

Minimalism vs. Complexity: User Experience and Cognitive Load

A User Study on the Impact of Web Interface Complexity on Perceived Cognitive Load and Perceived User Experience in First-Time Website Visitors

Aryan Khazanehdarloo

19arkh@sun.se

Södertörn University

Stockholm, Sweden

ABSTRACT

This study investigates how the complexity of a web interface influences the perceived cognitive load and user experience among first-time website visitors. The CNN website was used as an example of a visually complex interface, and a minimalist prototype was developed to contrast its design. Twelve participants took part in testing both interfaces by completing a series of tasks, followed by cognitive load questionnaires (NASA-TLX) and semi-structured interviews. The findings show that the minimalist prototype in comparison to the CNN website, was less straining on the mind, as indicated by lower NASA-TLX scores, and was generally perceived as more intuitive and aesthetically pleasing. In contrast, the CNN site was described as overwhelming and visually crowded, although some participants appreciated its variety of content. These results highlight the trade-offs between minimalist and visually complex designs, offering insight for web designers aiming to balance clarity, usability, and informational richness.

KEYWORDS

Minimalism, Visual Complexity, User Experience, Cognitive Load, Web Design, User Interface.

1 Introduction

In today's digital age, traditional physical interfaces have been largely replaced by digital ones, especially web interfaces, which have become the primary way users interact online (Deng, et al., 2023, p. 506). As more and more people use websites, it is important to create user interfaces that make it easy for users to use and find information (Albers, 2015, p. 256). Good usability and user experience enhance overall user satisfaction with a digital product's interface by helping users complete tasks more efficiently and with less effort (Mazumder and Das, 2014, p. 79). The first impression of a user is also a very important factor when deciding whether they will remain engaged or leave, aesthetic responses occur immediately at first sight, and thus the importance of first impressions is critical when it comes to user retention and overall user experience (Thielsch, et al., 2014, p.91).

There are various approaches that a designer can take when creating a web interface. For example, some interfaces follow a minimalist design, where the focus is on simplicity, showing only essential elements, and having a balance of negative space (Li and

Fu, 2023, pp. 831-832). In contrast, other interfaces may adopt a visually complex design, incorporating dense information, and showing more visuals at once (Alemerien and Magel, 2014, pp. 14-15). These interfaces often present a lot of information and can be structurally complex, which can overwhelm users. This overload is known as high cognitive load (ibid).

The purpose of this study is to examine how the complexity of an interface affects the perceived cognitive load of users and their experience during their first visit to a website. Understanding how different web design choices affect user experience and mental effort can provide valuable insights, due to the fact that it can help designers create more effective, user-friendly interfaces that enhance usability from the very first interaction.

The research question that this study will focus on is: "How does the complexity of a web interface affect a user's perceived cognitive load and user experience when accessing a website for the first time?"

2 Literature Review

2.1 Cognitive Load Theory

Plass, et al. (2009, p. 1) describe that originally, *Cognitive Load Theory* (CLT) was developed to predict learning outcomes by considering the capabilities and limitations of the human cognitive system. CLT was designed to consider several factors that could affect one's cognitive resources, such as information complexity, instruction presentation, and a learner's prior knowledge, to make learning more successful and more effective (ibid). The same authors further outline that CLT consists of three types of elements: *Intrinsic Load*, *Extraneous Load*, and *Germane Load*. *Intrinsic Load* refers to the difficulty of processing information due to the material being complex or difficult. *Extraneous Load* is the load that results from the material being poorly designed or confusing, and *Germane Load* is the load a person puts into comprehending the material.

Although CLT was first developed for learning purposes, Sweller (2011, p. 39) mentions that it has since expanded into a broader framework to better understand human cognition. CLT has adopted an evolutionary perspective of human cognitive architecture, which means that the framework is not just about making learning more efficient anymore but also understanding how the human brain processes and organises information (Sweller, 2011, pp. 39, 42).

As CLT evolved beyond its original focus, its principles have been applied and studied in other fields, including user experience (UX) design. In UX design, cognitive load plays an important role

in how users interact and engage with a digital product or service (Yablonski, 2024, p. 30). When a user, for example, navigates a digital product, tries to understand a page's layout or is interacting with UI elements while trying to focus on what the task was in the first place, it will require mental resources, and this can be quite challenging (Yablonski, 2024, p. 31). It is important to note that Yablonski (2024) presents these ideas in a book rather than a study, meaning his statement about the relation between UX and CTL might not be based on empirical research but rather on interpretations and applications of existing theories.

2.2 User Interface Design and Cognitive Load

The increasing complexity of digital information has led to web interfaces that contain large amounts of information and can cause high cognitive load for users (Deng, et al., 2023, p. 506). This overload can affect a user's working memory, potentially reducing general user satisfaction and even performance in certain situations (Schmutz, et al., 2009, p. 1).

Deng, et al. (2023, pp. 506-507) conducted a study on how different types of web design choices impacted users' cognitive load. They used methods such as eye-tracking, and user behaviour analysis to evaluate how much cognitive load was placed on users based on changes in layout, information structure, and presentation. The results showed that different types of design choices influence a user's cognitive load. Cognitive load was reduced when a website had less visual clutter, key information was placed in logical sequences, and had an easier navigation system (ibid). While this study provides valuable information about cognitive strain in relation to web design, it had a small sample size of 14 participants, which limits its generalizability.

Similarly, Durrani and Durrani (2009, p. 156) explored key elements of cognitive psychology that could be applied to graphical user interfaces. The researchers looked at elements such as the human motor system, memory limitation, colours, and screen layout, in relation to how user interface design can be optimised to ease processing and address human limitations (ibid). The paper states that cognitive load in users can be affected by how a user interface is designed based on how information is placed, how users react to visuals, and how much information they are required to remember (ibid).

2.3 User Interface Design and User Experience

A digital product's user interface affects the user experience through an indirect mechanism, which includes interface elements that both affect functionality and user engagement (Majumdar, 2023, p. 90). Usability plays a crucial role in Human-Computer Interaction (HCI) (Mazumder and Das, 2014, p. 79). Good usability increases user satisfaction, efficiency, and productivity, achieving the goal of helping users complete tasks with less effort, especially those with limited time and low computer literacy (ibid).

Jongmans, et al. (2022, p. 2078) investigated how the visual aspect of a website affects users' overall experience in the context of usability and pleasure. The researchers conducted two studies, one using two fiction travel websites, which was in a controlled setting, and two using real-life e-commerce websites to test out their findings in a practical setting (Jongmans, et al., 2022, pp. 2088, 2093-2094). The

highly attractive version from both studies had similar traits such as a clean layout, colours with low contrast, more modern shapes and fonts, while the less attractive versions were the opposite in every regard (Jongmans, et al., 2022, pp. 2088-2091, 2093-2096). Based on the two studies, the results showed that better visual design indirectly improved the user experience. Users reported that the websites with better visual design had better usability in terms of navigation, and the users were more willing to return and share them with others (Jongmans, et al., 2022, pp. 2092, 2097-2098). These results are in line with Majumdar's (Majumdar, 2023, p. 92) paper, which states that in both mobile applications and websites, a good visual hierarchy supports users in scanning and navigating the most important content in a quick manner, increasing the users' experience.

2.4 Minimalist User Interfaces

The term minimalism originated first in paintings after the end of World War II and later became recognised as a style in Western art. Minimalism's core principle is about "less is more," which was introduced by architects who prioritised functionality over decorative elements. In the digital world, minimalism follows the same core principle where designers prioritise simplicity and effectiveness in their work (Dong, 2019, p. 217; Gumber, 2023, p. 358). This form of simplicity and clear user experience is achieved by reducing elements such as gradients, shadows, and textures and instead focusing on fonts, colour, and white space, as noted by Gumber (2023, p. 358).

In a paper by Li and Fu (2023, p. 831), the authors further discuss in detail on what makes a user interface minimalist, outlining four principles: *The Principle of Negative Space*, *The Principle of Balance*, *The Principle of Less is More*, and *The Principle of Retaining Essential Elements*.

The Principle of Negative Space, also referred to as "white space", emphasises the importance of using empty space strategically around a design. Sufficient negative space helps to guide users' attention to key elements, improves readability, and reduces clutter and distractions (ibid).

The second principle, *Principle of Less is More*, is about eliminating unnecessary visual elements so that users can find the information they are after more efficiently without feeling overwhelmed (ibid).

Principle three, *Principle of Balance*, involves achieving visual stability of elements through symmetrical or asymmetrical arrangements. This ensures that there are no visual sections that appear to be dominant or chaotic, keeping users engaged in the content (Li and Fu, 2023, p. 831).

Lastly, *Principle of Retaining Essential Elements* is about retaining only the elements that serve crucial functions for user interaction. By streamlining the interface, it helps to enhance usability and reduce cognitive load (Li and Fu, 2023, p. 832).

However, according to Gumber (2023, p. 360), designers need to weigh the benefits and drawbacks of minimalist design before adopting it in their work. A few advantages of employing minimalist design, according to Damnjanović, et al. (2024, p. 125), are that it improves visual clarity, can speed up and improve the performance of digital platforms, supports better usability, and

can increase user focus. As mentioned above, minimalism also has certain drawbacks that designers must consider. Gumber (2023, p. 361) states that minimalism might limit creativity, make it more difficult to convey complex ideas or messages, and potentially lead to oversimplification or the removal of critical components that would have been essential for user engagement.

2.5 Visual Complexity

According to Miniukovich, et al. (2018, p. 1), visual complexity in a Graphical User Interface (GUI) is a characteristic of how objects, images, or designs appear. The more complicated the design is, the more effort it might take for users to understand it. Miniukovich, et al. (2018, p. 4) mention that there are four different facets of visual complexity that is commonly mentioned in the literature, the most common one being *Quantity of information*. This refers to the amount of information on the screen, and as the number of elements on the screen increases, the more complex it appears for users. Another facet is *Variety of Visual Form*, which considers the variety of visual forms such as the number of colours, shapes, sizes, and background textures. When the amount of these elements increases, so does the complexity. The third facet is *Spatial Organisation*, which refers to how visual elements are arranged and positioned. When the structure of the content of an interface is well-organised and aligned, it reduces perceived complexity. The final facet, *Perceivability of Detail*, reflects the limitations of human visual perception; the more effort it takes for the mind to process details, the more complex it is perceived (Miniukovich, et al., 2018, p. 4).

These features by Miniukovich, et al. (2018) to describe visual complexity are also referenced in studies by Riegler and Holzmann (2018, p. 207) and Alemerien and Magel (2014, p. 13), where they present automated methods to quantify complexity in Graphical User Interfaces. The automated method by Riegler and Holzmann's (2018, p. 207) analyses the complexity of mobile app user interfaces using metrics that focus on visual features. The system evaluates various aspects of a mobile app's user interface through screenshots and user interaction data. The captured screenshots are analysed to measure different complexity metrics, including the number, size, and alignment of visual elements, the density and balance of the layout, colour consistency, such as the number of dominant colours and colour combinations, and lastly, font usage (Riegler and Holzmann, 2018, pp. 213-214). Similarly, Alemerien and Magel (2014, p. 13) focus on the same core metrics. The metric model bases visual complexity on five factors, those being; object alignment, how objects are grouped, the size of the visuals present, how much of the screen the visual take, and lastly "balance" based on numbers of objects and size across different sections (Alemerien and Magel 2014, pp. 14-15).

2.6 Gaps and Justification

Although research has been conducted on cognitive load and its impact on user experience in interface design, certain gaps remain unaddressed. As mentioned, Deng et al. (2023, p. 517) found that a lower cognitive load improves user satisfaction and usability. However, the study focused on a specific website, "Design Intelligence Center" (DIC), and its findings may not be directly applicable to

other types of websites. Similarly, Durrani and Durrani (2009) do not go into detail about whether the cognitive load is a negative factor universally for all type of platforms and interfaces. Li and Fu (2023, p. 832) state that minimalistic design can help reduce cognitive load by reducing the number of user interface elements. However, it remains unclear if whether this always leads to a positive user experience. Elements that designers perceive as "non-crucial" may be interesting or valuable to users, which would have enhanced their experience if they existed.

These gaps highlight the need for further research into the relationship between cognitive load and user experience. This study aims to address those gaps by exploring whether lower cognitive load consistently results in a more positive user experience, or if certain design elements, despite increasing cognitive load, could enhance user satisfaction. Additionally, this study seeks to contribute to the existing research by examining another type of website that has not yet been thoroughly explored in previous studies. This will provide a more nuanced understanding of how minimalism and visually complex designs affect users across different types of websites.

3 Research Question

RQ: "How does the complexity of a web interface affect a user's perceived cognitive load and user experience when accessing a website for the first time?"

4 Methodology

To gather information on how the complexity of a web interface affects the perceived cognitive load of a user and the overall perceived user experience, a prototype was developed that reimagines the complex CNN website with a minimalist look and feel. The prototype was then used alongside semi-structured interviews and the NASA Task Load Index (TLX) questionnaire to assess common trends between participants' responses.

4.1 CNN

As previously noted, the CNN website was selected to represent a visually complex interface in this study (see Figure 1). A news-related website was chosen to enhance the originality of the research by avoiding commonly used examples such as e-commerce, travel, and creative websites, which were frequently referenced in the related work section. The CNN website can be classified as visually complex because it has a high quantity of information, a diverse range of visual elements, misalignment of content, and overall abundance of detailed features. These traits are in line with definitions of visual complexity as described by Miniukovich et al. (2018, p. 207), Riegler and Holzmann's (2018, p. 207), and Alemerien and Magel (2014, p. 13). Moreover, CNN's interface could exemplify real-world challenges users may face when navigating visually complex websites, which makes it suitable for evaluating the impact of minimalist redesigns and allows for investigating the usability implications when simplifying a complex interface.

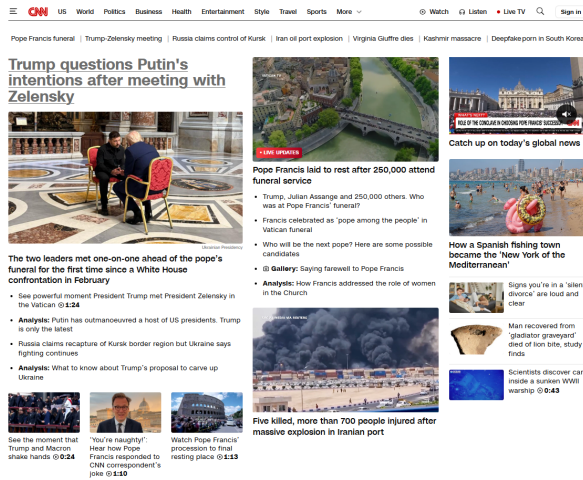


Figure 1: A visual representation of the CNN website (as of 04/26/2025)

4.2 Prototype

The prototype was designed with the use of the software called Figma (Figma Inc., 2016) and, at its core, functions the same as the CNN (Cable News Network, 1995) website but on a smaller scale (see Figures 2, 3 and 4). The prototype features a landing page and sub-pages for each article that exists on the front page.

4.2.1 Design. To achieve the minimalist design, the prototype was developed based on the findings of previous studies from Gumber (2023, p. 358) and, Li and Fu (2023, pp. 831-832), which highlight the importance of negative space, eliminating clutter, balancing elements, and retaining only crucial features to improve clarity. To achieve this, there were several design changes in the prototype compared to the CNN website. One of the most noticeable changes was the reduction in the number of articles displayed on the homepage. Other elements, such as auto-playing videos and pop-ups, were also excluded from the prototype to streamline the design. In addition, the prototype uses negative space, particularly around headlines and images, to separate content more clearly and avoid the feeling of crowdedness. The design of the sub-pages for each article was not changed that much due to the lack of elements. The only notable difference is that the CNN website, articles occasionally include embedded elements, such as a related article or a video within the body of the text, which interrupt the reading flow. This was not replicated in the prototype.

While the prototype looks different, it retains CNN's colour scheme across the whole design, which includes the use of the red accent, dark text on white background, and a similar-looking typographic style. This was done to preserve visual identity and ensure that the prototype remains recognisable as a minimal version of CNN rather than an entirely different website. For this reason, guidelines such as WCAG or W3C were not applied because the goal was to keep the design close to CNN's original structure and functionality. Applying such standards, especially if not present in the original CNN design, could have introduced new design elements beyond just making it minimalist.

4.2.2 Limitations. Although the prototype achieves a minimalist design, it has certain limitations. Due to time restrictions, the prototype was created on a smaller scale than the actual CNN website. As a result, the prototype contains less overall content, including fewer categories and media elements, and fewer interactive features. This potentially impacts the depth and realism of the user experience. Another limitation is that, while "less is more" is a core principle of minimalism (Li and Fu, 2023, p. 831), some of the features that were removed to make the experience less complex may have been ones participants valued.

4.2.3 Content Use and Attribution. The articles and images used in the prototype are taken from the CNN website to enhance the realism of the design. It is important to note that all copyright-related material remains with the original holders, and this study does not claim any ownership over any of the content used in the prototype. This is also acknowledged within the prototype itself, where each article includes the original author(s) and the source for the images for users to view.

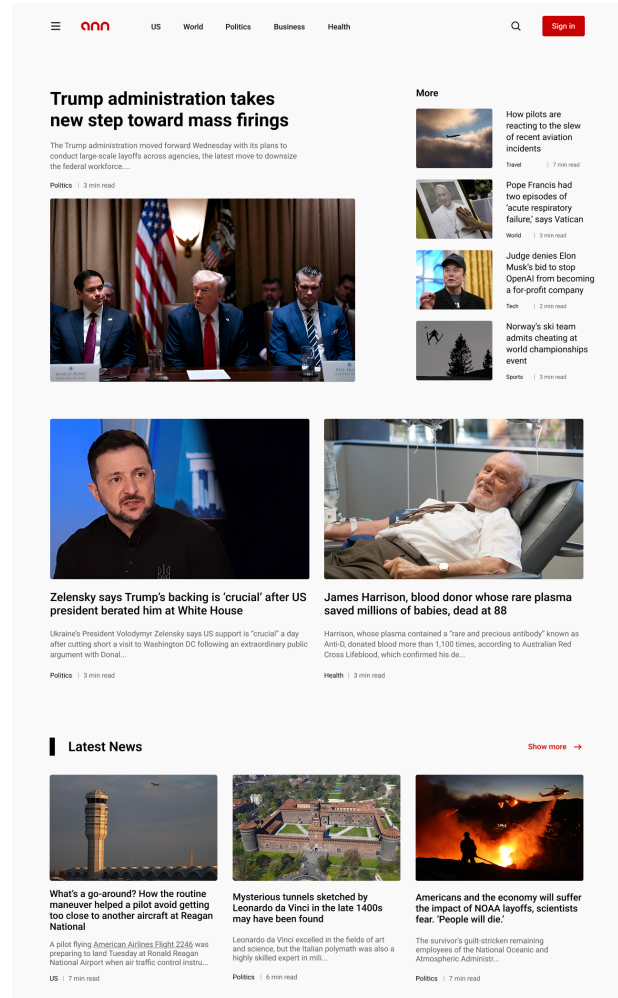


Figure 2: A visual representation of the prototype's landing page

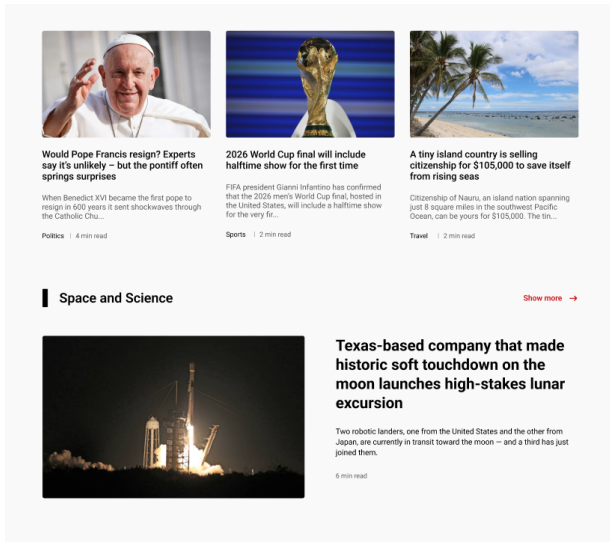


Figure 3: A visual representation of the prototype's landing page

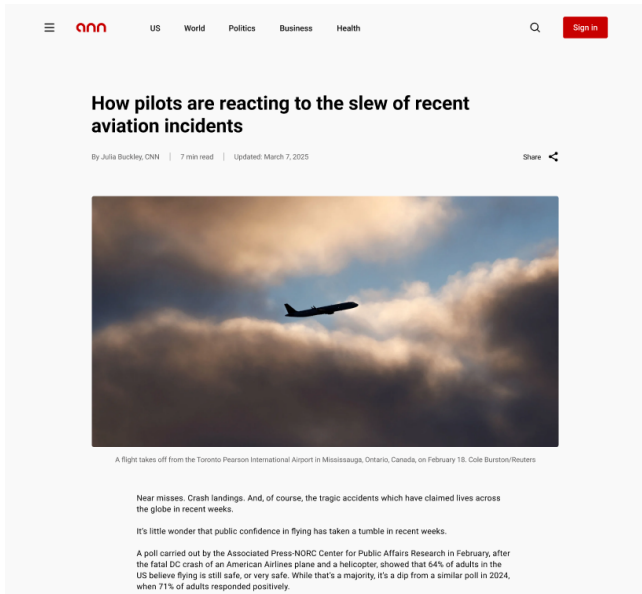


Figure 4: User view while reading an article in the prototype

4.3 Data Gathering

4.3.1 Participant Sampling . Participants in this study were selected by convenience sampling, targeting individuals 18 years of age or older who were readily available to participate due to time constraints. The target age was chosen to ensure that participants could provide informed consent independently, without the need for parental approval.

4.3.2 Recruitment Process . The recruitment process for this study was conducted using the instant messaging and voice chat application Discord (Discord Inc., 2016). To ensure relevance to the focus of the study, participants were asked if they had prior experience using the CNN website. Only those who had not previously used the website were included, as the study aims to gather information about the experiences and perceptions of first-time web visitors. In total, there were 12 participants, all between the ages of 18 and 26. Of the 12 participants, 10 were men and 2 were women.

4.3.3 User Testing and NASA-TLX . The user testing consisted primarily of two phases. In the first phase, participants were informed whether they would begin with the CNN website or the prototype, along with the tasks they were expected to complete. The starting point was alternated between participants, so when one began with the CNN website, the next participant would begin with the prototype and then proceed to the CNN website. This approach was implemented to minimise order effects and reduce potential bias, which could have been caused by fatigue or biased comparisons based on the first interface experienced. All user testing was done remotely, with participants testing the interfaces on their own desktop or laptop computers at home to ensure they could fully explore the prototype in a realistic setting. During the user tests, participants were assigned three tasks: reading the first article that appeared upon opening the prototype or the CNN website, locating a sports-related article and reading it, and locating a tech-related article and reading it. These tasks were designed to ensure that participants engaged meaningfully with the content and navigational features of each interface.

In the second phase, after participants completed tasks on the first interface, they filled out a NASA TLX questionnaire before proceeding to the second interface. After testing both interfaces, a second NASA TLX questionnaire was also administered for that interface. The NASA Task Load Index (NASA-TLX) was used to assess the perceived cognitive workload, which provides insight into how mentally demanding each website is to use. Participants were asked to rate six different dimensions of workload (mental demand, physical demand, temporal demand, performance, effort, and frustration) on 21-point scales ranging from 'very low' to 'very high' (Schmutz, et al. 2009, p. 3).

4.3.4 Interviews . The user testing was followed by a semi structured interview, which was done online using Discord (Discord Inc., 2016). During the interview, the participant was asked a series of questions designed to gather insight about the participant's experiences when testing the interfaces. The questions were formulated in a way that would not lead the participants to a predetermined answer or influence their judgment. The questions were also generalised and designed to make the participants talk broadly about the given question, which is in line with interview guidelines provided by Cote and Raz's (2015, p. 108). The questions were also supplemented with follow-up questions if the participant's initial answer required further clarification. This ensured that the data collected is more detailed, allowing for a deeper understanding of the participants' perceptions during the user testing (Cote and Raz, 2015, p. 108).

4.3.5 Ethical Considerations . Ethical considerations played a central role in the design of this research. Participants were provided with all relevant information about the study, including that their data, for the transcription and the questionnaire would be anonymised, to ensure that they had enough information to decide if they wished to participate (Lazar, 2017, p. 470). As part of this process, participants were informed beforehand that their voices would be recorded during the interviews. To protect participants' privacy, all data collected was stored locally, and the recordings were deleted after being transcribed and analysed (Lazar, 2017, p. 468).

4.4 Data Analysis

4.4.1 Thematic Analysis . For this study, *thematic analysis* was used to analyse the answers collected from the semi-structured interviews. The analysis approach closely followed the step-by-step guidelines provided by Cote and Raz (2015, pp. 108–112). The first step involved transcribing all recordings to become familiar with the data and begin identifying frequently recurring patterns across all participants (Cote and Raz, 2015, p. 109). After the data had been transcribed, the next step involved coding the data to identify themes, broad patterns, and characteristics, which were then grouped into distinct categories for analysis Cote and Raz, 2015, pp. 109–110). For instance, phrases such as '*I felt like CNN had too much going on the screen*' or '*I liked how the other website (Prototype) was more straightforward and clean*' were initially coded to capture recurring patterns about interface complexity and visual clarity. These initial codes were then refined and grouped into broader themes. To ensure consistency and relevance, the themes are based on when more than half of the participants expressed similar views.

4.4.2 NASA-TLX Calculation . The workload scores from the NASA-TLX questionnaires were calculated manually in accordance with the procedure outlined by Bustamante and Spain (2008). The NASA-TLX can be scored in two ways; one method involves participants weighing the dimensions based on the ones they felt contributed more to their workload (pairwise comparisons), while the other method treats all dimensions equally as important, without assigning any weights to them (Bustamante and Spain, 2008, p. 1523). For this study, the latter was chosen because it provides a more reliable overall cognitive load score, as it ensures that all dimensions are treated equally in the calculation, and it is more aligned with the focus of the study. Additionally, Bustamante and Spain (2008, p. 1523) note that pairwise comparisons are often avoided because they can introduce additional measurement errors.

To calculate the overall score (see Equation 1), each participant's ratings across all six dimensions were summed and then averaged to get an overall score reflecting the total cognitive load (Bustamante and Spain, 2008, pp. 1522-23). For example, if a participant rated the six dimensions as follows: Mental Demand: 65, Physical Demand: 40, Temporal Demand: 60, Performance: 90, Effort: 70, and Frustration: 30, the total score would be 355. Dividing this by six yields an overall cognitive load score of approximately 53.33.

$$TLX\ Score = \frac{MD + PD + TD + P + E + F}{6} \quad (1)$$

Equation 1: Calculation of the overall NASA TLX workload score, where MD = Mental Demand, PD = Physical Demand, TD = Temporal Demand, P = Performance, E = Effort, and F = Frustration.

4.5 Results

4.5.1 NASA-TLX Results . The NASA-TLX results indicate that the CNN website received higher overall workload scores, which suggests that it imposed a greater cognitive load on the users compared to the prototype. On average, the CNN website had an average score of 33.4 across all six dimensions, while the prototype received a lower average score of 16.9 (see Figure 5). When examining the average score per individual dimension (see Figure 6), the CNN website consistently scored higher than the prototype, with the main differences being in Mental Demand (CNN = 44.17; Prototype = 19.58), Effort (CNN = 40.83; Prototype = 17.92), and Frustration (CNN = 43.33; Prototype = 15.42). Both interfaces received similar scores for Performance (Prototype = 18.3; CNN = 17.5), which suggests that participants perceived their ability to complete the given tasks to be roughly the same across both websites, even though they felt that the CNN was more taxing than the prototype.

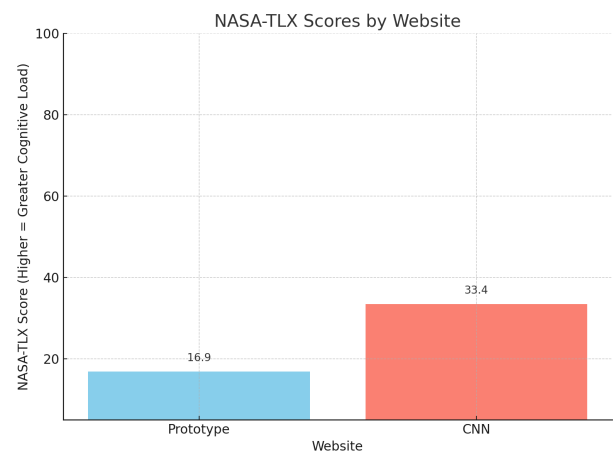


Figure 5: Overall NASA-TLX Scores

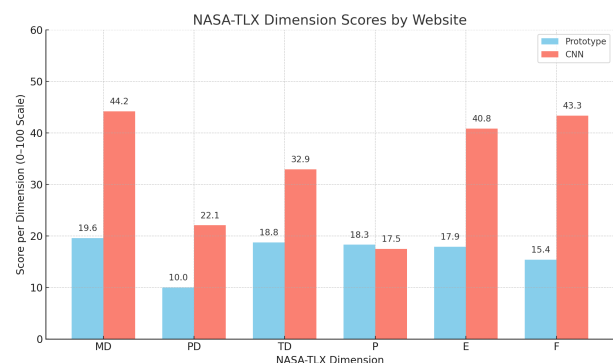


Figure 6: NASA-TLX Dimension Scores

4.5.2 Findings from the Thematic Analysis . The results derived from the thematic analysis revealed five main themes across both interfaces (see Figure 7). To be able to directly compare the two interfaces, the thematic analysis was divided into two sections. Two themes emerged from user responses about the prototype, and three from the CNN website. This allowed for a clearer differentiation in users’ perceived experience with each interface. The two themes identified for the prototype were *Seamless Experience* and *Aesthetic Appeal*, and the three themes for the CNN website were *Difficulty Staying Engaged*, *Elements of a Positive Experience*, and *Crowded Design*.

Seamless Experience. This theme represents the re-emerging pattern of participants stating how intuitive the prototype was. Specifically, they commonly mentioned that it was easy to find specific articles and categories they were interested in, the content was readable, and the navigation felt seamless. Participant 2 noted, "It was easier to read headlines and see things on the first website (prototype), and I thought it was easier to find the categories on it".

Aesthetic Appeal. Many participants commented on the visual design of the prototype during the interview sessions, stating that the prototype had a clean layout, looked modern, and was easy on the eye. An example is when participant 4 mentioned, "I'm not really into IT, but generally speaking, I found it easier to follow the second one (Prototype). It looked cleaner and modern compared to the first one (CNN)".

Difficulty Staying Engaged & Crowded Design. These two themes are closely related, as they frequently appeared within the same context or sentence when participants talked about the CNN website. It was usually mentioned that CNN’s website felt overwhelming to use and that it was difficult to maintain focus while browsing the site due to the interface being described as messy and crowded. This can be illustrated by participant 7 who said, "I don't like that CNN has so many articles 'in your face' right on the homepage. There's just way too much to focus on when you first land there. It's like random videos that don't play, buffering, then a GIF that's just there for whatever reason. And then a ton of images".

Content Diversity. Lastly, this theme reflects participants’ appreciation for the diverse content available on the CNN website, especially when compared to the prototype. Participants expressed a preference for the wide range of articles and categories that were available on the CNN website. As participant 11 noted, "I don't like how unclear it is what kind of topics the different sections cover. But at the same time, that's something I do like about it. There's more to choose from".

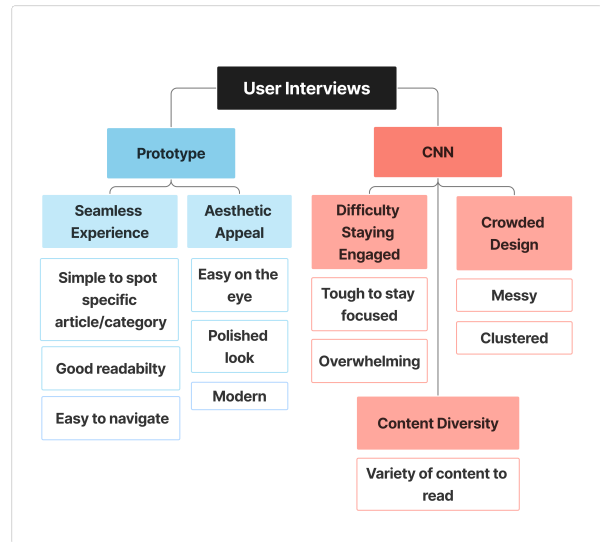


Figure 7: Thematic Analysis

4.6 Discussion

This study set out to study how web interface complexity influences perceived cognitive load and user experience among first-time website visitors. The findings from the NASA-TLX scores and thematic analysis provide insight into how minimal and visually complex interfaces compare to each other and how minimalist and visually complex interfaces compare in terms of user experience and mental effort.

4.6.1 Findings. The thematic analysis shows a clear contrast between the prototype and the CNN website in terms of user experience. The prototype, which represents minimalism for this study, is described as intuitive and visually appealing. The theme *Seamless Experience* suggests that participants perceived the minimalist design of the prototype to be simple to navigate, with high readability, and had a straightforward layout, which made it easy to find specific categories and articles. This is consistent with the Gumbert’s (2023, p. 360) statement that minimalism makes it easy for users to obtain the information they need in an effective way. Gumber (2023, p. 360) describes that when removing elements that may not seem unnecessary, a user’s focus is more drawn to the more important aspect of the design, which could explain the participants’ reasoning for stating that the prototype felt intuitive to use. The other related theme to the prototype *Aesthetic Appeal* reveals that the minimalism interface was perceived as modern, clean, and easy on the eye. When asked to elaborate on why they perceived the design as clean and modern, there was no common theme in the responses, suggesting that these impressions may be based on subjective aesthetic preferences. However, this might be partly explained by generational trends. Wibowo and Zainudin (2014, pp. 237, 245) found that minimalism strongly appeals to individuals from Generation Z (born 1995–2010), mainly through white space, neutral colours, and straightforward typography. As previously mentioned, the participants in this study were between the ages of 18 and 26, placing them under Generation Z, which may have

influenced their perception of the minimalist design. Furthermore, there could be a possible connection between the themes of *Seamless Experience* and *Aesthetic Appeal*. Jongmans, et al. (2022, pp. 2092, 2097-2098) mention in their paper that when an interface was perceived as aesthetically pleasing, it indirectly improved the user experience in terms of usability. However, in a similar study, Sauer and Sonderregger (2022, p. 1) found no correlation between visual aesthetics and user experience, although they state that the finding is in contrast to a large number of previous studies.

While the themes *Seamless Experience* and *Aesthetic Appeal* were linked to minimalism, the themes of *Difficulty Staying Engaged*, *Crowded Design*, and *Content Diversity* reflect participants' experiences with the visually complex interface. The data from the themes *Difficulty Staying Engaged* and *Crowded Design* point towards the visually complex interface being perceived as overwhelming and hard to focus on, mainly because it felt crowded and messy. Most participants stated that while navigating the CNN website, they found the layout displayed too many articles, which made it hard to focus on choosing something to read. According to, Guo, et al. (2021, p. 804), an interface with a high quantity of complexity tends to reduce user satisfaction, supporting the participants' perceived experience. Yet, interestingly, other research indicates that higher design complexity can sometimes enhance perceptions of aesthetics and ease of use. For example, a study by Lazard and King (2020, p. 95) found that increased design and feature complexity led to a higher evaluation of aesthetics and perceived ease of use in the context of eHealth websites. The difference in findings could be due to the type and purpose of a website. Certain websites may benefit from designs that contain more features and visual elements, whereas others are better suited by a simpler, more streamlined design. This is particularly evident in the theme, *Content Diversity*, which captures that participants enjoyed the diverse range of content available on the CNN website.

When it comes to the findings of the NASA-TLX assessment, the results show that the visually complex interface in this study was perceived as more cognitively demanding than the minimalist interface. Although both mean scores fall on the lower end of the 100-point scale (33.4 for the CNN website and 16.9 for the prototype), the perceived cognitive load associated with the CNN interface was nearly double that of the minimalist design, with a ratio of approximately 1.98 times higher. The average score per individual dimension shows the minimalism interface as being less demanding in all dimensions, except performance. The participants rated their performance on the CNN website slightly lower, with an average score 0.8 points lower (lower score means better performance) than on the prototype. Given the small difference in scores, it could be argued that the perceived performance was roughly equivalent across both interfaces. However, this contrasts with prior findings from Schmutz, et al. (2009, p. 1) that typically associate complex designs with lower performance levels. The minimal difference in performance could be attributed to the simplicity of the tasks the participants were given, which may not have been complex or demanding enough to reveal meaningful differences in performance levels. As a result, while participants may have felt more cognitively taxed when using the CNN website, their perceived performance was not substantially affected. Nonetheless, the overall results from NASA-TLX align lean towards previous studies

by Durrani and Durrani (2009, p. 156) and Deng, et al. (2023, pp. 506-507), which highlight that cluttered, information-dense interfaces lead to a higher level of cognitive load.

4.6.2 Design Implications. Several design implications could be drawn from the thematic analysis and the NASA-TLX assessment to support designers in creating more user-friendly interfaces that meet the users' needs. As this study was conducted using news website interfaces, the implications are particularly relevant to the design of news and other similar platforms. However, many insights could potentially be implemented in similar digital environments, as the data mostly aligns with prior research. It is also important to remember not to blindly apply these design choices, as each website should be evaluated individually to align with the goals of the user experience.

The findings highlight the value of minimalism in enhancing the overall user experience, in terms of being intuitive, easy to navigate and more aesthetically pleasing. Minimalism is also less cognitively demanding based on the NASA-TLX results, which provides a complete package for designers who aim to create interfaces that do not require excessive content and are intended to be quickly and easily processed by the users. This approach could work effectively in the context of news websites, where users seek fast access to specific information without being overwhelmed by visual clutter or too many options. However, news platforms likely prioritise engagement metrics such as clicks and ad impressions, which lead to a more visually dense and information-rich design. A balanced approach that maintains both simplicity while factoring in business objectives could be an effective solution in such cases. Additionally, given that all participants belonged to Generation Z and expressed a preference for the minimalistic interface, designers developing interfaces for this generation should consider using minimalism to meet users' expectations.

Lastly, when designing a user interface, a visually dense and information-rich design could be argued to be beneficial in some instances. The drawback would be that it would come at the potential cost of a higher cognitive load, which, as seen in this study, is mostly not preferred other than being rich in content in the context of news websites. That said, as mentioned earlier, this was not the case for eHealth websites in the study by Lazard and King (2020, p. 95), and as such, having a visually complex interface may be appropriate in contexts where deeper engagement or prolonged interaction is desired.

4.6.3 Study Limitation. While this study has provided valuable insight, it also has some limitations that should be considered when interpreting the findings. As previously mentioned, the study included 12 participants, which could be argued to be a relatively small sample size for gathering accurate data for questionnaires such as the NASA-TLX. While the results from the assessment offer a preliminary understanding of participants' perceived workload, there is a need for a larger number of participants to draw a more reliable conclusion. Additionally, since the sample consisted of individuals aged between 18 and 26, this means the findings may not be as applicable in the creation of interfaces for an older or younger audience. Individuals from older or younger age groups may have different preferences for digital interfaces, and their cognitive and physical responses might differ from each other. Moreover, as most

of the participants in this study were male, the results may reflect male perspectives more than female ones. If there had been an equal number of women and men in this study, different patterns or preferences could have emerged.

Furthermore, the prototype designed for the purpose of this study was implemented on a small scale compared to the CNN website. Thus, the prototype does not capture the whole experience of a news website, only a portion of it. This means that findings from this study may not accurately represent how users behave on a full scale news website.

Additionally, since the participants were given specific tasks to complete while navigating the prototype, this could make the overall experience for the user less natural in the sense of how a regular user would navigate a website otherwise, which potentially impacted their perceived user experience and cognitive load.

4.6.4 Future Research. For future research several options exist to further study how the complexity of a web interface influences cognitive load and the user experience. Future studies could include more participants with broader age groups to understand whether generational factors influence the perception of minimalism versus complexity in news-related web interfaces. This would be valuable because design preferences and cognitive processing may vary by age; older users may prefer complex layouts with more content, while the younger generation, as seen in this study, may prefer a minimalist design. In addition, incorporating a more balanced gender representation would help ensure that the findings reflect a wider range of user perspectives, as design preferences may also differ across genders. Future studies could also benefit from developing a full-scale prototype rather than a scaled-down one, as seen in this study. A prototype that is as close to the real experience as possible would contribute to a more accurate insight into how users perceive and respond to different interface designs in a realistic setting.

Finally, it would be valuable to investigate this study beyond first-time web visitors, as repeated exposure over time could potentially affect users' adaptation to these interfaces. For example, cognitive load levels could decrease, and users might change their stance on the visually complex interface as familiarity increases.

4.7 Conclusion

This study investigated the impact of minimalist versus complex web interface designs on perceived user experience and cognitive load by using the CNN website as a visually complex interface and a minimalist prototype designed to contrast with its design. The findings from thematic analysis suggest that the minimalist design was perceived as intuitive and aesthetically pleasing, whereas the visually complex interface was perceived as overwhelming and crowded, although participants appreciated the content diversity offered. The results from the NASA-TLX assessment show that the visually complex interface was considered more cognitively taxing compared to the minimalist interface.

In a broader context, this study contributes to the understanding of how interface complexity affects user experience, particularly among Generation Z users. The findings can offer guidance for designers of news and similar platforms who are aiming to balance clarity, usability, and informational richness. In addition, it helps

designers to avoid overloading pages with unnecessary visual elements, thereby reducing cognitive strain for users. Academically, the study adds to existing literature by reinforcing the theories that minimalism enhances usability and visually complex interfaces are seen as more cognitively demanding.

However, given the small sample size and the fact that the participants were generally from the same age generation (Generation Z) limit the reliability of the findings. The predominance of male participants may also skew the findings toward only the male perspectives, which reduces the ability to generalise the findings across both genders. Additionally, the prototype designed for this study was implemented on a small scale, and as a result, it most likely fails to capture the whole experience of a news website, which may have influenced how participants experienced the interface.

For future research, studies could further expand on how web interface complexity affects cognitive load and user experience by including diverse age groups and genders, developing a full-scale prototype, and also testing how repeated exposure to these interfaces changes the user experience over time. This would further support the literature in understanding how the complexity of an interface influences interface perception, usability, and cognitive processing in websites, ultimately contributing to the design of more effective and user friendly interfaces.

ACKNOWLEDGMENTS

I want to thank all the participants for their contributions to this study. I am also grateful to my supervisor, Hartmut Koenitz, for his guidance, support, and insightful feedback throughout the process.

REFERENCES

- Alemerien, M., and Magel, M., 2017. GUIEvaluator: A Metric tool for Evaluating the Usability of Graphical User Interfaces. *International Journal of Computer Applications*, 162(7), pp. 29-36.
- Bustamante, E. A., and Spain, R. D. 2008. Measurement Invariance of the Nasa TLX. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 52(19), pp. 1522–1526.
- Cable News Network., 1995. *CNN*.
- Cote, A., and Julia G. Raz., 2015. In-depth interviews for game research. In: Lankoski, P, and Björk, S., red. *Game Research Methods: An Overview*. Pittsburgh: ETC Press.
- Damjanović, D., Stojić, D., Vujičić, D., and Milosevic, M., 2024. Minimalistic User Interface Design and Dark Mode Usage in Human-Computer Interaction. In: *University of Kragujevac, Faculty of Technical Sciences, 10th International Scientific Conference Technics, Informatics and Education - TIE 2024*. Čačak, Serbia, 20-22 September 2024. Čačak: University of Kragujevac, Faculty of Technical Sciences.
- Deng, Z., Chen, Y., Yu, Q., Xu, Z. and Ye, X., 2023. An experimental study on web interface design optimization based on user cognitive load. In: *Proceedings of the 2022 International Symposium on Design Studies and Intelligence Engineering (DSIE 2022)*, Hangzhou, China, 29-30 October 2022. Amsterdam: IOS Press.
- Dong, R., 2019. Minimalist Style of UI Interface Design in the Age of Self-Media. In: *Francis Academic Press, Proceedings of the 9th International Conference on Information and Social Science (ICISS 2019)*. Manila, 12-14 July 2019. UK: Francis Academic Press.
- Discord Inc., 2015. *Discord*.
- Durrani, S. and Durrani, Q. S., 2009. Applying cognitive psychology to user interfaces. In: *Proceedings of the First International Conference on Intelligent Human Computer Interaction: (IHCI 2009)*. India, 20–23 January 2009. New Delhi: Springer India.
- Figma Inc., 2016. *Figma*.
- Guo, F., Chen, J., Li, M., Lyu, W., and Zhang, J., 2022. Effects of visual complexity on user search behavior and satisfaction: an eye-tracking study of mobile news apps. *Universal Access in the Information Society*, 21(4), pp. 795–808.
- Gumber, S., 2023. Minimalism in Design: A Trend of Simplicity in Complexity. *Journal of Visual and Performing Arts*, 4(2), pp. 357-365.
- Jongmans, E., Jeannot, F., Liang, L. and Dampérat, M., 2022. Impact of website visual design on user experience and website evaluation: the sequential mediating roles of usability and pleasure. *Journal of Marketing Management*, 38(17–18), pp. 2078–2113.
- Lazard, A. J., and King, A. J., 2020. Objective Design to Subjective Evaluations: Connecting Visual Complexity to Aesthetic and Usability Assessments of eHealth. *International Journal of Human-Computer Interaction*, 36(1), pp. 95–104.
- Lazar, J., Feng, Jinjuan Heidi, and Hochheiser, Harry. 2017. *Research methods in human-computer interaction*. 2nd ed. Amsterdam: Morgan Kaufmann.
- Li, F., and Fu, Y., 2023. The influence of Gestalt psychology principles on minimalist interface design. In: *Proceedings of the 2022 International Conference on Software Engineering and Application (SEAA 2022)*, Paris, France, 15-17 December 2022. Amsterdam: Atlantis Press.
- Majumdar, A., 2024., *Designing the Digital Experience: Exploring the Vital Role of Graphic Design in User Interface (UI) Design for the Modern Era*. In: *Proceedings of the International Conference on Innovation in Visual Arts (ICIVA'23)*. Noida, 17 October 2023. New Delhi: Excellent Publishing House.
- Mazumder, F. K. and Das, U. K., 2014. Usability guidelines for usable user interface. *International Journal of Research in Engineering and Technology*, 3(9), pp. 79-82.
- Miniukovich, A., De Angeli, A., and Sulpizio, S., 2018. Visual Complexity of Graphical User Interfaces. In: *Proceedings of the 2018 International Conference on Advanced Visual Interfaces (AVI '18)*. Castiglione della Pescaia, Italy, 29 May - 1 June 2018. New York: ACM Press.
- Plass, J.L., Moreno, R. and Brünken, R., 2010. *Cognitive Load Theory*. Cambridge: Cambridge University Press.
- Riegler, A., and Holzmann, C., 2018. Measuring Visual User Interface Complexity of Mobile Applications With Metrics. *Interacting with Computers*, 30(3), pp. 207–223.
- Sauer, J., and Sonderegger, A., 2022. Visual aesthetics and user experience: A multiple-session experiment. *International Journal of Human-Computer Studies*, 165, 102837.
- Schmutz, P., Heinz, S., Métrailler, Y., Opwis, K., and Kline, R., 2009. Cognitive Load in eCommerce Applications—Measurement and Effects on User Satisfaction. *Advances in Human-Computer Interaction*, 2009(1), pp. 1-9.
- Sweller, J., 2011. CHAPTER TWO - Cognitive Load Theory. *Psychology of Learning and Motivation*, 55(1), pp. 37-76.
- Thielsch, M. T., Blotenberg, I., and Jaron, R., 2014. User Evaluation of Websites: From First Impression to Recommendation. *Interacting with Computers*, 26(1), pp. 89–102.
- Wibowo, M. C., and Zainudin, A., 2024. The influence of minimalist design elements on visual preferences of Generation Z: A quantitative study. *International Journal of Graphic Design (IJGD)*, 2(2), pp. 236–247.
- Yablonski, J., 2024. *Laws of UX: using psychology to design better products & services*. 2nd ed Cambridge: O'Reilly.

APPENDIX A: Interview Script

- (1) What did you think of the two pages?
- (2) How did you feel about the differences between the pages?
- (3) What did you like about either page?
- (4) What things did you dislike about either page?
- (5) How was it navigating the first page?
- (6) How was it navigating the second page?