or disease.
- Use non-autistic, not autistic, or neurotypical instead of using “normal” people. People find it offensive since it suggests some sort of hierarchy, where only one “right” way of being exists.
- Autistic people are neurodivergent; autism is a neurological difference, and autism is a form of neurodivergence. Do not say that autism is a neurological disorder.
- Use terminology for autistic people with low or high support needs and autistic people without or with learning disabilities. Do not use terminology as low or high-functioning autistic people and severe or mild autism.
- Is it recommended to use terminology such as adjustments, support, needs, and access requirements and to avoid using terminology such as cure and treatment since autism is not a disease or illness and it can not be “cured” or “treated.”
- Use terminology such as common autistic characteristics and traits, and avoid saying signs or symptoms of autism because these words are commonly used to describe illness, and autism is not an illness.
- It is recommended to say that an autistic person who has unreliable, limited or no speech, who speaks few or no words. It is not recommended to refer to an autistic person as a non-verbal autistic person [52].

Chapter 9

Conclusion

This work contributed in the following main areas:

- There were collected and summarized already existing accessibility guidelines for the target audience.
- Following the most common accessibility guidelines and feedback from interviewed UX experts designing for neurodivergent users, the prototype of accessible websites was created and tested with the target audience. Based on the learnings from the testing sessions, additional ideas followed by the visual explanation of accessibility recommendations for people on the autism spectrum were created.
- Because there is no existing online usability and accessibility evaluation method for this target group, two different testing evaluation methods were used, described in detail, including their advantages and limitations.
- High-level content recommendations for testing with the target audience were collected and included in a separate section.

Chapter 1 introduced the autism spectrum condition and the importance of the Internet for people with an autism diagnosis. It also included the research questions and objectives.

Chapter 2 described digital accessibility and its importance. It explained possible cognitive barriers for people with cognitive disabilities and their potential consequences.

Chapter 3 introduced projects related to the accessibility of digital tools. These projects were designed for people with disabilities, and some of them were specifically designed for the target audience.

Chapter 4 listed already existing accessibility guidelines for people with cognitive disabilities, some of them specifically for autistic audiences. These guidelines were used as a base for designing the prototype, as explained in Chapter 5 - Methodology.

Chapter 5 explained the design thinking process framework and its results from the different phases, as well as the final wireframe and prototype. Chapter 6 explained the testing recruitment process, evaluation method, and results from two testing methods used to collect feedback from participants.

Chapter 7 discussed the main findings gained during the testing sessions, the pros and cons, and the comparison of methods used specifically for the target group. Chapter 8 provided an overview of design and recommendations for people with an autism diagnosis, and Chapter 9 concluded this research paper.

This dissertation summarized already existing accessibility guidelines and included additional accessibility recommendations for the target audience. To ensure that digital interfaces will be accessible for disabled people, it is essential to create social awareness about the need for tools to be accessible. People being aware of the needs and preferences of people with different disabilities will create a curiosity for people to gain knowledge in this particular field. Created guidelines in the form of a checklist, supported by the visual explanation are a great base to provide the overview needed for designers and developers to proceed with the interface creation. It is essential, that the target audience participates during the whole design interface process. Additionally, there should be added specific informative content study modules within the Media design and related fields about the importance of designing accessible interfaces.

Appendix A

Cognitive processes informing the experience of autism spectrum condition

Literality: People on the autism spectrum, especially children, usually understand their world in literal terms. For example, if a mother asked her son if he could tidy his bed, and he answered yes, it did not mean he would clean it; since his mother asked him if he could do so, she did not tell him specifically to tidy his bed.

Monotropism: It means having the ability to focus on one interest in time or one aspect of communication.

Non-generalized learning and thinking in closed pictures: The picture of the experience, event, or article may not consider scale, context, and intention. For example, if an autistic person sees a picture of an animal and sees it in real, he might think that since it does not seem exactly like the picture, it might not be this animal.

Non-social priorities: People with an autism diagnosis might lack social priorities and prefer the company of others being alone. Some people on the autism spectrum might lack decisions that encompass their needs, opinions and wants.

Difficulties with motion and time: Time, past, present, or future might appear always to be the present.

Difficulties with predicting outcomes: People on the autism spectrum might face difficulties predicting outcomes and consequences; hence, they prefer having

a coordinated and structured life.

Difficulties with the theory of mind: The need to comprehend that other people have their own emotions, opinions, and thoughts, which may differ from the other's ideas, etc [19].

Appendix B

Define phase - PersonAut

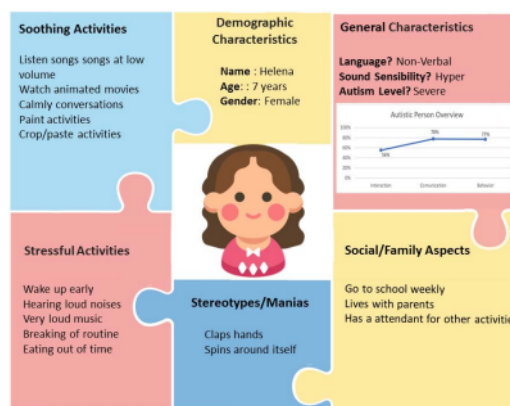


Figure B.1: PersonAut Model: type 1

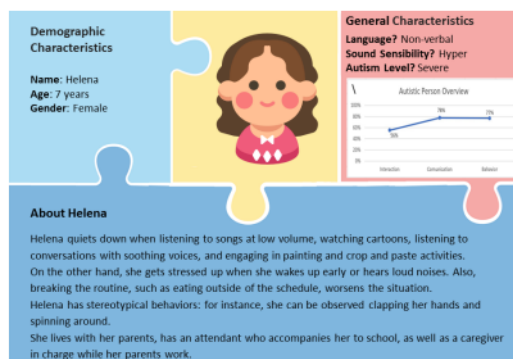


Figure B.2: PersonAut Model: type 2

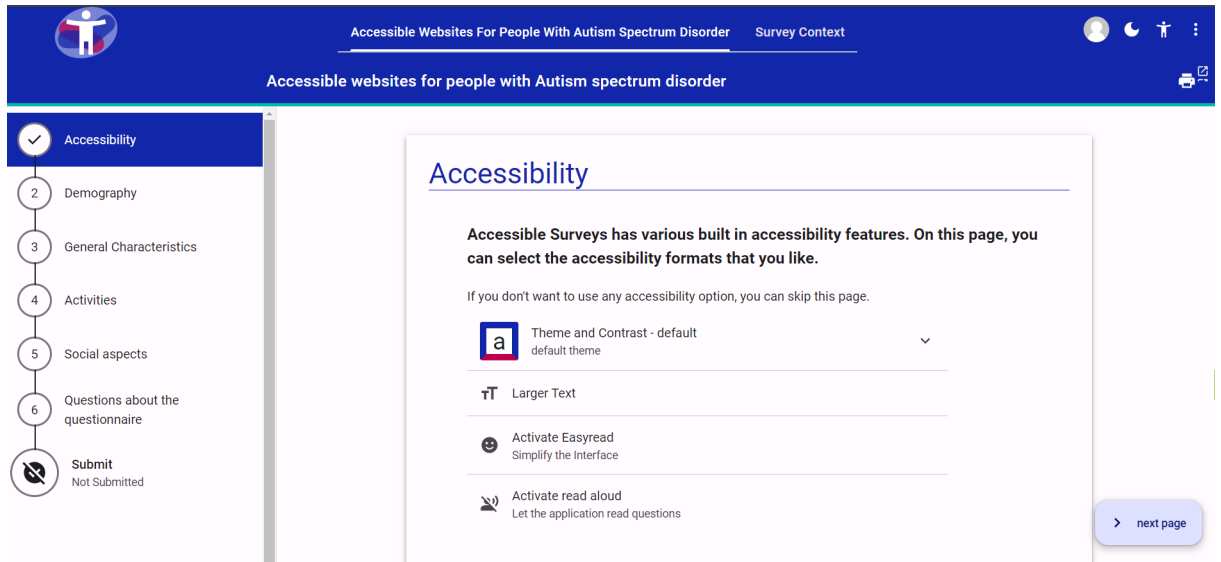


Figure B.3: Accesibility option [11]

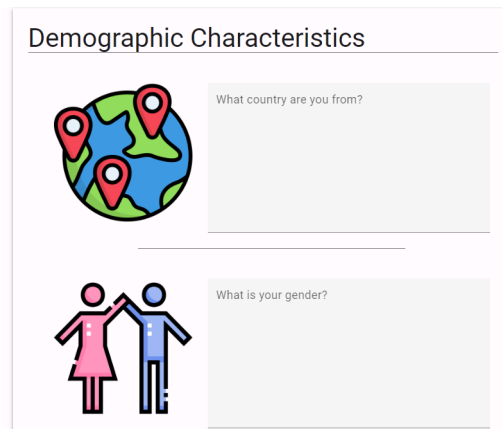


Figure B.4: Easyread option [11]

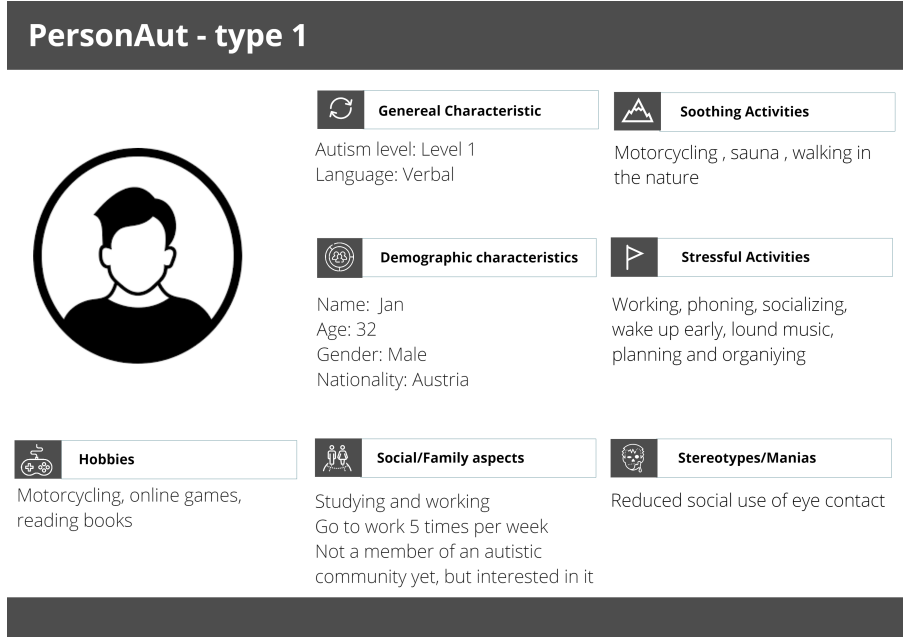


Figure B.5: The user persona

Table B.1: PersonAut - demographic characteristic

N.	Questions	Answers
Q1	What country are you from?	Austria
Q2	What is your gender?	Male
Q3	What is your age category?	30-39

Table B.2: PersonAut - general characteristic

N.	Questions	Answers
Q1	What is your level of autism?	level 1
Q2	Do you have any stereotypes of autistic behavior?	No, everyone is different
Q3	How often do you use the internet for a specific set of tasks or activities?	daily
Q4	What is your purpose for using the Internet?	online shopping, connecting with peers, searching for digital tools, online games
Q5	Does the internet help you with socializing?	Yes fb and insta
Q6	Have you ever used the internet to search events for people with autism?	Nope
Q7	Have you ever experienced you could not use the website because it was not accessible?	Never

Table B.3: PersonAut - activities

N.	Questions	Answers
Q1	Which activities or situations do you consider calming?	Motorcycling and sauna
Q2	Which activities do you find stressful during your day-to-day activities?	Working, phoning, doing social duties

Table B.4: PersonAut - social aspects

N.	Questions	Answers
Q1	Are you studying or working?	Both
Q2	How often do you go to the University or work?	5x / week
Q3	Are you a member of an autistic community group?	Not yet but intetested
Q4	How do you like spending your free time?	Most of the time just chilling and being alone. Otherwise coding
Q5	Could you describe your usual day?	Waking up without alarm, going to work with flexible time. Studying during the day because I work at university and I combine it. Going home between 3 and 4 and resting for 1-2 hours. Then social time with family and eating something. Going to sleep before 22:00.

Appendix C

Ideate phase

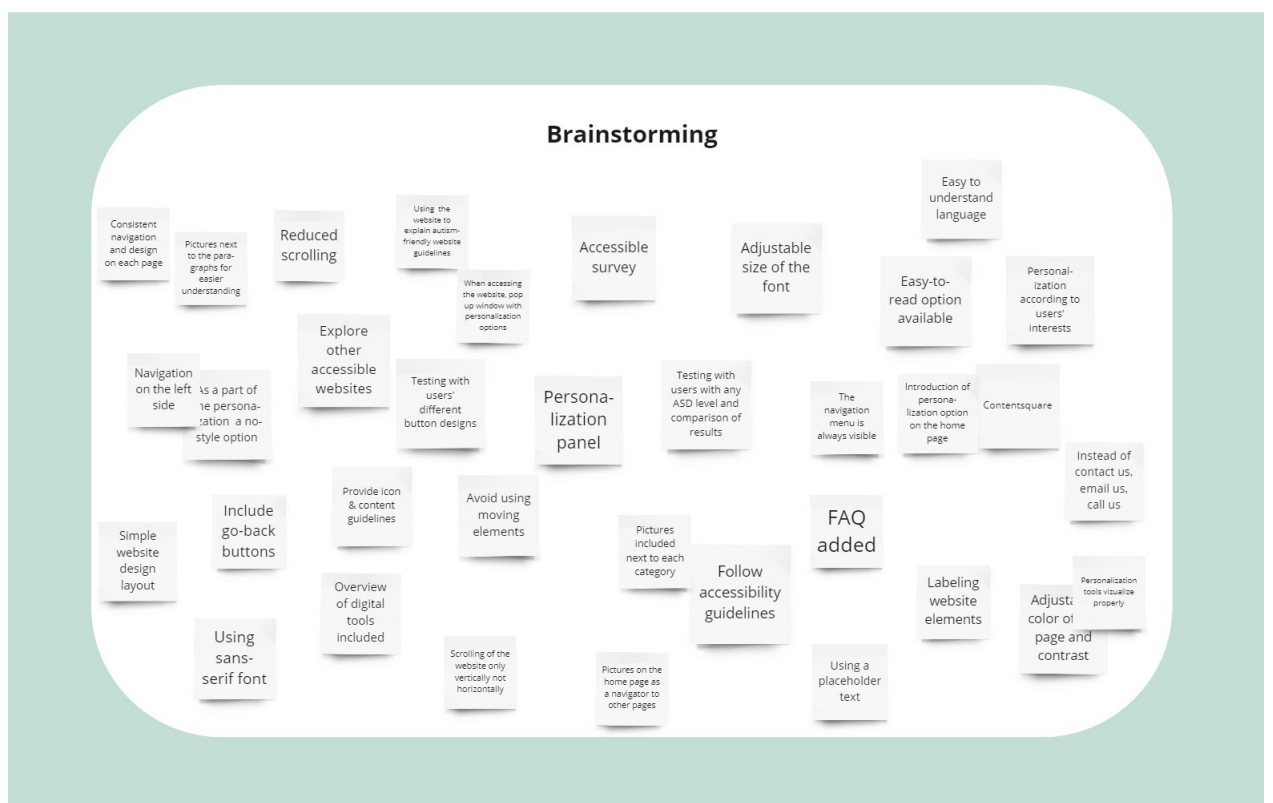


Figure C.1: Brainstorming

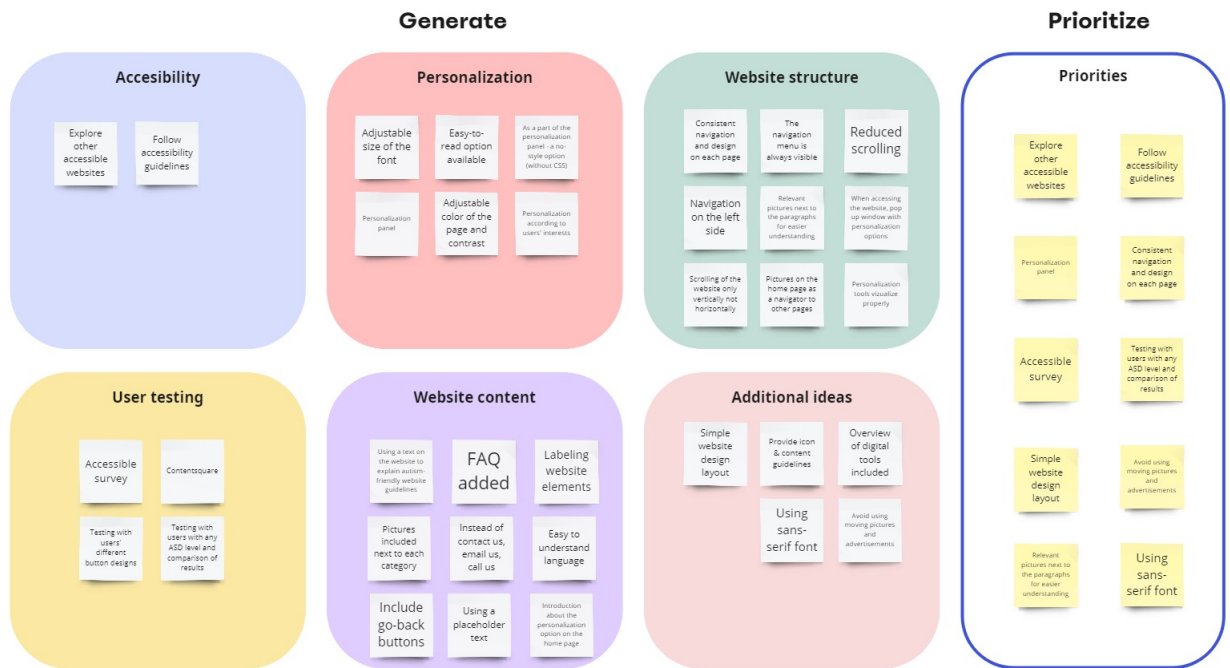
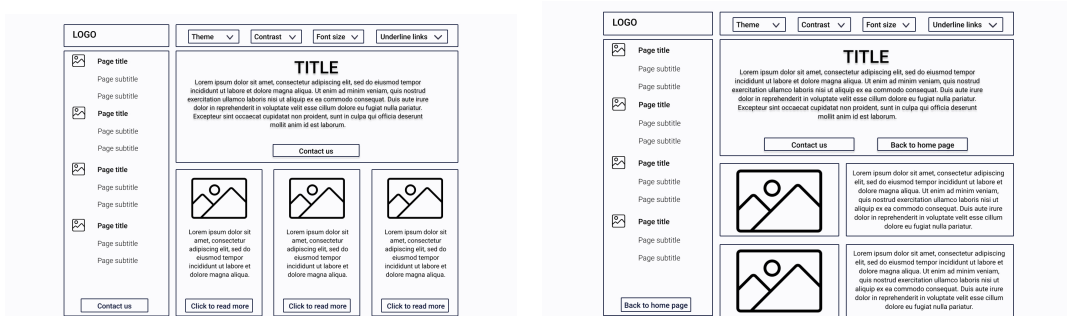


Figure C.2: The affinity diagram

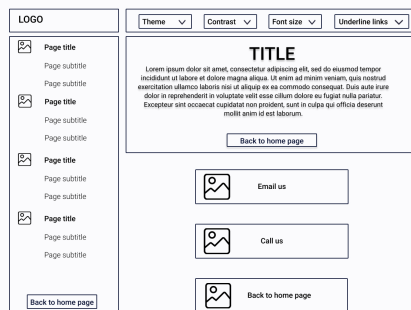
Appendix D

Wireframe and site map



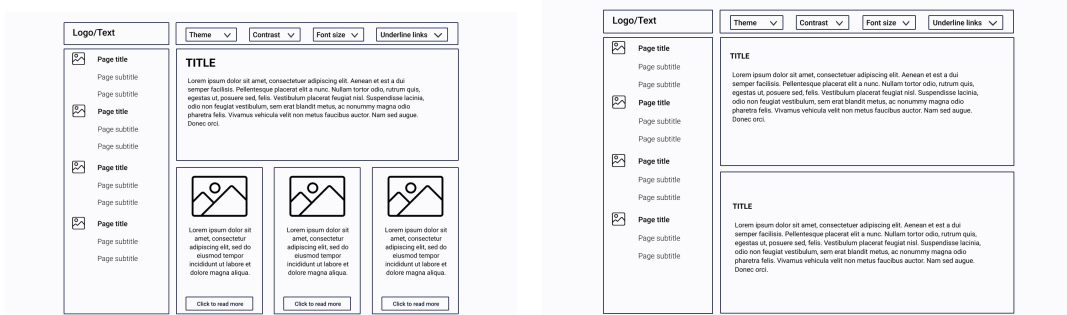
(a) Home page

(b) Landing page



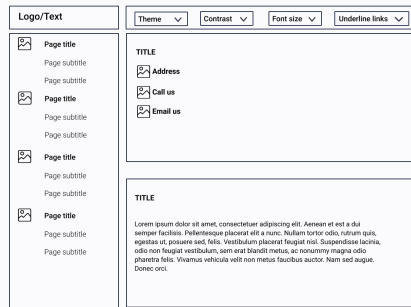
(c) Contact us page

Figure D.1: Wireframes - 1st version



(a) Home page

(b) Landing page



(c) Contact us page

Figure D.2: Wireframes - final version



Figure D.3: Site map

Appendix E

Prototype phase - website's color palette

To combine colors and check the color combinations' contrast, the Accessible color palette generator was used [53]. The light theme is also the default theme, including mild color with lower contrast. Figure E.1 shows different website content modules with numbers from the tables for easier understanding of the color and contrast schemes.

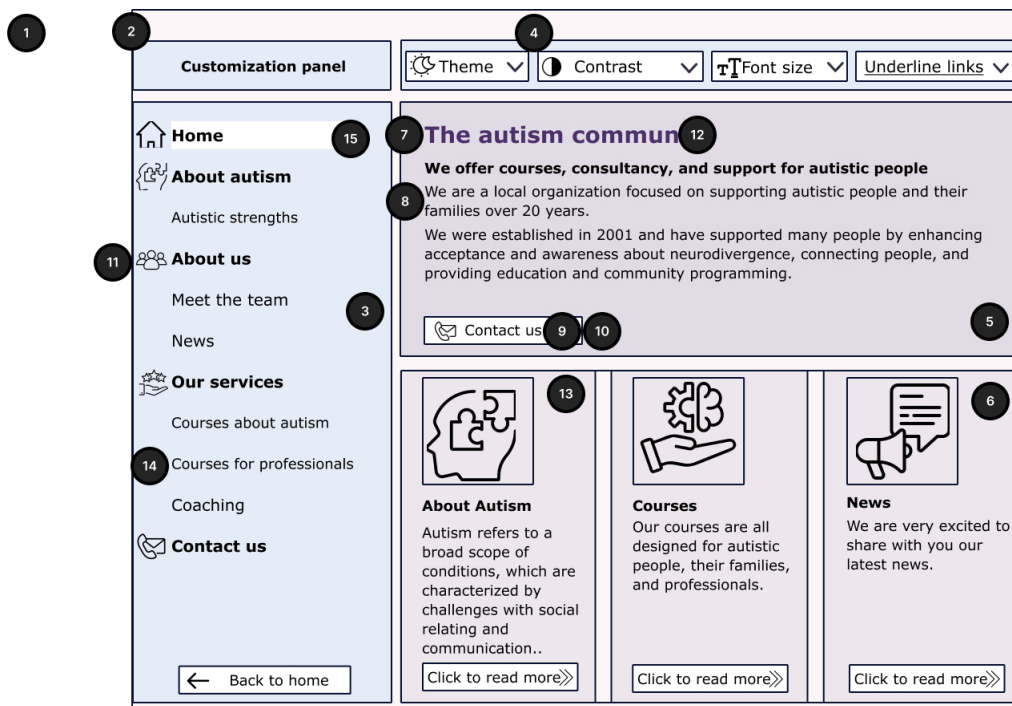


Figure E.1: Website content modules

Table E.1 displays defined theme schemes.

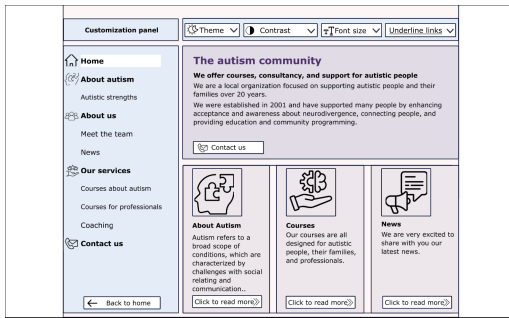
Table E.1: Theme color palette

Number	Content block	Theme light	Theme dark
1	Web.background	FFFFFF	4D306A
2	Web.interface	FCF6F7	B8B0C3
3	Navigation	E4ECF7	3A2652
4	Custom.panel	E4ECF7	3A2652
5	Introduction	E0DBE5	4D306A
6	Content blocks	EDE7EC	3A2652
7	Text main titles	4D306A	FFFFFF
8	Text body	000000	EDE7EC
9	CTA	FFFFFF	EDE7EC
10	CTA text	000000	000000
11	Icons in navigation	E4ECF7	EDE7EC
12	Icons in introduction	E0DBE5	EDE7EC
13	Icons in content blocks	EDE7EC	EDE7EC
14	Navigation title	000000	FFFFFF
15	Selected navigation	FFFFFF	4D306A

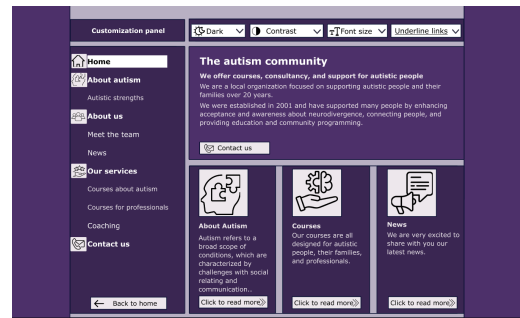
Figure E.2 displays the light and dark theme schemes applied on the accessible website.

Table E.2 displays defined contrast schemes.

Figure E.3 displays the high-contrast light and high-contrast dark schemes activated on the accessible website.

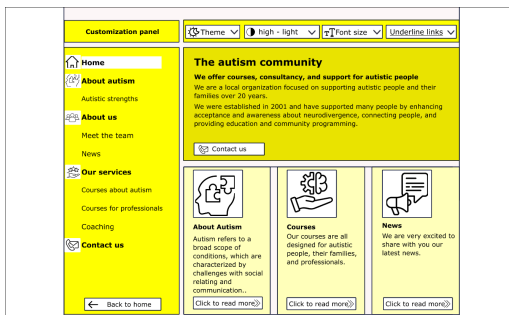


(a) Light theme

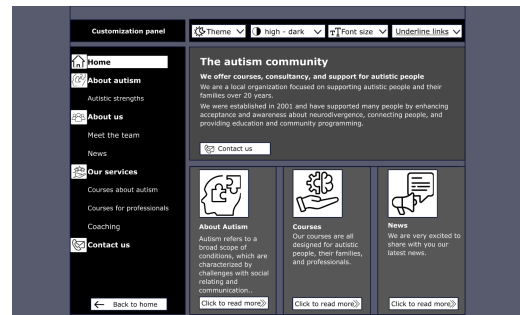


(b) Dark theme

Figure E.2: Customization panel - theme



(a) Light contrast



(b) Dark contrast

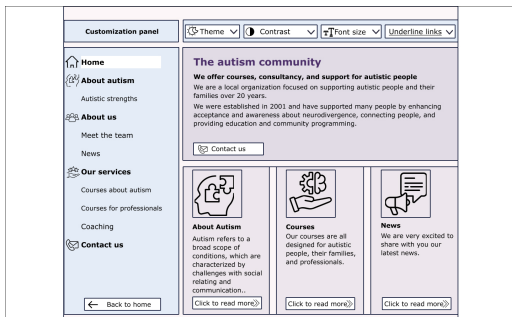
Figure E.3: Customization panel - contrast

Table E.2: Contrast color palette

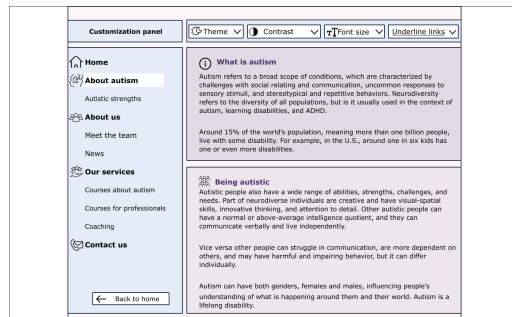
Number	Content block	Light contrast	Dark contrast
1	Web.background	FFFFFF	585A6D
2	Web.interface	FCF6F7	585A6D
3	Navigation	FFFF00	000000
4	Custom.panel	FFFF00	000000
5	Introduction	E9E300	484848
6	Content blocks	FFFFBA	575757
7	Text main titles	000000	FFFFFF
8	Text body	000000	FFFFFF
9	CTA	FFFFFF	FFFFFF
10	CTA text	000000	000000
11	Icons in navigation	FFFFFF	FFFFFF
12	Icons in introduction	FFFFFF	FFFFFF
13	Icons in content blocks	FFFFFF	FFFFFF
14	Navigation title	000000	FFFFFF
15	Selected navigation	FFFFFF	575757

Appendix F

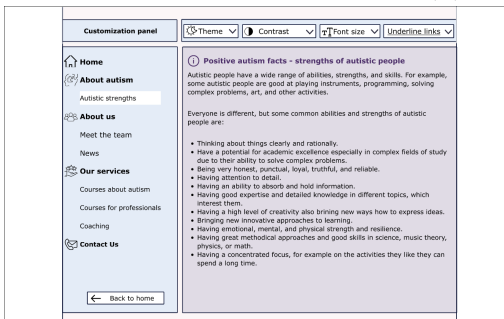
Prototype phase - website's prototype



(a) Home page

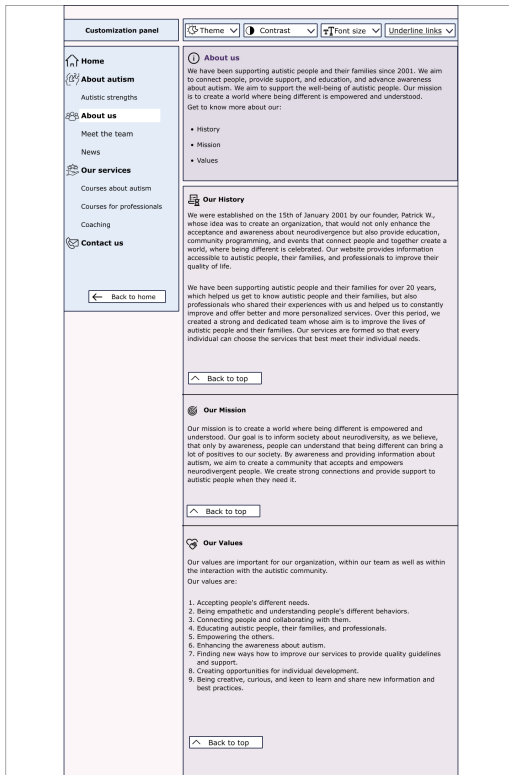


(b) About autism

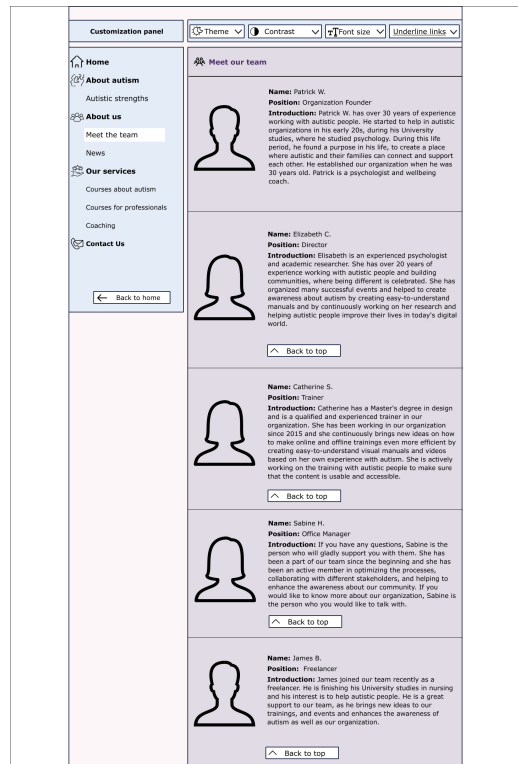


(c) Autistic strengths

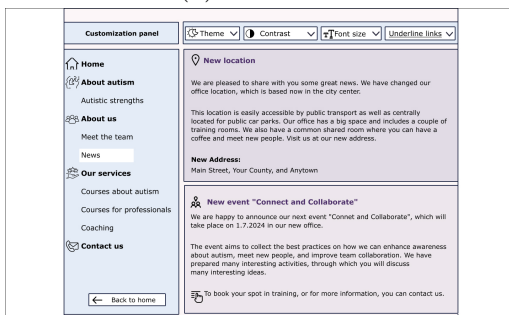
Figure F.1: Prototype - Home page, About autism, Autistic strengths



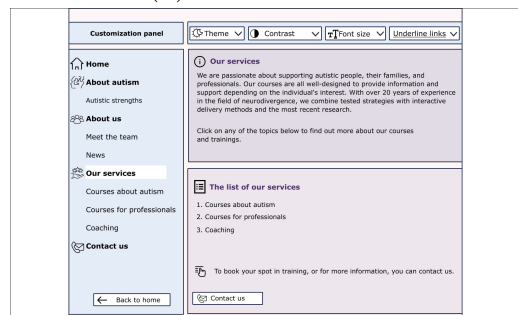
(a) About us



(b) Meet the team

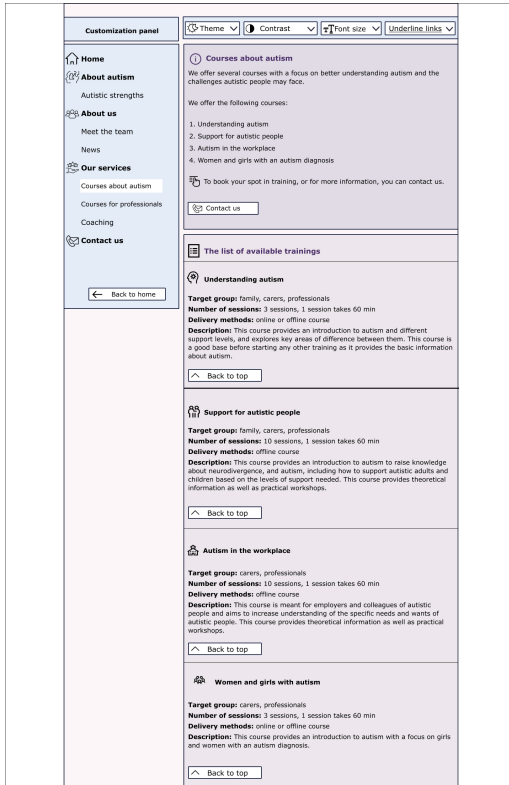


(c) News

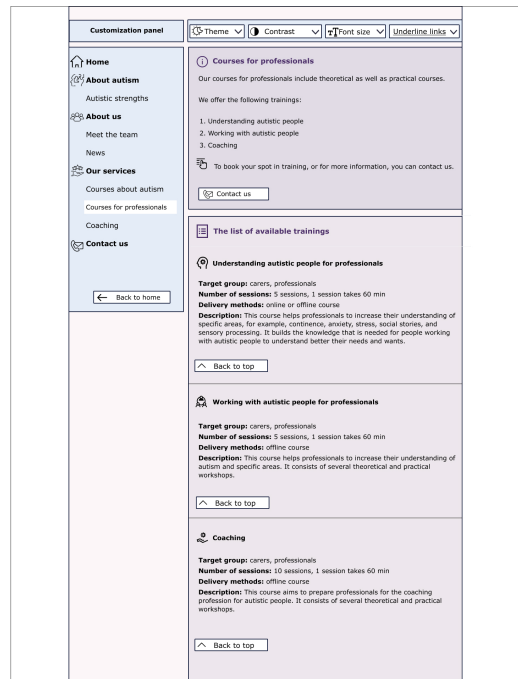


(d) Our services

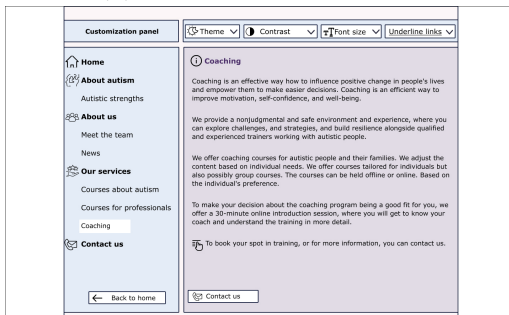
Figure F.2: Prototype - About us, Meet the team, News, and Our services.



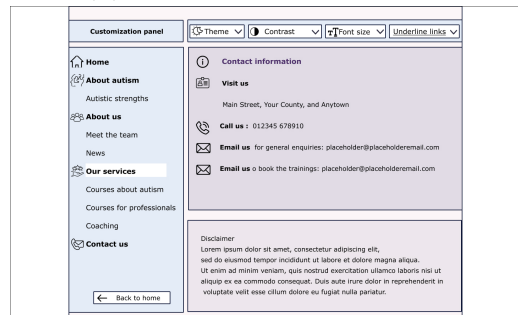
(a) Courses about autism



(b) Courses for professionals



(c) Coaching



(d) Contact us

Figure F.3: Prototype - Courses about autism, Courses for professionals, Coaching, and Contact us page

Appendix G

User testing 1

Table G.1: Difference between SUS and AUS questions

N.	SUS questions	AUS questions
Q1	I think that I would like to use this system frequently.	I would use this website frequently, if I had a reason to.
Q2	I found the system unnecessarily complex.	I found the website unnecessarily complex.
Q3	I thought the system was easy to use.	I thought the website was easy to use.
Q4	I think that I would need the support of a technical person to be able to use this system.	I think that I would need the support of another person to use all of the features of this website.
Q5	I found the various functions in this system were well integrated.	I found the various functions of the website made sense and were compatible with my technology.
Q6	I thought there was too much inconsistency in this system.	I thought there was too much inconsistency in how this website worked.
Q7	I would imagine that most people would learn to use this system very quickly.	I would imagine that most people with my assistive technology would learn to use this website quickly.
Q8	I found the system very cumbersome to use.	I found the website very cumbersome or awkward to use.
Q9	I felt very confident using the system.	I felt very confident using the website.
Q10	I needed to learn a lot of things before I could get going with this system.	I needed to familiarize myself with the website before I could use it effectively.

Table G.2: AUS scale

Response	Scale
Strongly Disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly Agree	5

Table G.3: Participants' general characteristics - user testing 1

N.	Question	User 1	User 2	User 3
Q1	What country are you from?	Portugal	Portugal	Tajikistan
Q2	What do you do for a living?	Student	Student	Student
Q3	What is your gender?	Male	Male	Female
Q4	What is your age?	18-29	18-29	30-39
Q5	What is your level of autism?	I do not have autism	I do not have autism	I do not have autism

Table G.4: Results from the user testing 1

userID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	AUS Score
1	5	1	5	1	5	1	3	1	5	1	95/100
2	5	1	4	1	5	1	5	2	5	1	95/100
3	5	1	5	1	5	1	3	1	5	1	95/100

Appendix H


User testing 2 - Questionnaire

Table H.1: Participants' general characteristics - User testing 2 - Questionnaire

N.	Question	User 1	User 2	User 3
Q1	What country are you from?	Czechia	Czech republic	Austria
Q2	What do you do for a living?	translator	Administrative worker-data analyst. I program some web scripts	IT Administrator
Q3	What is your gender?	Male	Male	Male
Q4	What is your age?	40-49	30-39	30-39
Q5	What is your level of autism?	Level 1	Level 3	Level 2

Table H.2: Participants' general characteristics - User testing 2 - Questionnaire

N.	Question	User 4	User 5	User 6
Q1	What country are you from?	Slovakia	Slovakia	Germany
Q2	What do you do for a living?	Process expert and senior accountant manager	IT	Marketing
Q3	What is your gender?	Female	Male	NB
Q4	What is your age?	30-39	40-49	30-39
Q5	What is your level of autism?	Level 1	Level 1	Level 1




I think that I would need the support of another person to use all of the features of this website. *

Strongly Disagree
 Disagree
 Neutral
 Agree
 Strongly Agree

Specify please your chosen option in the text field below. Please specify your chosen option. Your detailed explanation will help us to improve the website's accessibility


Please specify your chosen option*




I found the various functions of the website made sense and were compatible with my technology. *

Strongly Disagree
 Disagree
 Neutral
 Agree
 Strongly Agree

Specify please your chosen option and assistive technology in case you used it for the testing in the text field below. Please specify your chosen option. Your detailed explanation will help us to improve the website's accessibility. In case you didn't use any assistive technology, you can give feedback for using the website on your device, for example, a desktop. Note: assistive technology for autism can include a wide range of tools that can help someone learn, communicate, and carry out daily functions.



What would you suggest to improve on the accessible website...



Did you use and like the customization panel available on the a...

(a) AUS questions

(b) Open questions

Figure H.1: Questionnaire - example of the questions

Table H.3: Results from the user testing 2 - Questionnaire

userID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	AUS Score
1	5	2	4	1	5	1	3	2	4	4	77,5/100
2	5	3	5	1	5	3	4	1	3	4	75/100
3	5	2	5	1	4	1	5	1	5	1	95/100
4	1	3	5	1	5	1	5	3	5	1	80/100
5	4	2	5	1	4	2	4	1	3	4	75/100
6	3	1	5	2	5	1	5	1	4	2	87,5/100

Table H.4: User testing 2 - Questionnaire - Responses from user 1 and user 2

N.	Question	User 1	User 2
Q1	I would use this website frequently, if I had a reason to.	yes	I like this website
Q2	I found the website unnecessarily complex.	easy structure, good overview	I don't know, what to write.
Q3	I thought the website was easy to use.	Clear navigation, clear division of topics	Today almost everybody can use internet.
Q4	I think that I would need the support of another person to use all of the features of this website.	have you asked about my diagnosis?	I use websites daily.
Q5	I found the various functions of the website made sense and were compatible with my technology.	tested on mobile, great	Websites must have much functions to be practical.
Q6	I thought there was too much inconsistency in how this website worked.	thought through structure	I can't understand this sentence.
Q7	I would imagine that most people with my assistive technology would learn to use this website quickly.	I do not know about most autistic people	I think people with autism are able in various things.
Q8	I found the website very cumbersome or awkward to use.	easy	I think this website is good.
Q9	I felt very confident using the website.	not difficult, no unclear navigation	I must pay attention, what I write here.
Q10	I needed to familiarize myself with the website before I could use it effectively.	a lot of information, needed to explore	I didn't know the complete website before I have used it for some time

Table H.5: User testing 2 - Questionnaire - Responses from user 3 and user 4

N.	Question	User 3	User 4
Q1	I would use this website frequently, if I had a reason to.	why not, it is an interesting website	I have no reason to do so.
Q2	I found the website unnecessarily complex.	complexity is okay. good structure and everything to find	If i don't want any ads, i just use ad-block. If i want other changes, i'm more than capable to do so by myself.
Q3	I thought the website was easy to use.	yes, as mentioned absolutely easy to navigate.	I don't have any problems to use any website...
Q4	I think that I would need the support of another person to use all of the features of this website.	no everything works as intended	Just no
Q5	I found the various functions of the website made sense and were compatible with my technology.	right click does not work as intended. i dont need it at this specific website but it's a habit.	No problems
Q6	I thought there was too much inconsistency in how this website worked.	no it's not inconsistent. it works absolutely as intended	No problems
Q7	I would imagine that most people with my assistive technology would learn to use this website quickly.	yes, due to the structure it should work perfectly	Because generally we have no problem at all with websites
Q8	I found the website very cumbersome or awkward to use.	i haven't found any problems except some design things which i mentioned in the other fields	I don't have any opinion on it
Q9	I felt very confident using the website.	yes, it works	Like i said before...
Q10	I needed to familiarize myself with the website before I could use it effectively.	no, I was used to this site within 30 seconds	It's easy to use..

Table H.6: User testing 2 - Questionnaire - Responses from user 5 and user 6

N.	Question	User 5	User 6
Q1	I would use this website frequently, if I had a reason to.	i don't like that this input is mandatory	It it always useful to give friends / family resources to understand autism. But I wouldn't use it too often unless I'd take a course there :)
Q2	I found the website unnecessarily complex.	i don't like that this input is mandatory	Everything is very clear and understandable.
Q3	I thought the website was easy to use.	i don't like that this input is mandatory	Really easy to use :)
Q4	I think that I would need the support of another person to use all of the features of this website.	i don't like that this input is mandatory	Phone calls are hard, but since you can write e-mails all is good.
Q5	I found the various functions of the website made sense and were compatible with my technology.	custom zoom level	I used it in Microsoft Edge and it worked well.
Q6	I thought there was too much inconsistency in how this website worked.	i don't like that this input is mandatory	It's all very consistent.
Q7	I would imagine that most people with my assistive technology would learn to use this website quickly.	custom zoom level	-
Q8	I found the website very cumbersome or awkward to use.	i don't like that this input is mandatory	-
Q9	I felt very confident using the website.	i don't like that this input is mandatory	-
Q10	I needed to familiarize myself with the website before I could use it effectively.	i don't like that this input is mandatory	First I had to make sense of the options (contrast, etc.), but then it was easy.

Table H.7: User testing 2 - Questionnaire - Two additional questions

UserID	What did you like the most about the accessible website?	Where do you see room for improvement on the accessible website?
User 1	clear structure, design	nothing
User 2	A lot of practical functions, which I can use.	I don't understand the meaning of the sentence.
User 3	structure, definitely	yes. selectable text, the standard HTML dropdowns.
User 4	I don't know	I don't know....i just don't find it necessary. I think it would have more sens for the people with sight disabilities so you could add function "read out loud" for them
User 5	the site map on left side	more or customizable color schemes
User 6	The options to choose dark, light, and high contrast versions everywhere. Really easy.	Maybe a way to hide the customization panel. It should be viewable when first visiting the website, but once I'm done with it, it's distracting.

Appendix I

User testing 2 - A think-aloud session

Table I.1: Participants' general characteristics - User testing 2 - A think-aloud session - User 1, User 2, and User 3

N.	Question	User 1	User 2	User 3
Q1	What country are you from?	Austria	Scotland	United States
Q2	What do you do for a living?	IT – software development	Student	Website designer
Q3	What is your gender?	Male	Female	Male
Q4	What is your age?	30-39	18-29	30-39
Q5	What is your level of autism?	Level 2	Level 1	Level 2

Table I.2: Participants' general characteristics - User testing 2 - A think-aloud session - User 4, User 5, and User 6

N.	Question	User 4	User 5	User 6
Q1	What country are you from?	United States	United Kingdom	England
Q2	What do you do for a living?	Data analyst	Unemployed	Student
Q3	What is your gender?	Male	Female	Male
Q4	What is your age?	30-39	18-29	18-29
Q5	What is your level of autism?	Level 3	Level 1	Level 2

I.1 Results from the User testing 2 - A think-aloud session

Table I.3: The list of questions and tasks for the think-aloud session

N.	Questions	N.	Tasks
Q1	What country are you from?	T1	Share your 1st impression of the website.
Q2	What do you do for a living?	T2	Find a customization panel and test it
Q3	What is your gender?	T3	Find information about autistic strengths.
Q4	What is your age?	T4	Find information about the values of the autism community.
Q5	What is your level of autism?	T5	Find information about available services
Q6	Have you ever experienced a website interface not being accessible?	T6	Find out how you could book a course you would like to attend.
Q7	-	T7	Find information about Sabine H - Office manager.

I.1 Results from the User testing 2 - A think-aloud session

Five out of six users mentioned that they had already experienced the website not being accessible. They mentioned that some websites required too many interactions, which caused frustration; some websites did not work as they intended, drop-down menus were not working properly, there was wrong spacing, it was not user-friendly, etc.

Task 1: Please share your 1st impression of the website

All users found the website clear, explanatory, and easy to navigate. They liked the color and did not find the default color combination disturbing. One user mentioned that he did not like a combination of green and red colors in general, and one participant found the colors beautiful but mentioned they preferred darker color shades in general.

Participants also mentioned liking the navigation bar and its clarity and easiness

I.1 Results from the User testing 2 - A think-aloud session

of finding the pages. They found the navigation was self-explanatory and contained a consistent leveling and positioning of the navigation elements. They also liked that the main pages were in bold and included icons, which helped them to understand the content better. One participant referred to the navigation bar as a "customization panel" since the user thought it was its name. Participants usually focused on the navigation bar and customization panel; they liked the personalization option on the website.

One participant mentioned that they preferred full-screen websites rather than including the margin, but the rest preferred how the website was designed and would not change it. One participant asked if the prototype included a text-to-speech feature. One participant mentioned that they would appreciate it if the text was bigger.

Task 2: Find a customization panel and test it

All participants liked the customization panel and the personalization options it brings. They found it a nice addition to the website. After setting up their preferences, one participant responded, "This is really interesting. I love it in this way!" One user confused the customization panel with the main navigation bar due to the title above the navigation bar, which might be misleading. The specific options within the customization panel were commented as follows:

- **Theme and Contrast:** All users liked the color palettes and appreciated the functionalities to personalize them. They mentioned the darker background made the readability even easier. They also liked that the margins did not have the same color as the website's background, as it helped them to keep the focus on the website. The most favorite colors were theme-dark and contrast-high-dark. After setting the color to theme-dark, one user said: "The color is more outlined here. It is friendly to look at." One user asked how he could change the color to the default color and also mentioned that

I.1 Results from the User testing 2 - A think-aloud session

it looked like Theme and Contrast could be combined, not that they were separate color palettes. Some users mentioned they did not know which color to expect while clicking the theme-dark option, and some expected a black background, not a violet color.

- Font size: All participants thought the "Big" option from the font size would make the text bigger. None of the users liked the "small" size; they found it too small to read the text. One user suggested including at least one more font size option.
- Underline links: Most users liked and wanted to use this feature. One user found it nice but not needed.

Additionally, one user was missing the functionalities developed websites provide, for example, zoom-in while using the mouse and mouse wheel, a drop-down menu when clicking on the mouse-right button, and the possibility to copy and paste the content from the prototype. These challenges will be solved after the website is developed.

Task 3: Find information about autistic strengths

All users found this page quickly and felt familiar with the navigation bar. Participants' first impression of the page was positive. Users found this page simple and straight to the point. Some users mentioned that they appreciated having this page on the website, as it highlights autistic people's strengths. Most users mentioned they liked how the information was listed, one after another, using the bullet points. They found it clear, easy to read, and straight to the point. Some users mentioned they liked the simplicity of the website, not including too many elements and text.

Task 4: Find information about the values of the autism community

This information was included under the "About us" page, which caused some

I.1 Results from the User testing 2 - A think-aloud session

participants challenges, as they expected it to be visible in the main navigation bar.

Three out of six users guessed correctly that this information might be included under the "About Us" page. Some users first visited the "Coaching" page, which, according to them, seemed the closest to the "values," and some users needed help finding this information.

The overall feedback on the "About Us" page was positive. Users appreciated a table of contents at the beginning of the page leading to the history, mission, and values. These users who used the underline links feature liked that these clickable titles were highlighted. Users also liked the button "Back to top," which made navigation on the website even more straightforward. Some users mentioned that they preferred the values to be written one below another, compared to the history and mission that included the text written in the paragraphs. They would prefer bullet points over numbers because they made the text more straightforward.

Task 5: Find information about available services

All users found this page quickly, as it was included in the navigation bar. They liked that the list of the available services is listed below each other and leads to separate pages. Users who activated the "underline links" option mentioned they liked the clickable titles being underlined. Some participants mentioned "Contact Us" as they found its placement perfect, and it was easy to contact the team. One user mentioned they would suggest renaming "Coaching" to "Coaching for autistic people ." One user noted that they searched this page based on the icon, a hand holding a box, which suggested it might be about services. Participants were generally interested in exploring the available courses and provided additional feedback. They mentioned they liked the table of contents and icons since it helped them find the course they were interested in. Two users mentioned that

I.1 Results from the User testing 2 - A think-aloud session

including in the introduction text how many years of experience the organization has makes them feel comfortable; they find it factual, it brings a professional view of the organization, and they would not hesitate to contact the team.

Task 6: Find out how you could book a course you would like to attend

All participants found a way how to book the service quickly. Some users wanted to explore the “Contact Us” page further, even if it was not a part of the task, and mentioned that they liked the simplicity and clear explanation of how the team can be contacted. They also liked using the icons next to the contact details. One user mentioned they would appreciate having the contact of each team member or linking this page to the “Meet the Team page.” One user asked about the purpose of the “Disclaimer” part on the website, as he did not understand the language and that it was a placeholder.

Task 7: Find information about Sabine H - Office manager

Some users guessed correctly that this information would be placed under the “Meet the Team” page, but some participants needed support to find it. Most participants liked the page; they would only appreciate including the pictures of the team members except for the placeholder icons and every team member’s email and phone numbers. Some participants mentioned that this page brings a personalized experience to the user, and they could contact the team more comfortably since they would feel connected.

Additional feedback

Participants liked the left-side navigation bar and mentioned it helped them to interact with the website more easily. They found the layout consistent and easy to navigate. One user mentioned they would appreciate it if the “News” page included some information about autism research, news about autism, and achievements of people on the autism spectrum. In general, users liked the website, the clarity of the content, the customization panel, and its placement.

References

- [1] C. European Commission. Directorate General for Communications Networks and . I. Technology., Funka., “Inclusive web-accessibility for persons with cognitive disabilities: pilot project study: final report. publications office.,” p. 119, 2022. x, 5, 6, 9, 10, 11, 39, 40, 44
- [2] A. H. J. D. Brian Yu, Michael Murrietta, “A survey of autism spectrum disorder friendly websites,” *SMU Data Science Review*, 2018. x, 11, 12, 15, 16, 17, 42, 46, 48, 50
- [3] D. M. Raymaker, S. K. Kapp, K. E. McDonald, M. Weiner, E. Ashkenazy, and C. Nicolaidis, “Development of the aaspire web accessibility guidelines for autistic web users. autism in adulthood, 1 (2), 146–157,” 2018. x, 18, 19, 29, 30, 31, 46, 47, 49, 58, 59, 60, 61, 62, 67
- [4] A. Dattolo, F. F. Luccio, E. Pirone, *et al.*, “Webpage accessibility and usability for autistic users: a case study on a tourism website,” in *Ninth International Conference on Advances in Computer-Human Interactions (ACHI 2016)*, pp. 145–152, IARIA, 2016. x, 19, 20, 21, 47
- [5] N. Pavlov, “User interface for people with autism spectrum disorders,” *Journal of Software Engineering and Applications*, vol. 2014, 2014. x, 21, 22, 35, 36, 37, 38, 41, 47, 48, 49, 50, 58, 59, 60, 67
- [6] S. Sorce, V. Gentile, D. Oliveto, R. Barraco, A. Malizia, and A. Gentile, “Exploring usability and accessibility of avatar-based touchless gestural interfaces for autistic people,” in *Proceedings of the 7th ACM International*

REFERENCES

- Symposium on Pervasive Displays*, PerDis '18, (New York, NY, USA), Association for Computing Machinery, 2018. x, 23, 24, 48
- [7] Figma, “Sidebar navigation starter kit,” 2024. x, 61
- [8] J. S. ©, “Home page,” 2024. x, 61
- [9] A. Society, “Home page,” 2024. x, 61, 62
- [10] t. d. b. S. S. Accessible+, “Accessible+ — accessibility enabled website template,” 2020. x, 61, 62
- [11] A. surveys, “Accessible surveys a survey tool for everyone,” 2019. x, xi, 53, 61, 63, 104
- [12] www.autismspeaks.org, “What are the dsm-5 autism diagnostic criteria?,” 2023. xii, 2, 71
- [13] M. G. Friedman and D. N. Bryen, “Web accessibility design recommendations for people with cognitive disabilities,” *Technology and disability*, vol. 19, no. 4, pp. 205–212, 2007. xii, 33, 34, 48, 49, 50, 58, 59, 60
- [14] K. Wu, E. Petersen, T. Ahmad, D. Burlinson, S. Tanis, and D. A. Szafir, “Understanding data accessibility for people with intellectual and developmental disabilities,” in *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, CHI '21, (New York, NY, USA), Association for Computing Machinery, 2021. 1, 5, 44
- [15] M. C. Nicole Baumer, MD and G. C. Julia Frueh, MD, “What is neurodiversity?,” 2021. 1
- [16] V. G. Motti, “Designing emerging technologies for and with neurodiverse users,” in *Proceedings of the 37th ACM International Conference on the*

REFERENCES

- Design of Communication*, SIGDOC '19, (New York, NY, USA), Association for Computing Machinery, 2019. 1, 52, 71
- [17] S. Dodd, *Understanding autism*. Elsevier Australia, 2005. 1
- [18] A. R. Institute, “Is it autism?,” 2023. 2
- [19] W. Lawson, *Understanding and working with the spectrum of autism: An insider’s view*. Jessica Kingsley Publishers, 2001. 3, 102
- [20] P. Benford, *The use of Internet-based communication by people with autism*. PhD thesis, University of Nottingham Nottingham, 2008. 3, 5
- [21] Michelle, “Assistive technology for autism spectrum disorder (asd),” 2024. 3, 71
- [22] Magrid, “Understanding assistive technology for autism,” 2024. 3
- [23] M. Halpin, “How assistive technology works for people with autism,” 2023. 3
- [24] R. Moller, “Strengths and abilities in autism,” 2024. 3, 4
- [25] K. Gillespie-Lynch, S. K. Kapp, C. Shane-Simpson, D. S. Smith, and T. Hutan, “Intersections between the autism spectrum and the internet: Perceived benefits and preferred functions of computer-mediated communication,” *Intellectual and developmental Disabilities*, vol. 52, no. 6, pp. 456–469, 2014. 4, 5
- [26] C. J. Jordan, “Evolution of autism support and understanding via the world wide web,” *Intellectual and developmental disabilities*, vol. 48, no. 3, pp. 220–227, 2010. 5

-
- [27] V. Yaneva, “Autism and the web: using web-searching tasks to detect autism and improve web accessibility,” *ACM SIGACCESS Accessibility and Computing*, no. 121, pp. 1–1, 2018. 5, 44
- [28] W3C®), “Accessibility, usability, and inclusion,” 2023. 8
- [29] A. Dattolo and F. L. Luccio, “Accessible and usable websites and mobile applications for people with autism spectrum disorders: a comparative study,” *EAI Endorsed Transactions on Ambient Systems*, vol. 4, no. 13, 2017. 8, 14, 15, 34, 35, 37, 38, 39, 40, 42, 45, 46, 59
- [30] D. Kletenik, R. Minkowitz, A. Peric, M. Sahin, and R. F. Adler, “From awareness to action: Teaching software accessibility for neurodiverse users,” in *Proceedings of the 55th ACM Technical Symposium on Computer Science Education V. 1*, SIGCSE 2024, (New York, NY, USA), p. 687–693, Association for Computing Machinery, 2024. 10, 26, 27
- [31] R. Me, “Accessibility legislation,” 2023. 11
- [32] V. Yaneva, I. Temnikova, and R. Mitkov, “Accessible texts for autism: An eye-tracking study,” in *Proceedings of the 17th International ACM SIGACCESS Conference on Computers & Accessibility*, ASSETS ’15, (New York, NY, USA), p. 49–57, Association for Computing Machinery, 2015. 12, 33, 40, 41, 49, 59
- [33] S. Eraslan, Y. Yesilada, V. Yaneva, and L. A. Ha, “Keep it simple!”: an eye-tracking study for exploring complexity and distinguishability of web pages for people with autism,” *Universal Access in the Information Society*, vol. 20, pp. 69–84, 2021. 13
- [34] S. Eraslan, V. Yaneva, Y. Yesilada, and S. Harper, “Do web users with autism experience barriers when searching for information within web

- pages?,” in *Proceedings of the 14th International Web for All Conference, W4A '17*, (New York, NY, USA), Association for Computing Machinery, 2017. 13, 14
- [35] P. M. Lourdes Moreno, Helen Petrie and R. Alarcon1, “Designing user interfaces for content simplification aimed at people with cognitive impairments,” 2023. 22, 23, 47
- [36] A. Budd, “Heuristics for modern web application development,” 2020. 25, 26
- [37] A. Rapp, F. Cena, C. Frauenberger, N. Hendriks, and K. Slegers, “Designing mobile technologies for neurodiversity: Challenges and opportunities,” in *Proceedings of the 21st International Conference on Human-Computer Interaction with Mobile Devices and Services, MobileHCI '19*, (New York, NY, USA), Association for Computing Machinery, 2019. 26
- [38] W3C® , “Web content accessibility guidelines (wcag) 2.1,” 2023. 27, 28
- [39] W3C® , “Making content usable for people with cognitive and learning disabilities,” 2023. 28, 29, 48, 49, 50, 58, 59, 60
- [40] C. Putnam and L. Chong, “Software and technologies designed for people with autism: what do users want?,” in *Proceedings of the 10th international ACM SIGACCESS conference on Computers and accessibility*, pp. 3–10, 2008. 32, 33
- [41] T. Britto and E. Pizzolato, “Towards web accessibility guidelines of interaction and interface design for people with autism spectrum disorder,” in *ACHI 2016: the ninth international conference on advances in computer-human interactions*, pp. 1–7, 2016. 35, 36, 37, 38, 39, 40, 60

- [42] M. Alzahrani, A. L. Uitdenbogerd, and M. Spichkova, “Impact of animated objects on autistic and non-autistic users,” in *Proceedings of the 2022 ACM/IEEE 44th International Conference on Software Engineering: Software Engineering in Society*, pp. 102–112, 2022. 36
- [43] R. Zhu, D. Hardy, and T. Myers, “Co-designing with adolescents with autism spectrum disorder: From ideation to implementation,” *OzCHI '19*, (New York, NY, USA), p. 106–116, Association for Computing Machinery, 2020. 38, 60
- [44] M. Madsen, R. el Kaliouby, M. Eckhardt, M. E. Hoque, M. S. Goodwin, and R. Picard, “Lessons from participatory design with adolescents on the autism spectrum,” in *CHI '09 Extended Abstracts on Human Factors in Computing Systems*, CHI EA '09, (New York, NY, USA), p. 3835–3840, Association for Computing Machinery, 2009. 38
- [45] R. Me, “How to make a website accessible?,” 2023. 42
- [46] I. D. Foundation, “Design thinking,” 2016. 43, 44, 51, 52, 55, 58, 68
- [47] A. H. d. S. Melo, L. Rivero, J. S. d. Santos, and R. d. S. Barreto, “Personaut: A personas model for people with autism spectrum disorder,” in *Proceedings of the 19th Brazilian Symposium on Human Factors in Computing Systems*, IHC '20, (New York, NY, USA), Association for Computing Machinery, 2020. 52, 53
- [48] Miro, “Virtual brainstorming,” 2024. 55
- [49] Miro, “Affinity diagrams: A powerful way to organize ideas — and make them easier to act on,” 2024. 56
- [50] S. Innovation, “5 phases of design thinking – prototype,” 2021. 57

REFERENCES

- [51] Figma, “Figma design basics,” 2023. 64
- [52] N. A. Society, “How to talk and write about autism,” 2024. 65, 67, 98
- [53] Venngage, “Accessible color palette generator,” 2024. 113
- [54] usability.gov, “System usability scale (sus),” 2023. 72
- [55] F. B. E. J. Katherine Valencia, Cristian Rusu, “A methodology to evaluate user experience for people with autism spectrum disorder,” 2022. 69, 70
- [56] F. T. Labs, “Accessible usability scale (aus),” 2023. 72
- [57] J. Nielsen, “Thinking aloud: The 1 usability tool,” 2012. 81