

Exploring Web Accessibility and Usability for Users With Attention Deficit Hyperactivity Disorder: Evaluation of Specific Guidelines and Adaptations

Lucía Alonso Virgós^{1*} , Isabel Morales Gil² , Luis Rodríguez Baena¹ , Jordán Pascual Espada³ ,
Rubén González Crespo¹ 

¹ Department of Engineering, Universidad Internacional de La Rioja, Avda. de la Paz, 137, 26006 Logroño, La Rioja (Spain)

² Department of General Health Psychology, Organization, Universidad Internacional de La Rioja, Avda. de la Paz, 137, 26006 Logroño, La Rioja, (Spain)

³ Department of Engineering, Universidad de Oviedo, Calle Valdés Salas 11, 33007 Oviedo (Spain)

* Corresponding author: lucia.alonso.virgos@unir.net

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ABSTRACT

Attention Deficit Hyperactivity Disorder (ADHD) presents specific cognitive and attentional characteristics that can significantly affect web navigation and information processing. Despite the widespread adoption of the Web Content Accessibility Guidelines (WCAG), there is limited empirical evidence addressing their effectiveness for users with ADHD. This study evaluates the applicability of accessibility and usability guidelines through a set of controlled user tests conducted with adolescents diagnosed with combined ADHD. The tests assess multiple web design elements, including multimedia presentation, sound control, content layout, textual clarity, temporal elements, links, and iconography. These tests were adapted from previously validated experiments conducted with other neurodiverse users. Quantitative results were obtained by measuring task completion times, complemented by qualitative observations of user behavior. The findings reveal that certain guidelines significantly improve performance for users with ADHD, while others produce results that differ from standard WCAG recommendations. The results highlight the importance of considering the specific cognitive profile of users with ADHD and avoiding generalized accessibility assumptions. This study provides evidence-based design recommendations to support the development of more effective and inclusive web interfaces for this user group.

KEYWORDS

Attention Deficit Hyperactivity Disorder (ADHD), Website Accessibility, Website Adaptation, Web Content Accessibility.

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I. INTRODUCTION

In the field of web accessibility and usability, there is a lack of specific research addressing the access and usage needs of users with cognitive disabilities. Existing recommendations often focus on generalized guidelines for individuals with cognitive deficits, without considering individual variations in terms of characteristics, age, abilities, learning skills, and other relevant factors [1] - [5].

Our research team has previously conducted tests and studies tailored to users with Down syndrome, aiming to assess the specific accessibility and usability needs of this neurodiverse profile. Based on the positive results obtained from these tests, we decided to adapt and apply the same tests to evaluate the needs of users with attention deficit hyperactivity disorder (ADHD). Although the characteristics and challenges may differ between the two profiles, the tests remain

largely the same as they assess the same accessibility and usability guidelines [6] - [9].

The purpose of this research is to build upon our previous work by utilizing the previously designed and validated tests for users with Down syndrome and now applying them to users with ADHD. While we acknowledge that each profile has its unique characteristics and specific needs, we believe that the accessibility and usability guidelines that have proven effective for users with Down syndrome can serve as a solid foundation for evaluating the user experience of individuals with ADHD in web environments.

The tests we have designed include assessments of aspects such as background color, use of timers, audio utilization, presence of narrators, reading level, handling of abbreviations, unusual words, usefulness of links, and level of iconography. These tests are conducted taking into account the accessibility guidelines published in WCAG 2.1 and have

been slightly adapted to accommodate the particular characteristics and needs of users with ADHD but fundamentally evaluate the same accessibility and usability guidelines that have been found beneficial in previous neurodiverse profiles.

By conducting these tests and comparing task completion times between cases that adhere to accessibility and usability guidelines and those that do not, we aim to obtain relevant results that will help identify the most effective guidelines for enhancing the user experience of individuals with ADHD. While we expect to find differences and specific nuances related to the ADHD profile, the continuity in the testing approach allows for comparisons and exploration of similarities and differences among different cognitive disability profiles.

II. BACKGROUND

Accessibility and usability of websites are fundamental aspects to ensure that all individuals, regardless of their abilities or disabilities, can access and effectively use online information and services [6] - [9]. In this context, attention deficit hyperactivity disorder (ADHD) presents itself as a neurobiological condition that can significantly impact the user experience on the web [10].

ADHD is characterized by difficulties in concentration, impulsivity regulation, and activity control. These characteristics can have a negative impact on the ability of individuals with ADHD to efficiently use and navigate websites, thereby limiting their active participation in the online environment [10], [11].

In the field of web accessibility, guidelines and recommendations have been established to ensure that websites are accessible to as many people as possible. The Web Content Accessibility Guidelines (WCAG) are an internationally recognized set of recommendations that address various aspects of web accessibility. However, it is important to note that the latest WCAG guidelines, such as version 2.1, do not specifically address the needs of individuals with ADHD and other cognitive disabilities.

One of the challenges in web accessibility for individuals with ADHD lies in the diversity of individual capabilities and needs within this condition. Each person with ADHD may exhibit different abilities and specific requirements when interacting with websites. However, in general terms, accessibility guidelines tend to group all individuals with cognitive disabilities into a single category, without considering the existing individual differences [11].

The objective of this research is to provide practical and updated guidelines for web developers, enabling them to create more accessible and usable websites for individuals with ADHD. To achieve this, we will not only rely on general accessibility guidelines but also focus on analyzing the specific needs and challenges faced by individuals with ADHD when interacting with websites.

Through a more effective grouping of users with ADHD, based on common characteristics and similar neural capacities, we will be able to provide more appropriate and personalized accessibility recommendations. Through a more effective grouping of users with ADHD, based on common characteristics and similar neural capacities, the study aims to improve the user experience of individuals with ADHD on websites and promote their digital inclusion, thus fostering active participation in the online environment [11].

III. RESEARCH DEVELOPMENT

A. Subjects

Within Attention Deficit Hyperactivity Disorder (ADHD), several clinical profiles are identified. The main ADHD profiles are:

Hyperactive-Impulsive Predominant ADHD: In this type of ADHD, the most prominent symptoms are hyperactivity and impulsivity. Individuals with this profile tend to be restless, have difficulty staying still or being calm, and often struggle to control their impulses. They may talk excessively, interrupt others, and have difficulties waiting for their turn [10], [11].

Inattentive Predominant ADHD: In this type of ADHD, the main symptoms are related to inattention. Individuals with this profile have difficulty maintaining concentration, tend to get easily distracted, forget tasks or commitments, and struggle to follow instructions. They often appear disorganized and have difficulties completing tasks or activities that require sustained attention [10].

Combined ADHD: This type of ADHD involves the presence of symptoms of both inattention and hyperactivity-impulsivity. Individuals with this profile exhibit a combination of symptoms from both types [10].

Among these profiles, combined ADHD is the most prevalent subtype, accounting for approximately 50–70% of ADHD diagnoses, followed by the inattentive subtype, while the hyperactive-impulsive subtype is less frequent [10], [11].

For this study, we are working with individuals from the combined ADHD group.

To conduct user tests on web accessibility and usability, a group of 26 adolescents aged between 14 and 16 years, who have the combined ADHD profile, has been selected. 38.46 % of the children were 14 years old; 30.77% were 15, and 30.77% were 16 years old. These young individuals display symptoms of both inattention and hyperactivity-impulsivity, which can influence their interaction with digital interfaces. It is important to note that combined ADHD is the most common subtype within the classification of ADHD, and its intensity and manifestation can vary in each individual.

Furthermore, these subjects were assessed using various instruments to define their cognitive profile. The Wechsler Intelligence Scale for Children WISC-IV (Wechsler, 2003, 2005) was employed. The WISC-IV was used instead of the WISC-V to ensure methodological consistency with previous studies conducted by the research group and to allow direct comparability of cognitive indices across samples. This is an intelligence battery for children aged 6 to 16, comprised of 10 mandatory tests, which in turn form the scores for four factors (CV: Verbal Comprehension Index; RP: Perceptual Reasoning Index; MT: Working Memory Index; VP: Processing Speed Index).

The 10 tests together form the full-scale intelligence score: FSIQ (Full Scale Intelligence Quotient). Additionally, it includes 5 optional tests. The indices of the WISC-IV have a mean of 100 (SD = 15). The tests have a mean of 10 (SD = 3; Wechsler, 2005). The average coefficients of internal consistency of the indices are generally very good: .92 for VC, .91 for PR, .89 for WM, .86 for PS, and .95 for FSIQ (Wechsler, 2005). The interpretation of the different indices provided by the Wechsler scale can be observed in Table I.

TABLE I. INTERPRETATION OF IQ WECHSLER SCALE

IQ Classification	
Greater than 130	Very superior
121-130	Superior
111-120	High average
90-110	Average
80-89	Low average
70-79	Low
Less than 79	Very low

15.38% of the subjects exhibited an IQ in the low average range; 61.54% were in the average range, and 23.08% were in the high average range.

Verbal Comprehension (VC) assesses verbal reasoning, conceptualization, and the ability to understand, process, and express ideas using language. Difficulties in this index may affect text comprehension, interpretation of instructions, and understanding of written web content.

Perceptual Reasoning (RP) assesses nonverbal reasoning, visual-spatial organization, and the ability to interpret and manipulate visual information. Difficulties in this index may affect the understanding of website layouts, navigation structures, visual cues, diagrams, and other graphical elements presented on web pages.

Working Memory (WM) measures the ability to retain and store information, to mentally operate with this information, transform it, and generate new information. It consists of 3 subtests:

- Digits (D): assesses immediate memory and working memory, indicating sequencing skills, planning, alertness, and cognitive flexibility.
- Letters and Numbers (LN): measures the ability to retain and combine two types of information, organize it, and elaborate an organized set according to instructions.

TABLE II. PERCENTILES OF THE WORKING MEMORY INDEX IN THE SAMPLE¹

Percentile	Relative Frequency (%)
25	3.85 %
30	11.54 %
35	7.69 %
40	15.38 %
45	7.69 %

The results of the subjects in the sample regarding the working memory index are presented in Table II. It is worth noting that 46.15% of the participants ($n = 12$) scored at or below the 45th percentile, exhibiting lower working memory capacity. The remaining 53.85% of the sample ($n = 14$) was distributed across standard and higher percentile ranges, which accounts for the total sample of 26 adolescents evaluated in this study.

Processing Speed (PS) measures the ability to focus attention, explore, organize, and/or discriminate visual information quickly and effectively. It consists of 3 subtests developed under time constraints:

- Coding (CL): assesses associative speed skills, learning, visual perception, hand-eye coordination, attention, motivation, and resistance to repetitive tasks.
- Symbol Search (BS): measures associative speed skills, learning, visual perception, hand-eye coordination, attention, motivation, and resistance to repetitive tasks. The results of the subjects in the sample on the processing speed index are presented in Table III.

TABLE III. PERCENTILES OF THE PROCESSING SPEED INDEX IN THE SAMPLE

Percentile	Relative Frequency (%)
20	15.38 %
25	7.69 %
30	11.54 %
35	15.38 %
40	19.23 %
45	7.69 %
50	11.54 %
55	7.69 %
60	3.85 %

¹ Note. The data presented in Table II only includes participants who scored within the lower percentiles (≤ 45) of the Working Memory Index ($n = 12$). The remaining 53.85% of the sample ($n = 14$) scored in higher percentile ranges, completing the total sample size ($N = 26$).

B. Descriptive Analysis of Cognitive and Sociodemographic Variables

Relationship between Age and Working Memory and Processing Speed Indices:

- Subjects aged 16 tend to experience fewer difficulties in concentration on long tasks compared to those aged 14 and 15 (25% versus 40%). Subjects aged 16 do not experience difficulties in processing speed, while some subjects aged 14 and 15 do (33.33% and 20%, respectively). Based on the descriptive comparison of working memory performance across age groups, no consistent trend was observed that would indicate a clear relationship between age and working memory in the analyzed sample.

Relationship between IQ and Working Memory and Processing Speed Indices:

- Subjects with IQ in the mid-range (IQ between 90-110) appear to experience fewer difficulties in working memory and processing speed indices compared to those with IQ in the low or high mid-range.
- The descriptive analysis of task performance across different IQ ranges did not reveal a consistent pattern linking IQ level with difficulties in concentration on long tasks or sustained attention.

Given the cognitive and behavioral characteristics observed in adolescents with combined ADHD—particularly difficulties in sustained attention, impulse control, and motor restlessness—this population is especially susceptible to experiencing challenges during web navigation. These characteristics may directly affect task execution, interaction with interface elements, and reaction time, making this user profile particularly suitable for evaluating web accessibility and usability guidelines.

In the context of user testing to evaluate web accessibility and usability, the decision has been made to redesign and reuse the tests used in a previous research study involving individuals with Down syndrome. This choice is based on the utility and benefits derived from the reuse of successful tests, although it is important to highlight that they have been adapted and adjusted to cater to the level of the target population in the study.

The reuse of successful tests in this context provides additional benefits. In addition to methodological consistency, resource savings, reliability, research continuity, and result comparability, it also achieves adaptation and customization of the tests to meet the specific needs and characteristics of this user group. This ensures a more accurate and meaningful evaluation of web accessibility and usability for this user group.

C. Tests

In the context of web accessibility and usability, individuals with combined ADHD may face various barriers related to attention, impulsiveness, and information processing. The main barriers identified include:

Difficulty sustaining attention: maintaining focus during web browsing can be challenging, as users may be easily distracted by external or internal stimuli, hindering their ability to follow content and complete online tasks [10], [12] - [14].

Restlessness and impulsivity: hyperactivity and impulsivity can negatively affect interaction with digital interfaces, leading to rapid, disorganized, or unplanned actions while navigating web pages [12] - [14].

Difficulty following instructions and completing tasks: lengthy or complex instructions may complicate navigation on websites with multi-step processes, increasing the likelihood of task abandonment due to reduced sustained attention [11], [13].

Sensitivity to information overload: the presence of multiple visual elements, advertisements, pop-ups, or cluttered layouts can interfere with effective information processing and increase distraction levels [10], [13], [14].

Time management difficulties: challenges in task prioritization and time perception may cause users to lose focus on primary objectives, become engaged in unrelated activities, or miss deadlines while browsing the web [10], [11], [13], [14].

1. Web Test Methodology

Before conducting the tests, prototypes were developed to outline how the user tests would be carried out. To do this, specific requirements were derived from the previous conclusions and compared with reliable sources. The web tests consisted of designing two websites: one accessible and the other inaccessible, based on the recommendations derived from the previous research on Down syndrome. Both websites featured similar tasks to facilitate comparison. The structure of the websites included a HOME page and five additional pages where the tests were hosted. The user tests incorporated various elements such as text, audio, images, videos with and without subtitles, configuration options, and a form. The results of the tests were obtained through quantitative data, measuring the reaction times of each user and identifying any time improvements resulting from the application of specific guidelines. Additionally, qualitative results were extracted based on the users' reactions, comments, and impressions after the tests. These qualitative insights were particularly valuable in assessing the level of frustration experienced by the participants [6] - [9], [11], [14].

Before conducting the tests, a script containing dialogues and technical instructions was prepared to facilitate task understanding. The wording of the script was adapted to the cognitive and attentional characteristics of the participants with ADHD. During the tests, assistance was available to clarify doubts related to task comprehension, while avoiding guidance that could influence task resolution. Despite these adaptations, not all participants were able to complete all the tests due to comprehension difficulties or fatigue [15].

Each test was conducted individually in a separate room. Users entered the room one by one and were provided with an explanation of the test content according to the script. The order of the tests was not standardized. Volunteers completed each test in a random order to prevent them from learning from previous experiences, ensuring more objective results. The methodology and randomization of the tests varied for each participant due to their diverse needs [14]. Not all participants completed all the tests, either due to their disability preventing comprehension of certain sections or due to fatigue hindering their participation. It should be noted that participants are prone to distractions, and thus, the objectivity of the results could be affected if they were fatigued or distracted during the tests.

During each test, users worked on a specific page of the website, independently resolving the assigned tasks while verbalizing their steps. An assistant was available during the tests, aiming to promote the participants' autonomy [16]. However, the assistant was not allowed to provide clues or hints regarding the tasks and only clarified the meaning of buttons or phrases that the participant might not be familiar with. The meaning of potentially problematic buttons and tools, such as the CONFIGURATION button, was explained to the participants before initiating each test. Specific assistance was provided to address any doubts related to task comprehension during the tests.

Users were given the freedom to utilize as much time as they needed for each test, up to a maximum of 10 minutes per attempt. This time limit was established based on recommendations from professionals working with the target population. According to

experts' advice, if a participant took an excessively long time, they could become fatigued and lose concentration. Hence, considering the individual speed of each user, breaks were offered between tests to prevent exceeding the anticipated maximum time. The tests were recorded using screen recording software, capturing information such as the time and duration of each test. However, all tests were manually timed to ensure accuracy.

IV. USER TESTING PRESENTATION

This section presents the user testing carried out in the study and summarizes the observations derived directly from the experimental trials conducted with participants with ADHD.

A. Trials 1-6. Multimedia Elements Test

This set of trials evaluates WCAG Guideline 1.2.2 (Provide alternatives for multimedia content) by analyzing the impact of different combinations of video, audio, subtitles, and narrators on task comprehension and response time in users with ADHD.

There were six trials conducted on two websites for this test. The purpose of this test is to determine the most suitable method for reproducing multimedia content for individuals with combined ADHD. Three trials were conducted using 31-second videos with the option of looping. The objective was for the user to pause the video when prompted by the content. For instance, the narrator may say, "Pause the video when you simultaneously see a red triangle and a blue circle." This instruction could be delivered audibly, without a narrator, or verbally with or without a visible narrator. In other words, the message can be presented through audio and/or text.

- Audio + Video + Narrator. Audio + Video. Trials 1-2: This test involved playing two files with audio and video. One file included a visible narrator, while the other did not.
- Audio + Subtitles + Video + Narrator. Audio + Subtitles + Video. Trials 3-4: This test involved playing two files with audio, subtitles, and video. One file included a visible narrator, while the other did not.
- Video + Subtitles + Narrator. Video + Subtitles. Trials 5-6: This test involved playing two files without audio. One file included visible subtitles and a narrator, while the other had visible subtitles but no narrator.

The tests required the user to perform a specific action. It was determined that the user understood the test when they efficiently carried out the required action. In this case, volunteers were expected to pause the video when they simultaneously saw the specified objects.

B. Trials 7-9. Sound Evaluation

ADHD is characterized by difficulties in attention and impulse control, which can affect auditory processing and responses to sound-based stimuli. These difficulties can affect the ability of *participants* to process and respond appropriately to auditory stimuli, including sound and sound levels [17].

Participants may struggle to sustain attention on auditory tasks that require continuous processing of sounds or changes in sound levels. Additionally, the impulsivity associated with ADHD can lead participants to react excessively or inappropriately to auditory stimuli, making it challenging to accurately perceive and assess sound levels [10].

Therefore, when conducting tests related to sound and sound levels with individuals with ADHD, it is important to take these characteristics into consideration and adapt the tests to enhance accessibility. This may involve providing clear and concise instructions, minimizing auditory distractions during the tests, and allowing for regular breaks or pauses to help maintain attention and regulate impulsivity [17].

There were some trials conducted on two websites for this test. The purpose of this test was to assess the effectiveness of dB control in auditory messages and background noise. Two types of messages were played: one at 15 dB with slight background noise, and another at 15 dB without background noise, as well as at 20 dB. Additionally, two types of files were provided: one with sound adjustment tools, pause options, etc., and another that played automatically.

All the audio files contained messages prompting the user to complete a specific task. Thus, the evaluation not only measured the listening time but also the comprehension of the messages in each trial.

In these tests, Guideline 1.4.7 was considered: Low or No Background Audio. This test evaluated the impact of volume control and sound adjustment on the experience of users with ADHD. This criterion aims to ensure that foreground speech is clear and not disrupted by background noise, making audio content more accessible and audible for individuals with auditory processing or attention difficulties [18], [19].

C. Trials 10-12. Content Design Evaluation

Users with ADHD may experience difficulties related to attention regulation, working memory, and visual processing, which can affect their interaction with web content. These characteristics highlight the importance of visually simple layouts, clear content organization, and appropriate contrast levels to reduce cognitive load and facilitate information processing during web navigation.

This set of trials evaluates WCAG Guideline 1.4.3 (Ensure a minimum contrast between text and background) and Guideline 1.3.1 (Information and relationships) by analyzing the impact of visual simplicity, content organization, and contrast levels on navigation efficiency and content comprehension in users with ADHD.

To evaluate the impact of content design on users with ADHD presenting hyperactivity, a comparative test using different backgrounds on three websites is proposed: Website A with a monochromatic background, Website B with a textured background, and Website C with a monochromatic background but low color contrast [20], [21].

In these tests, users' navigation through each website was assessed, and the time invested and accuracy in finding information was measured. Website A, with a monochromatic background, offered a simpler and neutral visual environment, while Website B, with a textured background, presented a higher visual load. Website C, with low color contrast, made it challenging to visually distinguish between elements.

The results revealed that users with ADHD presenting hyperactivity performed better and were more efficient in Website A with a monochromatic background, while Website B with a textured background and Website C with low color contrast posed more difficulties and required more time to complete tasks.

These findings support the importance of clear, simple content design with appropriate contrast to improve browsing experience for users with ADHD presenting hyperactivity. By optimizing the design, attention, visual processing, and comprehension of information can be facilitated, providing a more effective and accessible experience for this user group.

D. Trials 13 -18. Textual Content Evaluation

26 people with ADHD may encounter challenges in language processing and communication due to their unique characteristics. ADHD is characterized by difficulties in attention, impulsivity, and hyperactivity, which can impact language comprehension [22].

In the context of textual content on websites, individuals with ADHD may face specific challenges. Their difficulties in sustaining

attention and managing impulsivity can make it harder for them to engage with and understand complex or lengthy written information. They may struggle with processing and retaining abstract concepts, figurative language, and non-literal expressions [23].

Moreover, individuals with ADHD may find it challenging to follow lengthy and dense text due to their tendency to become easily distracted or lose focus. Excessive use of technical terms, jargon, or complex language can further hinder their comprehension [24] [25] [26]. Websites that utilize abbreviations, acronyms, or specialized terminology may pose additional difficulties for individuals with ADHD, as they may struggle to decode and interpret such content accurately.

To ensure effective communication and engagement with individuals with ADHD, it is important for websites to provide clear and concise information, use straightforward language, and avoid excessive use of technical terms or jargon. Breaking down information into smaller, digestible sections with visual cues or bullet points can also help individuals with ADHD to better process and retain the content [6] - [9], [24], [25].

Three textual content tests were conducted to evaluate this.

- Trial 13-14. Unusual word + definition: An uncommon word was included in a specific text on both websites. On one website, the definition of the word was provided at the same time it was needed, while on the other website, the definition was not included.
- Trial 15-16. Abbreviated words: The same procedure as the previous test was followed, but instead of complex words, abbreviations were used. On one website, the abbreviation was included, and on the other website, the full word without abbreviation was used.
- Trial 17-18. Memory test, explanation 30 minutes before. A test related to reading level was conducted after analyzing the results of the previous vocabulary tests.

In these tests, Success Criterion 3.1.3 (Unusual Words) and Success Criterion 3.1.4 (Abbreviations) were taken into account. In the definition and abbreviation tests, the effectiveness of providing clear definitions and avoiding the excessive use of abbreviations was evaluated. These criteria are fulfilled by providing contextual definitions for uncommon terms and ensuring that the full forms of abbreviations are available, thereby facilitating content comprehension for users with ADHD.

Success Criterion 3.1.5 (Reading Level) was considered. In the segmented content test, the impact of dividing text into smaller, more manageable sections on the experience of users with ADHD was evaluated. This criterion is addressed by organizing lengthy or complex content into shorter paragraphs and distinct sections, lowering the cognitive load and creating an easier-to-process reading level for this user group. Guideline 1.4.10: Reflow. This guideline refers to the ability to adjust content to different screen sizes and orientations without losing information or functionality. In the content design test, when evaluating the impact of a visually simple and low visual load design on the experience of users with ADHD, this guideline can be applied by ensuring that the content adjusts appropriately and legibly on different devices and screen sizes.

Guideline 1.4.12: Text spacing. This guideline relates to the spacing between characters and words to ensure clear and legible reading. In the reading test, when evaluating the impact of different elements such as definitions and abbreviations on the comprehension of content for users with ADHD, this guideline can be applied by ensuring adequate spacing that facilitates reading and avoids visual congestion.

E. Trials 19-20. Links Evaluation

People with ADHD often experience difficulties in attention and impulsivity, which can affect their ability to navigate and interact

effectively with websites. This can include challenges in locating specific information, following instructions, and maintaining focus on tasks [27]. By evaluating the usability of text links and their perceptibility for individuals with ADHD, we can gain insights into their unique needs and potential difficulties in accessing content.

Neurologically, individuals with ADHD may exhibit differences in the brain areas responsible for attention, such as the prefrontal cortex. These differences can impact their ability to process visual stimuli and sustain attention during online tasks. Understanding how individuals with ADHD perceive and utilize text links can provide valuable information for optimizing website design and enhancing their overall user experience [28] - [30].

Additionally, the test aims to assess the utility of text links for individuals with ADHD, who may also experience difficulties in executive functioning. Executive functions involve cognitive processes such as planning, organization, and task initiation. Difficulties in these areas can affect an individual's ability to navigate websites efficiently and find relevant information. By evaluating the perceptibility and usability of text links, we can identify potential barriers or areas for improvement in website design to better cater to the specific needs of individuals with ADHD [28], [30].

In summary, conducting this test for individuals with ADHD can provide valuable insights into the usability and effectiveness of text links for individuals with attention difficulties [28] - [30]. By considering the neurobiological characteristics of ADHD, such as attention deficits and difficulties in executive functioning, we can tailor website design to better meet their needs and enhance their overall online experience.

A comparative test was designed to evaluate the effectiveness of text links in web navigation for individuals with ADHD. In the test, participants were presented with a text that required a specific action, which could be performed using a text link on Website A. On Website B, such a link did not exist, and the action resolution required manual intervention.

The aim was to determine how individuals with ADHD interacted with and responded to the presence or absence of text links in the web interface. By comparing participants' responses on both websites, the goal was to ascertain whether the presence of text links facilitated the completion of the action and whether their absence posed additional difficulties.

The test was based on the neurocognitive characteristics of ADHD, which include difficulties in attention and the need for clear directions and visual cues. It was expected that participants with ADHD would find and complete the task more easily on Website A, where text links were available, compared to Website B, where they were not.

In this test, Guideline 2.4.4 was taken into account: Provide a descriptive link text. In the link test, the impact of the presence of text links on the experience of users with ADHD was evaluated. The guideline is applied by ensuring that links have descriptive and meaningful names that clearly indicate the destination of the link.

Guideline 2.4.9: Link purpose (link only). This guideline refers to providing a clear and descriptive link purpose when a link is presented without adjacent text. In the link test, when evaluating the impact of text links on the ability of users with ADHD to locate and access relevant information, this guideline can be applied by ensuring that links without adjacent text have a clear and descriptive purpose.

F. Trials 21-23. Temporal Elements Evaluation

The test involves two websites with simple questionnaires where users with ADHD are required to select multiple options by clicking. The first website includes a visible chronometer that records the time when users complete the questionnaire. In the second website, there

is no visible chronometer. Additionally, there is a third trial where the chronometer is visible but can be hidden at the user's request.

The objective of the test is to evaluate how the presence of the visible chronometer affects the distraction and performance of users with ADHD. The times taken by users to complete the questionnaire on each website will be recorded, along with any difficulties or distractions experienced during the process.

Furthermore, feedback and perceptions will be collected from users with ADHD regarding their experience with the visible chronometer and how it affected their concentration and task completion [30].

The results of this test can provide valuable information on whether the presence of visible temporal elements, such as a chronometer, can be detrimental or beneficial for users with ADHD. These findings can guide the design of websites and applications that are more suitable and accessible for individuals with ADHD, taking into consideration their unique needs and minimizing any additional distractions or difficulties [24], [28].

In these tests, Success Criterion 2.2.1 (Timing Adjustable) was considered. In the timer test, the impact of the presence of a visible chronometer on the performance and distraction of users with ADHD was evaluated. This criterion relates to providing users with control over time-dependent elements. By allowing users to hide or adjust temporal elements (as implemented in Website C), the interface reduces time-related pressure and distraction, which benefits individuals with attention deficits and cognitive limitations. Additionally, Guideline 2.2.2 (Pause, Stop, Hide) was implemented. In the context of a live chronometer, this guideline is fundamental because the continuous updating of digits and the flashing of time separators (such as blinking colons) function as dynamic visual stimuli. For users with combined ADHD, who present underlying deficits in inhibitory control and sustained attention, such constant blinking acts as an involuntary attentional capture, significantly increasing cognitive load and distraction. Therefore, compliance with Guideline 2.2.2 was ensured by removing any flashing or pulsing effects from the timer interface, thereby neutralizing peripheral visual disruptions while the user completed the questionnaire.

G. Trials 24-25. Iconography Efficacy

In the current context, iconography plays a crucial role in visual communication by quickly and concisely conveying information using images or symbols that represent concepts or actions. However, its effectiveness may vary for different user profiles. For individuals with ADHD, specific challenges can arise due to the neurological characteristics associated with this condition, such as difficulty in maintaining attention and impulsivity [28], [31]. These characteristics can interfere with the processing and comprehension of visual information, particularly when abstract interpretation of symbols used in iconography is required.

To evaluate the efficacy of iconography for users with ADHD, we designed a test that involves a common task, such as making an online purchase. In Website B, the menu options are presented using words, while in Website A, iconography is used to represent the different options.

The objective of this test is to assess how iconography affects the user experience for individuals with ADHD when performing online tasks. Users with ADHD may face difficulties in quickly processing information presented in the form of icons, as it may require additional cognitive effort to associate and understand the meaning behind the symbols. Therefore, it is crucial to determine whether iconography is an effective and accessible way to present options and facilitate online interaction for this user profile.

The test will collect data on the time required to complete the task, error rates, and user satisfaction regarding the understanding and usability of the iconography. These results will provide valuable insights for website designers and developers, enabling them to tailor and improve the presentation of information to the specific needs of users with ADHD, thereby optimizing their user experience and ensuring greater effectiveness in performing online tasks.

In this test, Guideline 1.1.1 was considered: Provide text alternatives for non-text content. In the iconography test, the impact of including iconography instead of text in the experience of users with ADHD was evaluated. This guideline relates to the need to provide text alternatives when non-text content, such as icons, is used to ensure access and understanding of the content for all individuals.

V. RESULTS

A. Trials 1-6. Multimedia Elements Test Results

Based on the data provided, we can analyze the results of each test on the different websites:

Web A. In this website, a narrator, audio, and subtitles were used. The average time spent was 5.01 seconds. It was observed that 50.27% of the participants achieved a temporary gain compared to the average time. There were no reported cases of participants not completing this test.

Web B. In this website, a narrator was used without audio or subtitles. The average time spent was 3.59 seconds. It was found that 28.22% of the participants achieved a temporary gain compared to the average time. There were no reported cases of participants not completing this test.

Web C. In this website, a narrator and subtitles were used, but no audio was included. The average time spent was 7.23 seconds. It was observed that 60.72% of the participants achieved a temporary gain compared to the average time. There were no reported cases of participants not completing this test.

Web D. In this website, audio and subtitles were used, but no narrator was included. The average time spent was 9.15 seconds. It was found that 9.15% of the participants achieved a temporary gain compared to the average time. There were no reported cases of participants not completing this test.

In summary, it can be observed that the websites that included a narrator (Web A, Web B, and Web C) had a higher temporary gain compared to the website that did not include one (Web D). As for the number of participants who did not complete any of the tests, no cases of participants not completing any of the tests were reported in the provided data. The comprehensive breakdown of these reaction times—including the slowest, fastest, and average values along with their standard deviations—is displayed in Fig. 1, while the relative performance benefits are illustrated in Fig. 2.

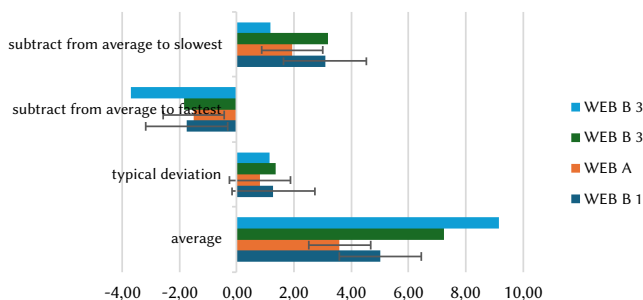


Fig. 1. Multimedia Elements Test Results of Slowest, Fastest, Standard deviation and Average.

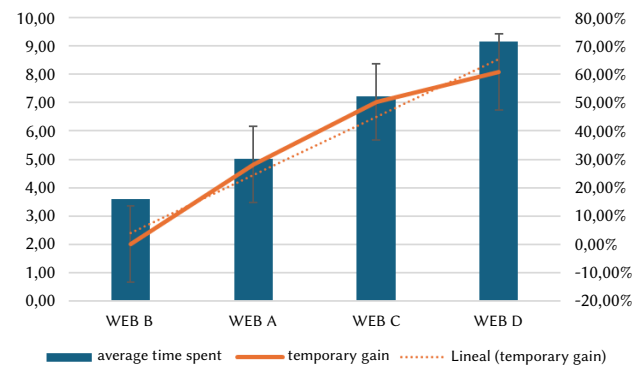


Fig. 2. Multimedia Elements Test Results about Temporary Gain.

It should be noted that within the graphical representations in Fig. 1 and Fig. 2, the labels 'WEB B 1', 'WEB B 2', and 'WEB B 3' correspond to the specific experimental sub-conditions evaluated for Website B, Website C, and Website D respectively, whereas 'WEB A' uniquely represents the fully accessible control site.

B. Trials 7-9. Sound Evaluation Results

The results show that, on average, participants took 4.10 seconds to complete the tests on website A at 20 dB, 4.75 seconds on website B at 15 dB, and 5.89 seconds on website C at 20 dB with background noise.

Regarding the variability of the times, it can be observed that website A had a standard deviation of 0.70 seconds, website B had 1.03 seconds, and website C had 1.50 seconds.

When comparing the average times between the websites, it can be concluded that website C had the highest average time, followed by website B, and then website A.

In terms of temporal gain, which represents the difference in time compared to the average, it is noteworthy that website A achieved a temporal gain of -13.65%, website B had -30.30% compared to website C. These distribution metrics and the corresponding variations across the noise-controlled environments can be seen in Fig. 3 and Fig. 4, respectively.

Regarding these graphical representations, the variable 'WEB A' displays the baseline data for the quiet environment at 20 dB, whereas the labels 'WEB B 1' and 'WEB B 2' align respectively with the performance metrics recorded for Website B (15 dB with slight background noise) and Website C (20 dB with background noise).

It is important to note that there were no unfinished tests or tests that lasted more than 10 seconds on any of the websites.

The most relevant findings are:

Regarding the average time, it can be observed that website A, which had the lowest average time, may be more suitable for individuals with ADHD as it requires less time to complete the tasks. This could be related to the ability of participants with ADHD to maintain attention and concentration in the tests, allowing them to complete them more efficiently.

On the other hand, website C, which had the highest average time, may be more challenging for individuals with ADHD due to potential difficulties in information processing, impulse control, and time management. These characteristics can affect their ability to complete the tasks in a shorter time.

Furthermore, considering the temporal gain, website B had a marked negative gain of -30.30%, suggesting that participants with ADHD may have experienced additional difficulties when performing the tests on this website. These difficulties could be related to the ability to follow precise instructions and control impulsivity, which may have influenced their performance.

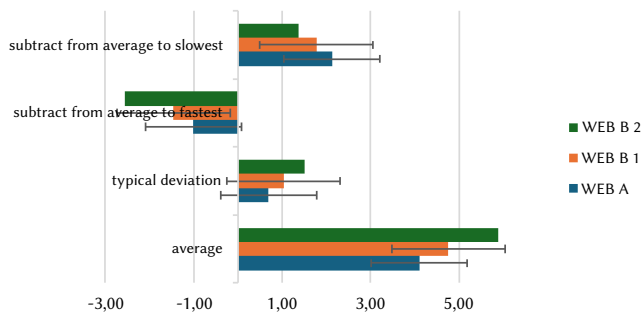


Fig. 3. Sound Evaluation Results of Slowest, Fastest, Standard deviation, Average.

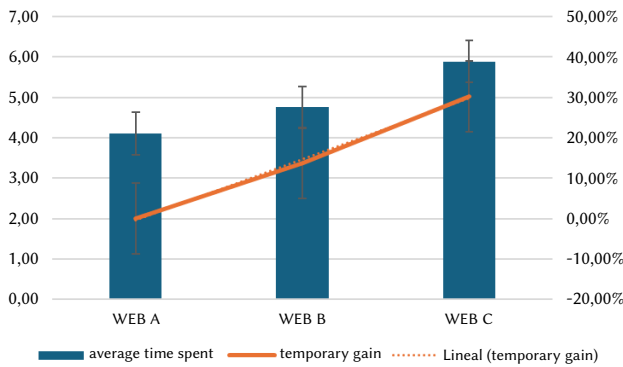


Fig. 4. Sound Evaluation Results about Temporary Gain.

C. Trials 10-12. Content Design Evaluation Results

In this comparative analysis of three trials conducted on different websites (Web A, Web B, and Web C) to assess the time spent by individuals with ADHD, substantial differences in the results were observed.

In Web A, which had a monochromatic background, an average time spent of 4.24 seconds was recorded. This configuration provided a simpler and neutral visual environment, allowing participants with ADHD to complete navigation tasks in a relatively short time. Furthermore, a temporary gain of 52.63% was observed compared to the average time, indicating their ability to adapt and improve performance as they became familiar with the task.

In Web B, with a textured background, an average time spent of 6.47 seconds was recorded. Although this time was higher than in Web A, participants with ADHD still achieved a temporary gain of 43.08%. Despite the increased visual load and potential distractions, they demonstrated their ability to adapt and optimize performance compared to the average time.

In Web C, which had a monochromatic background with low color contrast, an average time spent of 6.07 seconds was observed. Similar to Web A, a temporary gain of 52.63% was recorded. Despite the visual challenges, participants with ADHD managed to overcome them and improve their performance in this configuration.

These results highlight the influence of website design on the time spent by individuals with ADHD. Web A, with its monochromatic background and simple visual environment, provided the best conditions for efficient navigation. Although Web B and Web C presented additional challenges in terms of visual load and low contrast, participants with ADHD demonstrated their adaptability and ability to optimize performance.

These findings support the neural characteristics associated with ADHD, such as difficulties in attention and inhibitory control. Participants with ADHD showed their ability to overcome these

difficulties and improve performance as they became familiar with the tasks and optimized their processing skills.

In conclusion, participants with ADHD exhibited varied time spent in different website configurations, but achieved important temporary gains compared to the average time. These results underscore the importance of considering the neural characteristics of ADHD when designing accessible and optimized websites and highlight the ability of individuals with ADHD to adapt and improve performance in challenging digital environments. A visual representation of the navigation efficiency across monochromatic and textured backgrounds is provided in Fig. 5 and Fig. 6.

Within these figures, 'WEB A' tracks the results for the monochromatic baseline layout, while 'WEB B 1' and 'WEB B 2' correspond directly to the data collected from Website B (textured background) and Website C (low color contrast layout), respectively.

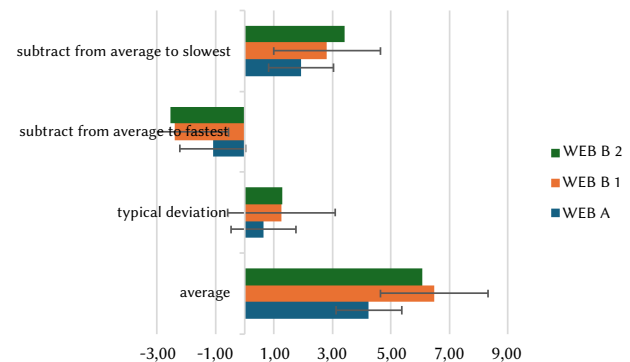


Fig. 5. Content Design Evaluation Results of Slowest, Fastest, Standard deviation, Average.

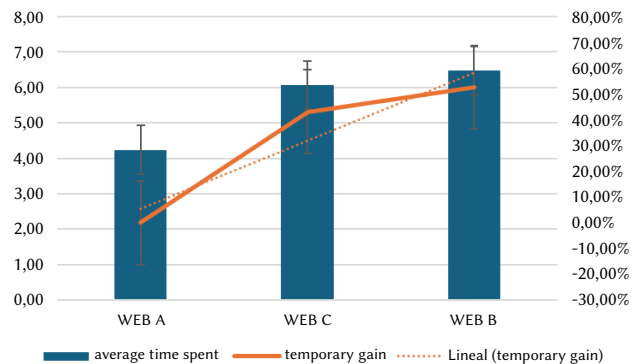


Fig. 6. Content Design Evaluation Results about Temporary Gain.

D. Trials 13-18. Textual Content Evaluation

1. Trial 13-14. Unusual Word and Definition Results

The results of the unusual word tests revealed significant differences in the time spent by users with ADHD on websites. In the case of the test conducted on website A, where the definition of the uncommon word was provided when needed, an average time of 4.91 seconds was observed. In contrast, on website B where the definition was not included, the average time was 8.53 seconds.

These results can be justified based on the neurological characteristics associated with ADHD. Individuals with ADHD often experience difficulties in attention and impulsivity, which can impact on their ability to quickly process new or unusual information. In the case of website A, where the definition was provided at the appropriate time, users with ADHD were able to understand and process the word more quickly, resulting in a shorter average time. On

the other hand, on website B, where the definition was not provided, users with ADHD faced additional difficulties in comprehending the word, which was reflected in a longer average time.

It is important to highlight the temporal gain observed in the test on website A, which was 73.80%. This indicates that the availability of the definition at the right moment was beneficial for users with ADHD as it allowed them to understand and process the word more efficiently. Conversely, in the test on website B, the lack of definition resulted in a lower temporal gain.

It is worth mentioning that some users were unable to complete the tests within the set time limit. On website A, the percentage of unfinished tests was 0.26%, while on website B it was 1.56%. These results indicate that some users with ADHD may face greater difficulties in completing tasks without the aid of clear definitions or contexts.

The results of the unusual word tests highlight the importance of providing appropriate definitions and contextual aids for users with ADHD. The availability of definitions at the right moment can significantly benefit the understanding and time spent by users with ADHD, whereas the lack of definition can hinder their processing of unusual information. These findings support the need to adapt content design and provide additional support to enhance the experience of users with ADHD in digital environments. The statistical parameters for these uncommon word trials are detailed in Fig. 7, and the generated temporal gains are plotted in Fig. 8.

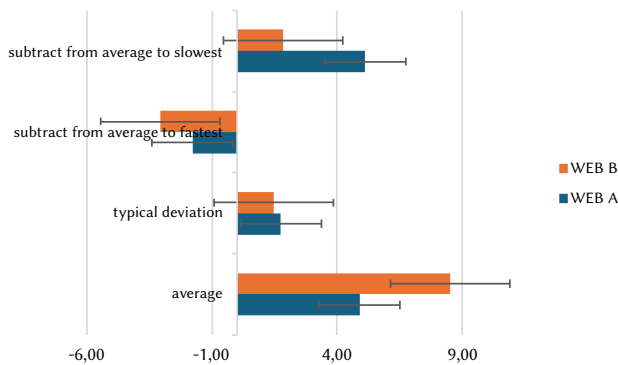


Fig. 7. Textual Content Evaluation Trial 13-14 Results of Slowest, Fastest, Standard deviation and Average.

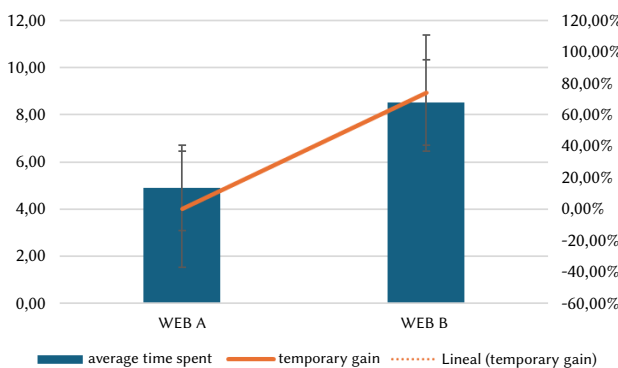


Fig. 8. Textual Content Evaluation Trial 13-14 Results about Temporary Gain.

2. Trial 15-16. Abbreviated Words Results

The results of the abbreviated words tests showed notable differences in the time spent by users with ADHD on the websites. In the test conducted on website A, where the full word without abbreviation was used, an average time of 4.42 seconds was observed. On the other hand, on website B where the abbreviation was included, the average time was 7.91 seconds.

These results can be explained based on the characteristics of ADHD. Individuals with ADHD may struggle with processing and decoding abbreviations, as they require additional cognitive effort to understand and interpret. In the case of website A, where the full word was provided, users with ADHD were able to quickly recognize and comprehend the text, resulting in a shorter average time. Conversely, on website B, where abbreviated words were used, users with ADHD faced difficulties in understanding and decoding the words, leading to a longer average time.

The temporal gain observed in the test on website A was particularly significant, at 78.82%. This indicates that the presence of abbreviations facilitated faster processing and comprehension for users with ADHD, resulting in a substantial reduction in the time spent. On the other hand, the absence of abbreviations on website B led to a lower temporal gain.

It is worth noting that there were no unfinished tests in either website A or B, indicating that users with ADHD were able to complete the tasks within the set time limit for this test.

The results of the abbreviated words tests highlight the challenges faced by users with ADHD in processing and understanding abbreviations. The avoidance of abbreviations can notably improve their processing speed and comprehension, leading to a higher temporal gain. These findings emphasize the importance of considering the cognitive characteristics of individuals with ADHD when designing content, particularly in terms of using clear and easily understandable language, avoiding the use of abbreviations, and providing contextual aids to enhance comprehension. As shown in Fig. 9, the avoidance of abbreviations improved the completion speed, with the overall impact on temporal efficiency summarized in Fig. 10.

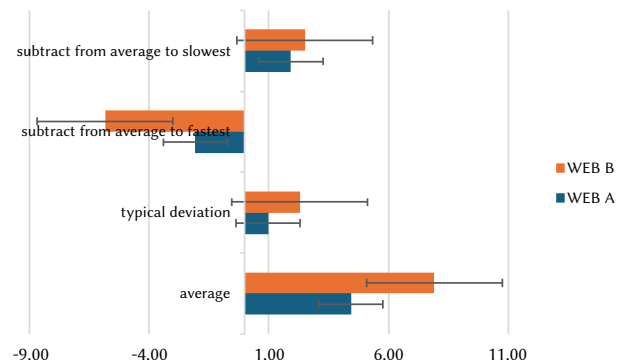


Fig. 9. Textual Content Evaluation Trials 15-16 Results of Slowest, Fastest, Standard deviation and Average.

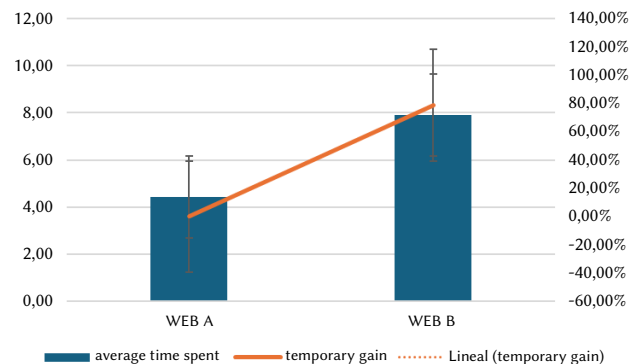


Fig. 10. Textual Content Evaluation Results about Temporary Gain.

3. Trials 17-18. Reading Level and Memory Test Results

The results of the memory tests conducted after the vocabulary tests showed significant differences in the time spent by users with ADHD on

the websites. In the trial of website A, an average time of 4.68 seconds was recorded, while on website B, the average time was 9.24 seconds.

These results can be explained by considering the characteristics of ADHD. Individuals with ADHD may experience difficulties in retaining and retrieving information from working memory. In the case of website A, where an explanation was provided 30 minutes before the memory test, users with ADHD were able to benefit from that contextual support, leading to improved performance and reduced time spent. On the other hand, in website B, where no prior explanation was given, users with ADHD faced greater challenges in retaining and retrieving information, resulting in a longer average time.

It is worth noting the high temporal gain observed in the trial of website A, reaching 97.55%. This indicates that the prior explanation provided a significant benefit for users with ADHD, enhancing their ability to retain and retrieve information from working memory. In contrast, in website B, where no prior explanation was given, the temporal gain was lower.

Furthermore, it is important to mention that there were no incomplete or unfinished tests in website A, while website B had a percentage of 2.08%. These results suggest that some users with ADHD may encounter additional difficulties in the memory test without the contextual support of a prior explanation.

In summary, the results of the memory tests demonstrate that users with ADHD can significantly benefit from prior explanations to enhance their performance and reduce the time spent. These findings emphasize the importance of providing contextual support and strategies to assist individuals with ADHD in improving their retention and retrieval of information. When designing content, it is crucial to consider these cognitive characteristics and provide appropriate support, such as prior explanations, to optimize the experience for users with ADHD. Fig. 11 presents the comparison of retrieval times, while Fig. 12 details the high temporal gains achieved through prior explanations.

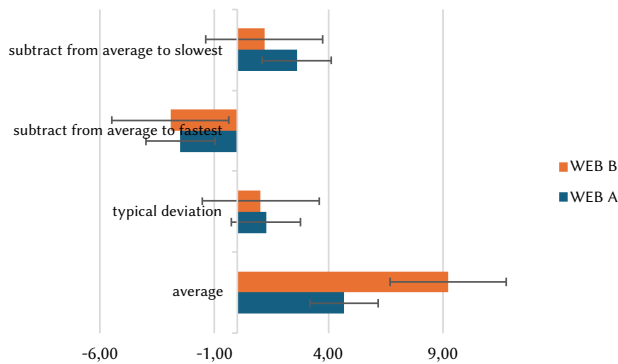


Fig. 11. Textual Content Evaluation Trials 17-18 of Slowest, Fastest, Standard deviation, Average Gain.

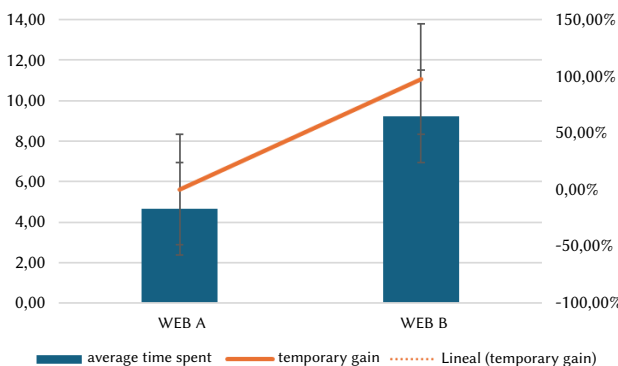


Fig. 12. Textual Content Evaluation Results about Temporary Gain.

E. Trials 19-20. Links Evaluation

The results of the tests comparing Website A and Website B showed significant differences in the average completion times and temporal gains for individuals with ADHD. On Website A, where text links were available, the average completion time was 3.70 seconds, while on Website B, where no text links were present, the average completion time was 7.07 seconds.

These findings suggest that the presence of text links in Website A significantly facilitated task completion for individuals with ADHD compared to Website B. The average completion time was almost twice as fast on Website A, indicating the effectiveness of text links in guiding users and reducing the time needed to complete the action.

Additionally, the temporal gain observed in the test was substantial, with a 90.94% improvement on Website A compared to Website B. This further highlights the significance of text links in enhancing the efficiency and usability of the website for individuals with ADHD.

It is important to note that no tests were left unfinished or exceeded the time limit, indicating that participants were able to successfully navigate and complete the tasks on both websites within the designated timeframe.

Overall, these results emphasize the importance of incorporating text links in web design to optimize the user experience for individuals with ADHD, enabling them to navigate more efficiently and complete actions more effectively. For a comprehensive overview of the slowest, fastest, and average completion times, see Fig. 13; the corresponding percentage improvements are illustrated in Fig. 14.

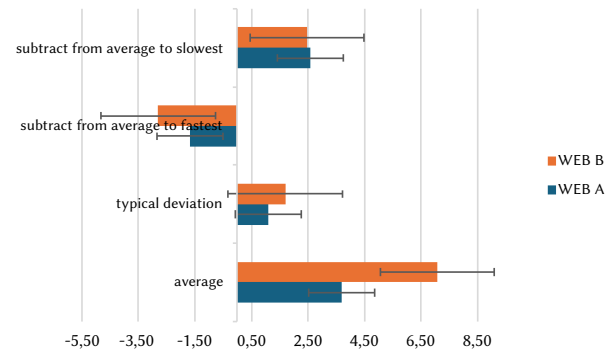


Fig. 13. Links Evaluation Results of Slowest, Fastest, Standard deviation, Average.

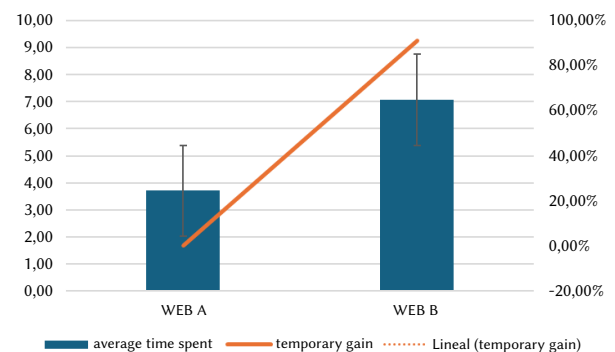


Fig. 14. Links Evaluation Results about Temporary Gain.

F. Trials 21-23. Temporal Elements Evaluation

The results obtained in the tests show the differences in the performance of users with ADHD on the three websites: A, B, and C.

On average, users on website A took 4.42 seconds to complete the questionnaire, while on website B and C, the average times were 5.66 and 6.05 seconds respectively.

The standard deviation indicates the variability of response times. On website A, the standard deviation was 0.81 seconds, while on website B and C, it was 1.53 and 1.78 seconds respectively. This indicates that users on website C experienced greater variability in their response times compared to the other two websites.

By subtracting the average times from the fastest time, the difference in seconds is obtained. On website A, users were 1.34 seconds slower than the fastest time, while on website B and C, they were 2.46 and 2.97 seconds slower respectively.

By subtracting the average times from the slowest time, the difference in seconds is obtained. On website A, users were 1.95 seconds faster than the slowest time, while on website B and C, they were 3.52 and 3.37 seconds faster respectively.

No unfinished tests or tests that exceeded 10 seconds were recorded on any of the websites.

Regarding the temporal gain, compared to the fastest time, users on website A experienced a temporal gain of -21.97%, while on website B and C it was -26.92% respectively. This indicates that users on all three websites were slower compared to the fastest time.

These results highlight the differences in the performance and efficiency of users with ADHD on the three evaluated websites. Website B, which has no visible chronometer, shows slightly better performance in terms of response times and variability compared to website C, which offers the option to hide the chronometer at the user's request. However, overall, users with ADHD on website A (with a visible chronometer) were the fastest, which suggests that a non-flashing temporal element might help this user profile maintain focus and complete tasks more efficiently.

However, overall, users with ADHD on all three websites were slower compared to the fastest time, indicating potential difficulties associated with the visible chronometer and time management in this user profile. These performance differences are graphically outlined in Fig. 15 and Fig. 16.

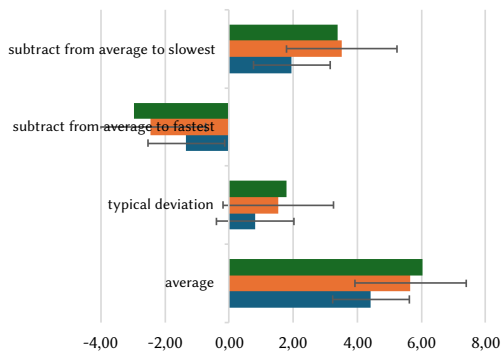


Fig. 15. Temporal Elements Evaluation Results of Slowest, Fastest, Standard deviation, Average.

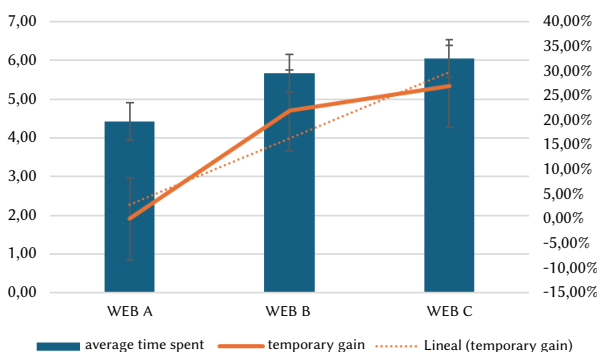


Fig. 16. Temporal Elements Evaluation Results about Temporary Gain.

It should be noted that in the graphical representation shown in Fig. 16, the labels 'WEB B 1' and 'WEB B 2' correspond directly to Website B and Website C, respectively.

G. Trials 24-25. Iconography Efficacy

The results of the test conducted on Websites A and B provide insights into the performance and efficiency of users when presented with iconography versus word-based menus.

On average, users on Website A took 4.46 seconds to complete the task, while users on Website B took 6.22 seconds. This indicates that users on Website A, which employed iconography, were able to complete the task more quickly compared to users on Website B, where words were used.

The standard deviation represents the variability in response times among users. In the case of Website A, the standard deviation was 1.29 seconds, while for Website B it was 2.19 seconds. This suggests that users on Website A exhibited less variability in their response times compared to users on Website B.

When comparing the average response times to the fastest time recorded, users on Website A were 2.11 seconds slower, while users on Website B were 2.95 seconds slower. Similarly, when comparing the average response times to the slowest time recorded, users on Website A were 3.04 seconds faster, while users on Website B were 3.19 seconds faster.

No tests were left unfinished or exceeded the 10-second time limit on either website, indicating that users were able to complete the task within the specified timeframe.

The temporal gain represents the improvement in response time compared to the slowest recorded time. In this case, users on Website A experienced a temporal gain of 39.58%, suggesting that the use of iconography facilitated quicker task completion and enhanced efficiency compared to Website B.

These results demonstrate that for users with ADHD, the inclusion of iconography in website design can lead to improved performance and efficiency in completing tasks. The visual representation of options through icons may aid in reducing cognitive load and streamlining information processing for individuals with ADHD. This highlights the significance of considering the accessibility and usability of iconography in web design to cater to the specific needs of users with ADHD and enhance their overall user experience (see Fig. 17 and Fig. 18).

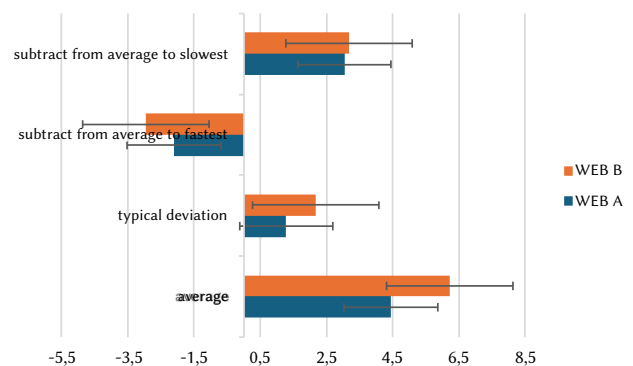


Fig. 17. Iconography Efficacy Results of Slowest, Fastest, Standard deviation, Average.

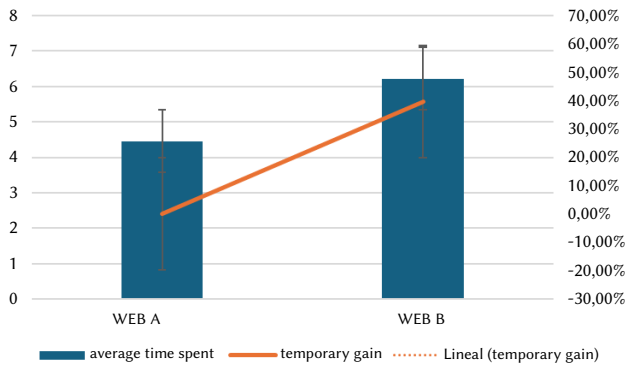


Fig. 18. Iconography Efficacy Results about Temporary Gain.

H. Temporal Gain in Multimedia Element Evaluation

In the audio + video + narrator test, the temporal gain was 28.22%. This demonstrates that the presence of a narrator in multimedia elements can facilitate comprehension and information processing for users with ADHD.

In the audio + subtitles + video + narrator test, the temporal gain was 50.27%. The combination of subtitles and a narrator further improves the experience for users with ADHD by providing multiple ways to access the information.

In the video + subtitles + narrator test, the temporal gain was 60.72%. The inclusion of subtitles and a narrator in the absence of audio is particularly beneficial for users with ADHD, as it allows them to follow and understand the visual content more effectively.

I. Temporal Gain in Sound Evaluation

In the sound test, the temporal gain was 13.65% for version B and 30.30% for version C compared to version A. These results indicate that volume control and the presence of adjustment tools can help users with ADHD maintain attention and better understand auditory messages.

J. Temporal Gain in Content Design Evaluation

In the background test, the temporal gain was 43.08% for version A and 52.63% for version C compared to version B. This demonstrates that visually simple content design with a low visual load can facilitate navigation and comprehension for users with ADHD.

K. Temporal Gain in Textual Content Evaluation

In the definitions test, the temporal gain was 73.80% compared to the version without definitions. Providing clear and concise definitions for uncommon terms facilitates content comprehension for users with ADHD.

In the memory test, the temporal gain reached 97.55% for the version with a prior explanation. Providing contextual support and explanations 30 minutes before the task notably enhances the retention and retrieval of information for users with ADHD.

L. Temporal Gain in Links Evaluation

In the links test, the temporal gain was 90.94% compared to the version without links. The presence of text links enhances the ability of users with ADHD to locate and access relevant information more efficiently.

M. Temporal Gain in Temporal Elements Evaluation

In the chronometer test, version A achieved a temporal gain of 26.94% and version B achieved 6.44% compared to version C. The use of a fixed, visible chronometer can help users with ADHD maintain focus and complete tasks more efficiently than when the chronometer is absent or hidden.

N. Temporal Gain in Iconography Evaluation

In the iconography test, the temporal gain was 39.58% compared to the version without iconography. The inclusion of effective iconography can facilitate comprehension and navigation for users with ADHD.

In conclusion, the application of specific accessibility and usability guidelines, such as the presence of narrators in multimedia elements, the use of subtitles, sound volume control, visually simple design, clear definitions, avoidance of abbreviations, text links, effective temporal elements, and appropriate iconography, can significantly enhance the experience of users with ADHD by making information more accessible, understandable, and easy to process. These guidelines are crucial for web developers as they enable them to create more inclusive and optimized websites that meet the needs of users with ADHD.

VI. CONCLUSIONS

Throughout this research, data has been found that could contradict the usability recommendations of WCAG 2.1. For example, according to Guideline 1.2.2 of WCAG 2.1, providing subtitles is recommended to ensure accessibility for individuals with hearing disabilities. However, in our research, it was observed that the presence of subtitles alongside the video resulted in a longer average time taken by participants with ADHD compared to the video without subtitles. Website C showed the highest average time (5.89 seconds), followed by Website B and Website A.

Another example is Guideline 1.4.3, which aims to improve readability by ensuring adequate contrast between text and background. However, in our research, we found that a low-contrast design performed better than a high-contrast design with textured backgrounds. This contradiction can be attributed to the difficulties individuals with ADHD face in quickly perceiving and differentiating visual elements within a set of many elements [6] - [9].

Similarly, according to Guideline 1.1.1, emphasis is placed on using text as accessible content or providing text labels when an icon is used. However, in our research, it was found that using iconography instead of text was more efficient in an online navigation task, especially when the icon was not accompanied by a label. This contradiction can be explained by the fact that icons can be more efficient and understandable for some individuals with ADHD as they reduce the cognitive load associated with processing text.

Lastly, according to Guideline 3.1.5, dividing extensive content into smaller sections is suggested to facilitate comprehension. However, in our research, we found that a design with segmented content in smaller sections resulted in a longer average time taken by participants with ADHD compared to longer and continuous content. This contradiction can be explained by the fact that some individuals with ADHD may find it easier to process and retain information when it is presented more continuously and in a more extensive format [6] - [9].

The importance of this research lies in its comprehensive focus on each neurodiverse profile, such as ADHD, and their specific navigation needs. While WCAG 2.1 provides general guidelines for web accessibility, it is crucial to recognize that not all recommendations are equally applicable to every individual profile. By understanding these contradictions, web developers and designers can adapt their approaches and customize their websites and applications to ensure a more inclusive and accessible experience for individuals with ADHD and other neurodiverse profiles.

CREDiT AUTHORSHIP CONTRIBUTION STATEMENT

Lucía Alonso Virgós: Conceptualization, Methodology, Project administration, Writing – original draft.

Isabel Morales Gil: Data curation, Investigation, Validation.

Luis Rodríguez Baena: Software, Formal analysis, Visualization.

Jordán Pascual Espada: Investigation, Validation, Writing – review and editing.

Rubén González Crespo: Supervision, Resources, Funding acquisition, Writing – review and editing.

DATA STATEMENT

The quantitative and qualitative datasets generated and analyzed during the user tests evaluated in this study are available from the corresponding author upon reasonable request.

DECLARATION OF CONFLICTS OF INTEREST

We have no conflict of interest to declare.

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Lucía Alonso Virgós

Dr. Lucía Alonso Virgós is an Industrial Design Engineer and a Contracted Professor at the School of Engineering and Technology of the Universidad Internacional de La Rioja (UNIR), Spain. Her research bridges Human-Computer Interaction (HCI) and social inclusion, with a primary focus on evaluating how web developers apply usability principles natively and designing inclusive web

platforms for individuals with intellectual disabilities. She has co-authored a broad body of research published in indexed international computer science journals, focusing heavily on cognitive web accessibility and educational technology.



Isabel Morales Gil

Isabel Morales Gil is a Clinical Psychologist, researcher, and Associate Professor at Universidad Internacional de La Rioja (UNIR), Spain, where she is the Academic Director of the Master's Degree in General Health Psychology. Her research focuses on mental health, digital interventions, artificial intelligence in healthcare, and the prevention of psychological disorders. She has authored

several publications in peer-reviewed journals and is involved in research and innovation projects aimed at improving mental healthcare through technology.



Luis Rodríguez-Baena

Luis Rodríguez-Baena holds a PhD in Sociology and is currently a faculty member at the School of Engineering and Technology of the Universidad Internacional de La Rioja (UNIR), Spain. His research interests include usability, accessibility, and user experience. He has published in peer-reviewed indexed journals and has presented his research at international conferences in these fields.



Jordán Pascual Espada

Jordán Pascual Espada received a PhD in Computer Science from the University of Oviedo (Spain) in 2011. He is a professor at Computer Science Department of the University of Oviedo (Spain). B.Sc. in Computer Science Engineering and a M.Sc. in Web Engineering from the University of Oviedo. His research interests include the

Internet of Things, exploration of new applications and associated human computer interaction issues in ubiquitous computing and emerging technologies, particularly mobile and Web applications. He has been author of published papers in several journals and recognized international conferences and symposiums.



Rubén González-Crespo

Rubén González-Crespo received his Ph.D. in Computer Science and currently serves as a senior academic and research leader at Universidad Internacional de La Rioja (UNIR), Spain. His research interests include artificial intelligence, educational technology, software engineering, digital transformation, and human-computer interaction. He has authored numerous scientific publications in

indexed journals and international conferences and has participated in research, innovation, and institutional projects related to technology-enhanced education and digital ecosystems.