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Employing Inclusive User Experience Design Considerations in Color for Autistic Children

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Abstract

User experience (UX) design is crucial in shaping our interactions with technology, it's essential to acknowledge that not all users have the same needs and abilities. Autism, a condition that affects a portion of the population and presents unique challenges when it comes to digital experiences. This research article explores the importance of considering color-based UX design, for children on the autism spectrum. The research highlights the employment of color in UX design for autistic children that can effectively enhance engagement and cognition and also can lead to overload and anxiety. Through reviewing existing literature conducting case studies and consulting with experts we aim to identify suggestions that can be implemented. Additionally, this study explores UX design considerations and best practices to determine their applicability in creating experiences for autistic children. We proposed design considerations and recommendations tailored specifically to this user group, to foster an accessible digital environment for autistic children by understanding the importance of color, in UX design and employing thoughtful and sensitive design methods. Focus group discussions among UX designers and experts concluded that selecting soothing, engaging colors with appropriate contrast and distinguishability is crucial for autistic children. The researchers emphasize the need to consider special requirements, choices, and strategies of autism spectrum disorder children in design to create visually engaging and comfortable experiences while maintaining brand identity. The study asserts that enhancing color brand identity without causing vision over stimulation in autistic children is essential.

Keywords: Accessibility, Autism spectrum disorder, Color considerations, User experience

Introduction

User experience (UX) design plays a role in shaping our interactions with technology in today's era. Whether it's apps or websites, how we engage with these platforms greatly impacts our lives. When it comes to UX design, it is important to acknowledge that different users have varying needs and abilities. One particular group that often faces challenges is children on the autism spectrum.

Autism is a disorder characterized by difficulties in interaction, communication, and repetitive behaviors. According to a study conducted by the Centers for Disease Control and Prevention in the United States, ~1 in 54 children globally are affected by autism spectrum disorder (ASD) as of 2021. Research in Egypt found a wide range of ASD prevalence, ranging from 5.4/1000 to 33.6%. At the same time, studies in Egypt were restricted to constrained locations, facility-based research, and

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a small sample size (Meguid, 2021; Metwally *et al.*, 2023). As the digital landscape continues to evolve, it becomes imperative for UX designers to consider the requirements of children to create inclusive and accessible experiences.

Key Norton partner at Google Ventures stated that ‘Start with a problem we would like to solve. UX design is focused on anything that affects the user's journey to solve that problem, positive or negative, both on-screen and off. The role of UI designers is focused on how the product's surfaces look and function. Color holds importance in UX design, as it helps create appealing and functional designs. According to psychologists, color impression accounts for 60% of a product's acceptance or rejection. As a result, unsuccessful color scheme can have the same impact on the

overall UX as poor text or a slow page load time. However, when it comes to people with autism, color can be an edged sword. Certain color combinations can enhance interest and comprehension; however, specific colors or visual stimuli may trigger overload or anxiety.

This research paper aims to employ the UX color design considerations in website design when it comes to color choice for children on the autism spectrum.

Hypotheses

Q1: Are colors used in the design to ensure the brand identity of the websites prevent autistic children from navigating properly? Fig. 1.

Q2: Is using shades of the brand identity with reference to ASD UX color design consideration is beneficial? Fig. 2.



Fig. 1. Designs of hypothesis 1 in the focus group (designed by the author).

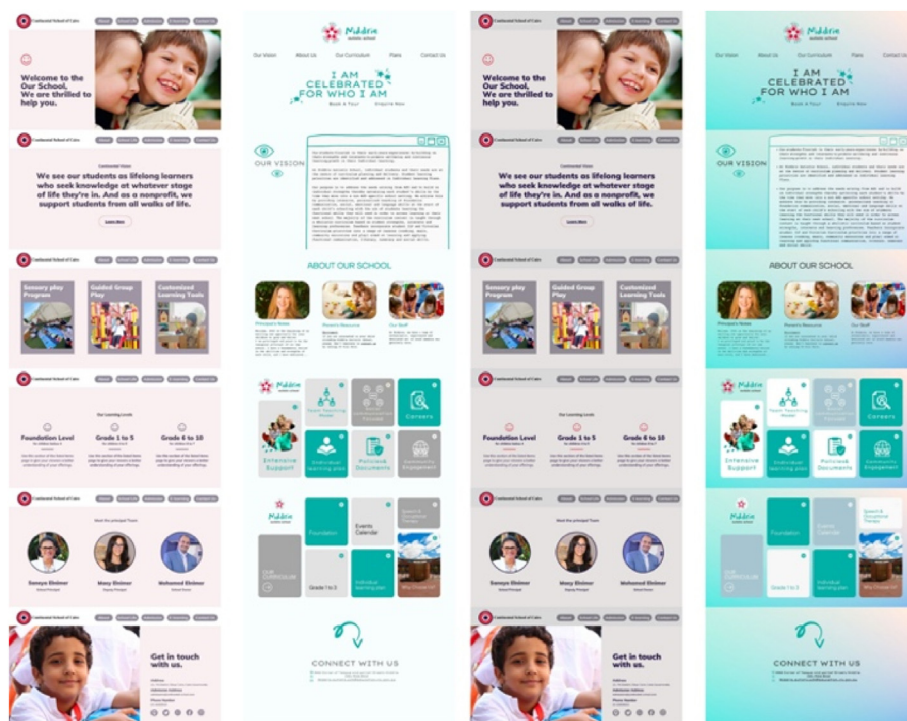


Fig. 2. Designs of hypothesis 2 in the focus group (designed by the author).

Review of literature

User experience (UX) design considerations in color

Color plays a crucial role in website design because it evokes meaning and emotion, often subconsciously. Color is a significant tool for expressing a brand message and building brand identification when utilized carefully. According to (Kimmons, 2020) considerations that designers should incorporate in UX design are a few considerations that may be useful for choosing dominant colors that affect emotions that cope with the design goals, making sure of the sufficiency of color contrast and the color usage of color is strategically allowing learning identification of important content clearly and readily to follow intended user pathways. And added that when dealing with content that contains contrast with the color scheme (complicated content requires a simpler color scheme, whereas simpler content might benefit from a more complicated color scheme). Kimmons (2020) recommended the use of white areas and the written content using the colors white, black, and gray for balancing the color

usage and contrast and enumerated some important factors to consider when using color in UX projects, for example ensuring contrast, directing attention, conveying meaning, and achieving harmony.

Contrast

The presence of contrast affects the accessibility of websites significantly, usage of high contrast colors in website design to improve legibility. White writing on a darkened background, for example, or the opposite. Color contrast captures one's focus and may create some crucial things that visually stand out. However, excessive color contrast on a webpage might strain our eyes. See Figs. 3 and 4.

Attention

Second, colors can be utilized quickly and efficiently to draw the eye's attention to visual elements of importance. Any color variation will normally focus the learner's attention on the variance; therefore, UX designers can employ this approach to actively direct the attention of the user to areas that count while avoiding superfluous variation of color in irrelevant parts.

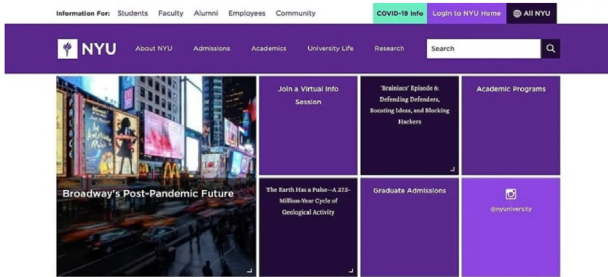


Fig. 3. A bad example of how low contrast in web design affects navigation well (Romanchuk, 2024) 19 examples of bad website design in 2024 [+ what they got wrong], HubSpot Blog. Available at: <https://blog.hubspot.com/website/bad-vs-good-design> (Accessed: December 4, 2023).

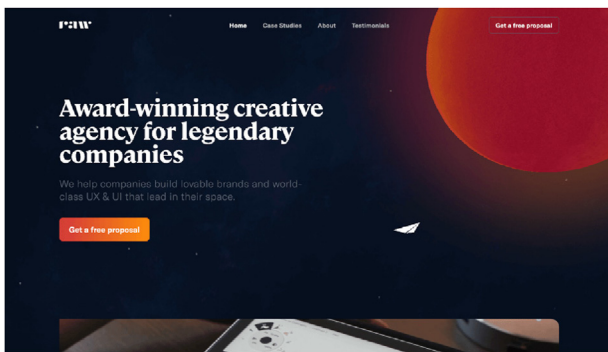


Fig. 4. A good example of how to balance high and low (How to strategically use colors).

Meaning

Emotional significance can be transmitted by color (and sometimes even intellectual) to

students, colors should be employed in a way that highlights the overall project's and individual content pieces' intended meaning. As seen in (Figs. 5 and 6), blue, for example, would have a completely different vibe when used as a primary color in a modern, minimalist design than when used as an accent color in a more complicated, corporate design. As previously stated, the significance and emotional impact of colors can vary widely based on context and personal preference. However, some color associations are relatively consistent across cultures and individuals: Shades of gray often indicate neutrality or insignificance. Warm hues, like reds and yellows, tend to evoke emotions such as passion, excitement, or conflict. Cool colors, such as blues and greens, often create a sense of calm, familiarity, or consensus.

Harmony

To effectively leverage colors in any design, the designer must grasp not just the feelings evoked by every color, but also how to employ colors collectively in harmonic manners that fit the project's intended aims. Colors with short wavelengths, like warm hues, naturally stand out more than those with longer wavelengths (cool colors). Vivid colors also attract attention more than faded shades. However, an

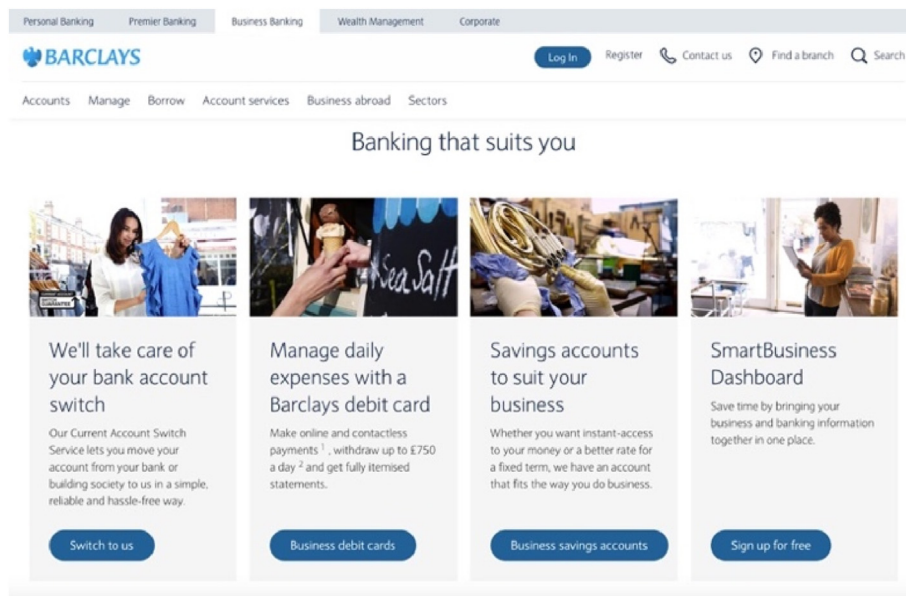


Fig. 5. A good example of how color is used to give the right meaning in web design (Chapman, 2018) The role of color in UX: Toptal, Toptal Design Blog. Available at: <https://www.toptal.com/designers/ux/color-in-ux> (Accessed: September 4, 2023).



Fig. 6. A bad example of how color is used to give the misleading meaning in web design (Kotulskyi, 2020) Good and bad websites [10+ examples], Seogene. Available at: <https://seogene.com/blog/good-and-bad-design-websites/> (Accessed: September 4, 2023).

experienced designer understands not only which colors to choose but also how to combine different colors in a balanced, harmonious, and intentional manner (see Figs. 7 and 8).

Color perception in UX design

Color, as it is a mental impression produced by various visible light wavelengths, Colors range from low-frequency reds to high-frequency violets. Some colors are produced by a specific range of wave lengths. Whereas additional colors have been created by combining various color wavelengths. For example, when all color wavelengths are combined, white light consists of a mixture of all the colors in the visible spectrum. When white light passes through a dispersive prism, it is separated into its component colors, forming a rainbow-like spectrum. This is because the prism reflects different wavelengths of light at different angles, causing the colors to spread out. Kimmons (2020). According to WCAG 2.1 (Web Content Accessibility Guidelines) (Web

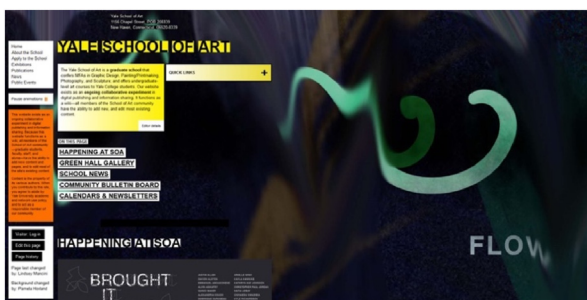


Fig. 7. A bad example of how color is used with harmonious colors yet not successful in web design (No date).

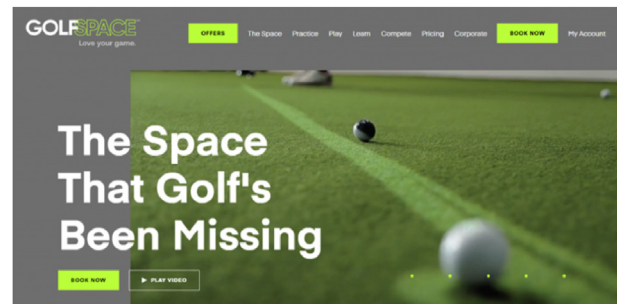


Fig. 8. Website Using the successful harmonious Color scheme (Hos-tinger (no date)).

Content Accessibility Guidelines (WCAG) 2.1 covers a wide range of recommendations for making Web content more accessible), color plays a crucial role in designing effective web content, making it visually appealing, easy to use, and accessible. However, not everyone can perceive colors equally. Individuals with impaired vision, such as partial sight or age-related sight issues, may struggle with color perception. Additionally, users with devices that display limited color or use monochrome settings would not be able to access information presented solely in color.

Yu (2023) claimed that reading color as a sign has been developed as a method of comprehending its meanings in visual design. While Gaines and Curry in Kimmons (2020) agreed that 'color is understood as a way of visual communication, a special kind of language, consisting of particular signs. Each color sign has several levels of meaning varying in depth. Depending on the context and conditions of its use, the same tone or hue can act in different roles. It can function as an index, the form of which follows and is provoked by its content; as a copy, in which the form repeats the content; or as a symbol, with its form linked to the content quite arbitrarily and conditionally'.

Color psychology is the study of how color affects our moods, emotions, and behaviors. This makes it an effective design and marketing tool. People are drawn to different colors for a variety of reasons, including how they make them feel. Colors, on the other hand, might elicit a tangible reaction, causing people to avoid identifying with them. Context and color play a vital role in color perception. Red may elicit feelings of fear and anxiety, while, in

certain situations, it might arouse desire and excitement. Color in website design must combine fluidly with other aspects of the webpage, such as typography, graphics, copywriting, and cultural differences meaning (Kimmons, 2020). Quetzalli (2023) asserted that colors play a crucial role in creating visually attractive and readable website designs for documentation. However, it is essential to consider color choices carefully to ensure accessibility for everyone, especially individuals with visual impairments.

Kimmons (2020) declared that selecting color is a key component in designing the UX that is sometimes disregarded in design courses and studies or treated in a nonscientific manner. On the other hand, designers need to be aware of the diverse emotional and physical responses that colors evoke in users. These reactions are influenced by the unique characteristics of the color (such as its hue, saturation, and brightness) and also by the user's personal experiences and cultural background (for instance, the color might trigger a specific association or memory).

According to world wide web consortium (The global community brings together organizations, staff, and the public to collaborate on creating standards for the internet that are accessible to all) W3C, in WCAG 2.1 mentioned in guideline 18: 'Ensuring that a contrast ratio of at least 4.5 : 1 exists between text (and images of text) and background behind the text.' The objective of this technique is to make sure that users can read text that is presented over a background. If the background is a solid color (or all black or all white), then the relative luminance of the text can be maintained by making sure that each of the text letters has a 4.5 : 1 contrast ratio with the background (see Fig. 9). It could be calculated through many different tools, like the color ratio contrast analyzer online service, where it analyzes the luminosity contrast ratio by entering the pantone color of the background and the color of the foreground and calculates the luminosity ratio according to the WCAG 2.1 guidelines.

The Carnegie Museum website offers color palette suggestions that meet WCAG accessibility standards. Figs. 8 and 9 illustrate these

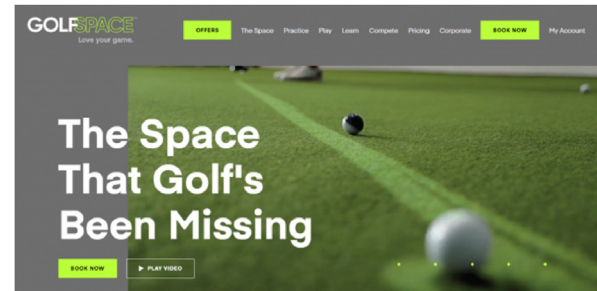


Fig. 9. An example of enhancing the visibility of the company logo through using dark background, allowing for the use of light-colored letters (Whatmread, 2024) Review 2437: The guest room, whatmread. Available at: <https://whatmread.com/2024/05/27/review-2437-the-guest-room/> (Accessed: November 9, 2023).

suggestions: Fig. 10 shows examples of color combinations on a white background, and Fig. 11 provides examples of neutral colors on colored backgrounds (Quetzalli, 2023).

With the help of online tools like the WebAIM Color Contrast Checker, is one approach to validate that the colors used in your documents comply with WCAG criteria.2. These tools allow you to enter the color values for your text and backdrop and then calculate the contrast ratio to see whether it fulfills WCAG requirements. Colors have adequate



Fig. 10. 'Colors on a white background,' referenced from CarnegieMuseum.org (edited) (Web accessibility guidelines v1.0 foundations - overview (no date) Color|Accessibility Guidelines. Available at: <http://web-accessibility.carnegiemuseums.org/design/color/>. (Accessed: September 9, 2023).



Fig. 11. 'Neutrals on a colored background,' referenced from [CarnegieMuseum.org](https://www.carnegiemuseum.org) (edited) (Web accessibility guidelines v1).

contrast if the score reaches or surpasses the minimal criteria of 4.5:1 (Quetzalli, 2023). People have varied emotional and physiological reactions to the colors represented by the color wheel, which impact their overall experiences as well as their learning. Kimmons stated that Krathwohl, Bloom, and Masia (1964) developed a classification system for the area of learning known as the affective domain, which encompasses aspects of learning that are connected to 'a feeling of tone, an emotion, or a degree of acceptance or rejection' even as expressed through goals oriented towards 'interests, attitudes, appreciations, values, and emotional sets or biases.'

According to Corrigan (2023) and Swasty and Adriyanto (2017), some color associations give a specific meaning and feeling when they are combined with different contexts in UI design for websites, such as:

Colors with long-wavelength (e.g., reds and yellows) are more stimulating (e.g., higher heart rate and breathing) than short-wavelength colors (e.g., blues and greens).

Furthermore, several studies have revealed that primary colors are preferred to colors with secondary or tertiary hues, and that all these are preferred to grays. Some of these reactions can be explained by changes in photoreceptor stimulation intensity in the eye (e.g., the eye revealed greater sensitivity to red), whereas others are likely the outcome of typical environmental experiences, such as linking color white with cleanliness and the colors blacks and greys with dirtiness (Kimmons, 2020) (see Table 1).

Best practices for color design: enhancing user experience

Considering the password prompt interfaces in Fig. 12, how could your emotional and behavioral response to a prompt alter depending on its color if you were presented with each of these interfaces? When you see a red prompt, you might think to yourself, 'Is this really a secure site?' An orange prompt, on the other hand, may catch your attention but be somewhat confused or alarming; a grey prompt may seem boring but also appear secure or professional; and a blue prompt may make you feel comfortable submitting your information when you should not be.

As in Fig. 13, there are four design options for a learning app for young children to encourage them to take responsibility for their pets' care. Designs were two using a threatening image of a grown-up dog, and the alternative two using an image of a soft puppy. The options are two reds and two greys, Option (1) feels aggressive due to color and content; however, option (3)

Table 1. Color emotion on web UI Design (Designed by the Author).

Color	Color meaning/feeling
Red	Passion, Power, Love, Danger, Anxiety, Excitement, Importance, Youth
Blue	Trust, Competence, Peace, Logic Lighter shades: Safety, calm, openness. Darker shades: Strength and Reliability
Green	Health, Nature, Abundance, Prosperity, Growth, Stability, Financial and environmental themes
Yellow	Optimism, Creativity, Friendliness Darker shades: Happiness, enthusiasm, antiquity
Orange	Fun, Freedom, Warmth, Comfort, Playfulness, Uniqueness, friendliness, Arise energy and a sensation of movement
Purple	Sophistication, Loyalty, Creativity Lighter shades: Luxury, Romance. Darker shades: Mystery
Pink	Nurturing, Gentleness, Sincerity, Warmth
Brown	Nature, Security, Protection, Support
Black	Elegance, Power, Control, Sophistication, Depression Edginess and timeless
White	Purity, Peace, Clarity, Cleanliness, Simplicity, Virtue
Grey	Formality, Neutrality, Melancholy
Ivory	Elegance, simplicity, comfort
Beige	Traits of surrounding colors, humility, a secondary or background color



Fig. 12. Four hue examples of user interfaces that evoke distinct behaviors, levels of trust, and attitudes in users (Kimmons, 2020) 'Color theory in experience design', *Learner and User Experience Research*, pp. 103–125.

appears to be a discrepancy between what is displayed and how it is presented, creating contradicting feelings. However, the unbiased gray backdrop for (2) and (4) grants the information to express emotion. So, if we want youngsters to develop a good attitude towards pet care, option (4) is probably the best choice. Hue is not the sole factor that determines mood; color saturation (how little white is mixed in with it) and brightness (how little black is mixed in with it) also affect mood.

In Fig. 14, although a range of shades of blue exists, each tint elicits distinct emotional reactions in the viewer's mind. Such as (a) would make it pleasant, however, not stimulating or overpowering, generating tranquility; (b) it would be immensely delightful and to some extent exciting yet follower, prompting astonishment or amazement; (c) it would be the least enjoyable and most neutral in terms of excitation and power, generating boredom; (d) it

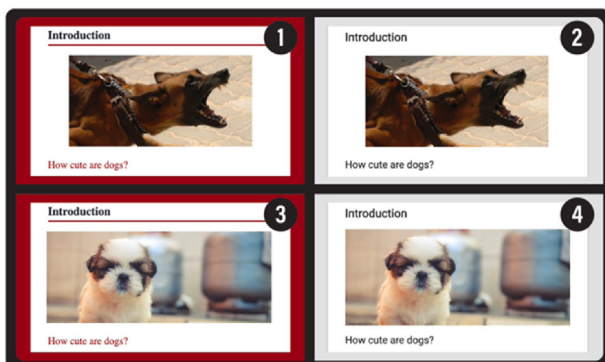


Fig. 13. Four different options for a mobile app focused on pet care. These options include variations in both color and content (Kimmons, 2020) 'Color theory in experience design', *Learner and User Experience Research*, pp. 103–125.

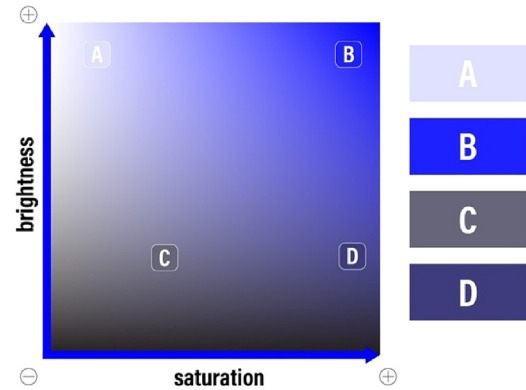


Fig. 14. Exploring Variations of Primary Blue Hue: Brightness and Saturation Parameters with Illustrative Examples (Kimmons, 2020) 'Color theory in experience design', *Learner and User Experience Research*, pp. 103–125.

would provide high stimulation and dominance, yet unbiased in terms of happiness, producing a sense of boldness or hostility (Valdez and Mehrabian in (Kimmons, 2020)).

Color for autistic people

In today's world, the importance of web accessibility for users with disabilities is widely acknowledged. However, simply mandating accessibility through laws is not sufficient. The main issue lies in the absence of a pervasive sense of access amongst web professionals, who often struggle to understand and meet accessibility requirements, as well as design websites that are accessible. Additionally, the accessibility guidelines themselves, which are intended to assist web designers, are often presented in legal documents that are not easily accessible to them (Gaggi and Pederiva, 2021). Liss *et al.* (2006) declared that people with ASD typically perceive, explain, and display abnormal sensory and attention patterns. Alzahrani *et al.* (2021) claimed that people with ASD are vulnerable to sensory overload and have atypical behavior of attention deficit. They may also suffer from a syndrome known as stimulus over-selectivity, in which users respond exclusively to a subset of tasks or environmental stimuli, resulting in reduced cognitive performance. Eraslan *et al.* (2019) concurred that people with ASD face sensory difficulties including hypersensitivity (over-sensitivity) or hyposensitivity (under-sensitivity) to specific odors, lighting, textures,

noises, and colors, while Nair and colleagues asserted that colors affect autistic children differently depending on how they see them. Most people perceive them to be more intense than they are. While [Kimmons \(2020\)](#) said that those features may make online browsing more difficult for them. [Jun, 2023](#) stated that Naidoo and Singh developed a visual communication board to make communication between patients with ASD and dental care specialists easier. They showed a color-coded scheme to differentiate between classifications on the dental communication board, which made ASD patients more comfortable. The implementation of the dental communication board as a visual tool employing colors and the development of visual aids to enhance speech and communication skills in dental settings for children diagnosed with ASD. That resulted in the effectiveness of ASD people by the visual support in teaching. According to WCAG guidelines, different users with varying cognitive experiences may encounter challenges when navigating websites. For instance, for individuals with autism, excessive use of vibrant colors, especially multicolored icons, can be

overwhelming and make it difficult for them to use the website effectively. While, [Rezae et al. \(2020\)](#) recommended that avoiding bright colors and pop-up distractions facilitates more concentration and focus for ASD people. [Eraslan et al. \(2019\)](#) reported that they ‘use color coordination for various aspects of the site relating to each other’ and ‘use the key for different colors for different sections.’ [Jones \(2021\)](#) stated an ultimate guide for autism friendly colors by examining it through a colored sensory room for autistic kids. According to [Jones \(2021\)](#), patterns with large, eye-catching designs and colors that are extremely saturated or bright should be used sparingly in interior design. Overusing these elements can lead to sensory overload in a room. The table below concludes the most autistic-friendly colors, the colors to be avoided, and their psychological impact on them [Table 2](#).

[Nair et al. \(2022\)](#) concurred that employing color schemes that cater to individuals with autism, such as soft hues, neutral tones, and subdued shades, can foster a sensory environment that promotes relaxation and is appropriate for an autistic educational atmosphere

Table 2. Color impact on users with autism spectrum disorder (Designed by the Author).

Colors	Impact	Feeling
Pink Lilacs	Positively affects autistic users	Safety, love peaceful feelings and induce a condition of tranquilly in an individual with autism
Greens and Blues (Soft tunes)	Reduced neural activity is observed in the brain	Banish the feeling of chaos, has soothing feeling and reducing over-stimulation
Soft Muted Oranges	Possible colour choices that are suitable for individuals with autism	Giving soothing warming effect and stimulate appetite
Neutral colors (beige, greys, creams or tans)	Has a great effect on people with autism	Due to their lack of distraction, they can have a soothing effect
White	Although beige appears neutral, it can be overwhelming and fatiguing for individuals with autism due to its brightness. It may also evoke negative associations with clinical environments, such as hospitals and medical facilities	It is possible that they experienced discomfort
Bright and fluorescent colors	Lead to difficulty concentrating, increase irritability, and the onset of headaches	Causing a sense of disorientation and confusion.
Reds	Red color can greatly impact individuals with autism. They may experience red as unusually bright or fluorescent, which can cause increased blood pressure and feelings of tension or agitation	Trigger meltdowns or general upset
Yellow	Can be overstimulating for people with autism	This action may cause an adverse reaction for people with autism. To ensure a positive and comfortable sensory experience, avoid this action within their sensory space.

since they promote learning, enhance attention, and boost energy levels. However, outstanding and vivid colors should be avoided since they can be overstimulating and have a disturbing effect, leading to autistic children being aggressive and tense, autistic children may experience agitation, depression, or confusion as a result of certain stimuli, leading to their retreat.

User experience design for autistic users

Dattolo and Luccio (2017) defined the main difference between UX and user interface design lies in the fact that UX design specifically promotes and facilitates interaction between the user and the system and added that the quality of UX directly influences the perception and value of the technology, as well as its human variables might influence this; consequently, it is critical for those who have cognitive impairments. Rezae *et al.* in Yaneva (2016) declared that users with autism take more time to finish a task on websites than non-autistic people, and they can react with web pages efficiently less. According to their findings, individuals with autism tend to visually explore a greater number of items on websites and navigate between user interface elements more frequently, suggesting a higher level of cognitive effort in processing the web page. The authors said that individuals with autism are prone to being readily diverted by extraneous items on online pages.

However, Dattolo *et al.* (2016) claimed that there are no current websites that are functional and accessible for persons with ASD, allowing them to freely browse inside them and make autonomous decisions (such as choosing a tour).

Baxter *et al.* (2015) investigated the sensory processing characteristics observed in users with ASD. These included heightened sensitivity to color contrast challenges in filtering out information and a preference, for visual simplicity. Furthermore, we will investigate the influence of color on emotional well-being, concentrating on its ability to reduce anxiety or elicit negative emotions, stimulate engagement, support communication, and increase independence, lowering the likelihood of challenging behavior.

AASPIRE web accessibility physical guidelines

The Academic Autism Spectrum Partnership in Research and Education is a global collaboration of academic researchers, adults with autism, family members, disability service providers, and healthcare professionals located in the United States that carries out research regarding the requirements of individuals who are adults and diagnosed with ASD. The collaboration has followed the principles of community-based participatory research (CBPR) (Israel *et al.*, 2005) since its establishment in 2006, in which both researchers and community members have equal authority and influence in the research process (Nicolaidis *et al.*, 2019).

That document outlined the main points of accessibility guidelines discovered and implemented throughout their study. They didn't require any specialized knowledge other than fundamental web programming and technology communication skills. They recommended that anybody developing websites designed for individuals with autism adhere to the Academic Autism Spectrum Partnership in Research and Education Web Accessibility Guideline, along with other web and communications guidelines and requirements (Raymaker *et al.*, 2019).

They started physical accessibility guidelines, especially for using color, to offer a minimum of one-color palette choice with low contrast that is suitable for individuals with sensitive vision, to satisfy color and contrast sensitivities, and to make accessible a range of color schemes, featuring both a dark and a light background. Additionally, it is recommended to provide a no-style option to allow browser customization for users who do not want styling formats and to contribute easy, consistent navigation and exceptionally consistent site behavior for better simplicity of operation. Finally, to avoid textured backgrounds, moving graphics, decorative features that do not transmit data, and other visual and/or auditory 'clutter', those features might make the website challenging to understand.

Methodology

The methodology applied in this research study incorporates a combination of diverse

methods to comprehensively explore and understand the phenomena under investigation. The following methods were utilized:

Documentation: Extensive documentation was conducted to gather existing literature, reports, and relevant materials related to the research topic. This method enabled a comprehensive review and analysis of previous studies, theories, and practical applications, serving as a foundation for the research.

- (a) **Practical Application:** The researcher redesigned three school websites for autistic children to gain practical insights, real-world scenarios and applications were explored. This involved implementing the researched concepts in practical settings, observing their effects, and gathering data through experimentation and observation. This hands-on approach allowed for a deeper understanding of the subject matter and its real-life implications.
- (b) **Focus Group of Designers:** A focus group of seven experienced UI/UX designers and academic experts in UI/UX was assembled to obtain expert opinions and perspectives and study the artifact to propose improvements in the design. Through interactive discussions and a structured questionnaire that is divided into two sections: the first section is a group of long answered questions to gather feedback on UX design color considerations in websites designed for children with ASD by measuring keeping up the color of the brand identity, while the second section is multiple-choice questions where the design experts choose between two designs that are designed with shades of the brand identity with referencing to ASD UX color design consideration. Valuable insights were gathered regarding the researched phenomena and giving their experienced opinion on the design the researcher designed. The input from the designers provided a rich source of qualitative data, capturing their experiences, opinions, and suggestions related to the topic.
- (c) **Qualitative Exploration of Phenomena:** The research methodology also emphasized qualitative exploration of the phenomena under investigation. This involved conducting in-depth interviews, surveys, and observations to gather subjective data, allowing for a deeper understanding of the underlying factors and intricacies of the phenomena.

Qualitative analysis techniques, such as thematic analysis, were employed to derive meaningful insights from the gathered data.

By employing this multi-faceted methodology, the research was able to provide a comprehensive and nuanced understanding of the phenomena, combining theoretical perspectives, practical applications, expert opinions, and qualitative exploration. This approach ensured the research was well-rounded, and rigorous, and yielded valuable insights into the subject matter.

Results and discussion

Concerning hypothesis 1 in the focus group discussion among UX designers and experts, the impact of color choices on the appeal and usability of website designs for children who are diagnosed with ASD was explored. The designers analyzed three different website designs and shared their thoughts on the color palettes. The consensus among the designers was that the first and second designs, which featured the dominant use of whites and reds, were considered triggering and unappealing for ASD children. The third design, with its pastel and harmonious colors, was generally well-received. However, there were concerns about potential confusion caused by the contrast between the blue font and green shapes in the third design. Overall, the designers agreed that a more thoughtful selection of colors, considering the specific requirements and sensitivities of children with ASD, would be crucial in creating an inclusive and user-friendly design. The designers also discussed the contrast and distinguishability of colors used in the three designs. The first and third designs were considered to have good contrast and were easy to distinguish, while the second design lacked contrast. The first design was praised for its use of background color to enhance contrast and readability. The second design, on the other hand, was seen as having excessive contrast, which could be distracting for children with ASD. The third design was considered to have a harmonious color palette with sufficient contrast. The designers noted that the color contrast in all the designs facilitated readability, but there were concerns about the harshness of the contrast in some designs,

particularly the use of red and navy as accent colors. Overall, the majority of the designers agreed that the first and third designs had appropriate contrast and were easy to distinguish, while the second design lacked sufficient contrast and could be problematic for children with ASD.

In hypothesis 2 of the focus group, two different options of web designs were shown for every single design (1 and 2) to the group. Considering visually appealing designs, designers have more tendency toward the design option using grays and pastel colors, while in the second design option there was a consensus that the design using pastels and greys is the best, which indicates that using grays and pastels is appealing to ASD people. By assuring contrast and distinguishability in design option one, some of the designers have more tendency to use greys rather than greys and pastels, while the contrary occurs in design option two, which means that using brighter shades of blue has a greater contrast than using pastels and grey only, yet using grays with dark blue results in more contrast. Designers affirmed that using grey with light shades of color identity is engaging, drives attention, and creates a harmonious and balanced visual experience for ASD children to the web design more than adding red pastels or bright blue. Additionally, around 70% of the focus group participants see that using gray with a light color palette is inclusive and representative of a wide range of ASD children.

Conclusion

In this study and after focus group discussion among UX designers and experts, the researchers concluded that the chosen colors were deemed appealing, while other colors were considered uncomfortable or triggering for ASD children. The designers emphasized the importance of selecting colors that are soothing, engaging, and harmonious for children with ASD. The focus group participants also highlighted the need for appropriate contrast and distinguishability in color choices to ensure readability and ease of navigation. The designers recognized the importance of considering the specific requirements and choices of children with autism in design

choices and suggested various strategies, such as using different tints and tones of cool colors, emphasizing pastel and muted colors, and incorporating greens and baby blues, to create a visually engaging and comfortable experience for ASD children while maintaining brand identity. Furthermore, UX designers stated that enhancing color brand identity without occurring vision stimulation to autistic children is asserted by using grays with the shades of brighter colors is engaging brand identity.

Conflict of interest

There are no conflicts of interest.

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