Optimising Visual User Interfaces to Reduce Cognitive Fatigue and Enhance Mental Well-being

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ABSTRACT

User interface design is a key priority in modern computer systems, especially when the users are non-technical. Due to the importance of designing more user-friendly interfaces, the focus has been increased on designing human-centred systems over functional-centred systems of the past. Any human-computer interface can cause different levels of cognitive fatigue in the user, which can cause significant mental stress, which is not healthy for the users. This study has used the critical literature review method and reviewed six theories/concepts related to the design of visual user interfaces which could potentially reduce user cognitive fatigue. The reviewed theories are attention restoration theory, cognitive load theory, Gestalt principles, Fitts's law, progressive disclosure and UX honeycomb. The current commercial purposes of interface design do not seem to consider the user's mental health or well-being when designing user interfaces and user experience. They only try to maximise user retention and engagement. The study findings advocate for a paradigm shift towards designing visual interfaces that prioritize human-centric principles, with a primary emphasis on promoting user mental health and well-being over commercial objectives of constant user retention and engagement. For example, attention restoration theory can be considered as one of the key theories which is helpful to design better interfaces which consider user health and well-being. However, there are challenges to the

designers to find the right equilibrium between user engagement and user well-being. Designers can use the findings, subject to further empirical validations.

Keywords: *Cognitive restoration, Cognitive fatigue, Human-computer interaction, Interface design, Mental well-being*

INTRODUCTION

In today's digital era, people routinely engage with digital interfaces for personal and professional tasks, leading to a notable decrease in cognitive demand through the automation of functions that previously relied on human cognitive processing (Florian Brachten et al., 2020). However, there is a residual amount of cognitive fatigue associated with human-computer interactions (Hoehe & Thibaut, 2020; Kosch et al., 2023). This aspect is inherent to any computer system and cannot be avoided. Prior research indicates that excessive computer and internet usage can lead to health issues, including detrimental effects on mental well-being (Habibzadeh 2018: Venu, 2023: Nakshine et al., 2022). According to Mental Health Europe (2022), adoption of digital technologies have caused to improve the mental health as well as reduce the mental health. However, they are not equally distributed. In this case, it is important to find ways to minimise the risks and maximise the potential of digitalisation in terms of mental health and well-being.

User interaction with interfaces typically encompasses visual, audio, or motion modalities, each enhancing the overall user experience. Visual interactions are predominant in everyday devices more commonly (Nijholt, 2015). Optimal approaches for designing human-computer interfaces to minimise cognitive fatigue and complexity for users have been highlighted by previous researchers (Mohammed & Karagozlu, 2021). There is an increasing emphasis on human-centred design principles for interfaces, which prioritise user needs, preferences, and limitations (Panagiotis Germanakos & Marios Belk, 2016). This approach places users at the core of design, contrasting with traditional methods that prioritise system functions. Human-centred systems generally offer greater accessibility, intuitiveness, adaptability, and aesthetic appeal to users (MacDonald et al., 2020). By implementing these techniques, such systems aim to minimize cognitive fatigue during user experiences. However, human behaviour is complex (Hayes & Wilson, 1995), emphasizing the importance of understanding cognitive processes and their integration into interface design for enhanced usability.

Various approaches have been proposed to elucidate the human cognitive process. Generally, this process encompasses facets such as language, memory, attention, reasoning, problem-solving, decision-making, and perception (Wang & Chiew, 2010). Cognitive fatigue may arise when the brain is taxed with mental activities beyond its capacity or prolonged engagement in cognitive tasks exceeding an individual's cognitive limits (Tanaka, 2015). Factors contributing to cognitive fatigue include exposure to digital screens, sleep deprivation, multitasking, lack of breaks, or excessive workloads (Small, 2020). Cognitive restoration, the process of replenishing cognitive resources to alleviate mental fatigue, is crucial (Small, 2020; Flanagan & NathanRoberts, 2019). Both cognitive fatigue and restoration play pivotal roles in determining the mental health and well-being of computer system users.

The visual user interface design is pivotal in the realm of human-computer interaction (Nijholt, 2015). Theories such as human-centred system design prioritise user satisfaction. However, beyond satisfaction, research proposes the significance of user mental and physical health, as well as the overall well-being of the user in human-computer interaction (Scott et al., 2016; Small, 2020; Hoehe & Thibaut, 2020). Exposure to computer interfaces can detrimentally affect these aspects. Hence, it is crucial to develop interfaces with minimised negative impacts and ideally, foster positive impacts on user health and well-being through interaction. While human centred design focus on user experience, Panakaduwa et al. (2024) suggest to proceed a further step by focusing on the user development. This includes education, awareness and overall enhancement of user performance.

This paper is a continuation of the idea of the user development on top of user experience (Panakaduwa et al., 2024). As a part of the user development in human computer interaction, this study aims to explore methods for enhancing visual user interfaces to promote better health and well-being outcomes in human-computer interaction.

METHODS

The study expected to review theories related to visual interface design and synthesize these theories with real-world examples wherever possible to make recommendations. Considering the importance of theories and concepts to make more generalized recommendations, a search was carried out to find out the potential theories that can be used for visual interface design. There are numerous theories and concepts in the literature. However, this review concentrates on six theories that the authors consider most relevant to the focus of the current analysis with the purpose of promoting better health and well-being in human-computer interaction. A general literature review was conducted to identify these theories and they do not form any specific order of preference. The authors wish to acknowledge the potential "selection bias" of not including important theories. In order to minimise this bias, an AI search was carried out to brainstorm the theories on Google Gemini, Microsoft Copilot and ChatGPT. The results were synthesized and summarised to propose the following six theories/concepts for evaluation; attention restoration theory, cognitive load theory, Gestalt principles, Fitts's law, Progressive disclosure and UX honeycomb. The theories/concepts are introduced and critically discussed with the support of real-world examples where available.

FINDINGS

Attention Restoration Theory

The theory was proposed by Rachel and Stephen Kaplan in the 1980s. This is involved with attention fatigue. Attention fatigue occurs when an individual is required to concentrate on tasks with low motivational appeal, despite the availability of activities that offer higher intrinsic motivation. An example of attention fatigue is having to file a tedious tax return while the children are playing outside on a sunny day. Addressing attention fatigue is important as it may lead to poor decision-making abilities, lower self-control and overall reduction of mental health, exposing the person to risks. The theory suggests that involving natural environments can improve cognitive functions by reducing attention fatigue (Ohly et al., 2016).

According to a study conducted in the virtual 3D environment, it has been found that even the virtual environment of nature has a restoration effect on mental fatigue. Accordingly, the researchers argue that the restoration levels in a virtual forest are closely similar to a person in a real forest. The sample has shown a positive effect on their mood, vitality and the restoration of mental fatigue. The researchers conclude that a virtual natural environment helps users reduce their mental fatigue and improve digital well-being (Mattila et al., 2020). There is a growing level of literature in terms of using artificial environments for attention restoration. Due to the increasing engagement of humans with digital interfaces, research findings show the possibilities of attention restoration for better health. However, most of these studies are conceptual and more empirical research is required (Liu et al., 2024).

Cognitive Load Theory

This theory was introduced by John Sweller in the 1980s. The theory is mainly used in education (Sweller, 2011). The theory talks about the limited capacity of the brain. There are three main types of cognitive loads; intrinsic cognitive load, extraneous cognitive load and germane cognitive load. Intrinsic load is the usual complexity of the material intended to be processed by the person. Extraneous load is the unnecessary complexity of the material. This can be unnecessary information, unnecessary complexity of the presentation, errors or mistakes. Germane load is the load that is reserved for learning the material. For example, developing a model to understand a complex process can help to reduce the load (Garnett, 2020).

When it comes to the design under the cognitive load theory, it is not always simple to identify the cognitive load of a given task. Different users perceive the same task at different levels of complexity and fatigue. The study suggests that the measurement of cognitive load should be examined from the user's perspective. Accordingly, physiological measures can be used to measure the cognitive load, coupled with subjective measures (Ayres et al., 2021). Another study has found that tangible user interfaces in virtual 3D environments create a lesser cognitive load than graphical user interfaces (Chandrasekera & Yoon, 2015). This can be a novel idea and good news as reality technologies are becoming popular.

Gestalt Principles

These principles have been emerged from the Gestalt school of thought and widely used in visual arts, design and psychology. There are more than ten Gestalt principles of design. The prominent six principles can be identified as figure-ground, proximity, similarity, continuity, closure and symmetry (Chapman, 2024).

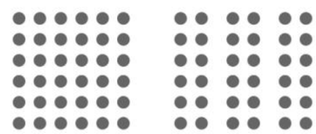
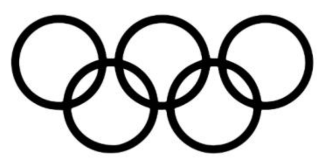
	Principle	Description	Example
1	Similarity	Similar objects are visually grouped.	
2	Continuation	The human eye prefers to follow the smoothest line.	
3	Closure	The brain will fill in the missing part of a picture to create meaning.	
4	Proximity	Objects are put closer to each other to group them.	
5	Figure/ground	Taking advantage of how the brain processes negative space.	
6	Symmetry	Symmetrical or organised objects are more aesthetically pleasing.	

Table 1: Gestalt principles description (Chapman, 2024)

As far as the Gestalt principles are concerned, they do not exist independently most of the time. The principles are better considered together, looking at what would be the prominent principle in the given case (Liang, 2018). For example, in the case of designing a TV remote, volume up and down buttons are put together, which comes under the principle of proximity. On the other hand, these two icons should be similar but in different directions. Accordingly, the user can easily recognise the functionality of the button. The buttons shall be put symmetrically. So it will create less user stress to recognize the functionality of the buttons. Although this is a simple example, the whole idea is the same for highly complex applications as well.

Fitts's Law

This is a law proposed by Paul Fitts (psychologist) in user interface design. The law describes the movement of time to move an object from one location to a target location. In human-computer interaction and ergonomics, this law is useful to design and optimise the interactive elements of interface such as buttons, links or icons. The law suggests that the movement time increases when the distance to the target and the size of the target increase (Scott, 2018). The law is currently used in applications such as touch screens, mouse cursors, wearable devices, virtual reality and many more. However, even the graphical user interface had not been invented by the time this law was introduced in the 1950s.

Fitts's Law has evolved multiple times since its introduction. Currently, user interaction has been extended to 3D and virtual reality applications. The literature has proposed models to use the law in virtual environments as well. However, due to the diversity and complexity of modern devices and their functionalities, the literature is still not rich enough to fully contextualise the application of Fitts's law and its challenges. Further research is recommended (Jiang & Gu, 2020).

Progressive Disclosure

This is a concept widely used in user experience and user interface design in software development. This is especially important when highly complex systems are designed. The users are taken through a journey of increasing complexity to avoid cognitive overload. Information is presented in a way that gradually reveals advanced and detailed features, options and content as the user experience evolves. The presentation of information is structured, hierarchical, and easily comprehensible throughout the journey (Nielsen, 2006).

Google Maps can be considered as a perfect example of using the concept of progressive disclosure to the user. In Google Maps, the user is given a snapshot of the route first, with the details of the overall route, estimated arrival time and highlights of the route. Then Google Maps gives turn-by-turn navigation as the user drives the vehicle. It magnifies the map where necessary. For example, at a junction. Special landmarks or ad-hoc incidents are reported to the user. It uses online traffic information to suggest alternative routes. In general, Google Maps does not give all the details at once. However, it takes the user through a journey according to the level of user requirement and capacity to make sure the user is getting the right information at the right time (Spillers, 2004).

While the importance and usability of progressive disclosure are acknowledged, there is a competing interest that always comes with it. It is the transparency of the content. Content transparency deals with user confidence and familiarity with the system. When the progressive disclosure is increased, it will reduce transparency. The user will worry about the content to what extent it can be complex. Identifying the user traits, system heuristics and potential errors, the interfaces need to be designed to a level of equilibrium between progressive disclosure and content transparency (Whittaker & Springer, 2020).

UX Honeycomb by Peter Morville

One of the key concepts in user experience design can be considered the UX honeycomb introduced by Peter Morville. He described some of these concepts in the book he co-authored "Information Architecture for the World Wide Web". The original honeycomb concept was reported to have been introduced in 2004 on his website Semantic Studios (Uxcel, 2024). The framework can be presented as follows.

Figure 1: UX Honeycomb (Morville, 2004)

According to Figure 1, there are seven criteria to focus on in designing a better user experience in visual computer interfaces. As a brief introduction to the framework, the parts of the honeycomb can be identified as follows. Useful; the product shall create value for the user. Findable; the product and the content shall be easily found by the user. Usable; the product should be easy to use by the user. Accessible; the product shall be accessible and inclusive to almost everyone. Desirable; the product shall be attractive to the users. Credible; the content provided by the product shall be trustworthy. Valuable; the product shall create value for both users and promoters (Morville, 2004).

As far as the UX Honeycomb framework is concerned, there are complimentary ideas for the user's mental well-being. For example, usefulness and desirability focus on user satisfaction and attractiveness (Disha, 2023). It is basically about creating a pleasing experience for the user. The credibility should reduce the user's mental fatigue involved with uncertainty and poor trust. Further, accessibility also confers the idea of creating more user-friendly interfaces. In general, the honeycomb framework is to create more user-focused interfaces. Although mental well-being is not directly spoken, it is expected that the framework is complimentary with the mental well-being of the user. However, it can also be argued that better attractiveness of the user experience shall increase user attraction to the system, which could ultimately affect user mental well-being.

DISCUSSION

Screen Time

The amount of time associated with digital screens is a critical criterion for measuring digital influence on people. Most mobile devices such as phones and tablets have a feature to measure screen time and they alert the user about the trends of screen time. According to (HSE, 2024), excessive screen time can cause stress, anxiety, and mental and physical fatigue. The maximum amount of screen time recommended for children between the age of 1 - 5 is only one hour per day (World Health Organization, 2019). Although there is no recommended screen time for the adults found, it is recommended to take a 5 - 10-minute break every hour of screen time (HSE, 2024). Another issue associated with screen time is blue light. According to Harvard Health (2020), blue light can mainly cause sleep deprivation. Furthermore, researchers have found that excessive screen time can potentially contribute to the development of diseases such as diabetes, cancer, or heart failure.

When considering screen time and blue light exposure, the interface design itself offers limited possibilities. However, by leveraging user interactions with the system, it is ideal for users to be reminded to take regular breaks. While some applications incorporate this feature, it is less common within operating systems. Another potential solution involves utilizing eye tracking through a device's front camera. Given that most modern devices are equipped with a front camera, this technology could monitor user fatigue and screen time, contingent upon addressing user privacy and ethical considerations (Yamada & Kobayashi, 2018). Only the attention restoration theory can be linked to screen time when it comes to reducing user fatigue. The other theories focus on increasing user engagement.

Content

Content can be a critical factor in inducing attention fatigue among users, which manifests in two main aspects: content influence and content overload. Attention fatigue may arise when the content fails to captivate the user's interest. Additionally, excessive exposure to the screen can also lead to attention fatigue. While overexposure to screens has been addressed in the previous section, this section aims to delve into the topics of content and content overload. The theories discussed above offer valuable insights for optimizing content to enhance user experiences while minimizing cognitive fatigue. Specifically, the cognitive load theory and Fitts' law emphasize streamlining content to a more manageable level for users. Moreover, the Attention Restoration Theory highlights the potential benefits of incorporating elements of natural environments into digital interfaces, promoting improved mental health and overall well-being. UX Honeycomb also focuses on optimising the content for the user. However, while progressive disclosure and Gestalt principles have been shown to mitigate negative health effects, their precise application in fostering positive mental health and well-being remains less clear. Further research is needed to elucidate effective strategies for leveraging these principles in digital design to promote optimal user experiences and well-being.

Social Interaction

The use of digital interfaces can show signs of a lack of social interactions due to excessive engagement with the digital interfaces (Kumar et al., 2023). Their social interactions can indeed happen online. Due to the current influence of social media and the use of smart devices by people, digital social interactions can be observed to be prominent. However, digital social interactions may have limitations and they may not work out the same way as in the physical world. Theories such as progressive disclosure and Fitts's law are used to reduce the cognitive load and help user-informed decision-making. However, they do not focus on the improvement of social interactions of the user. Research suggests that people with better social interactions have better mental health and well-being (Ono et al., 2011). Considering the same, it can be recommended to develop interfaces which can improve social interactions, at least virtually. It is further recommended to conduct more research to find out how social interactions can help users reduce their cognitive fatigue.

Digital Addiction

The design of current digital interfaces primarily emphasizes user engagement and retention metrics, often overlooking considerations of cognitive load and fatigue. Examples include features like auto-playing videos, endless scrolling pages, and frequent notifications, which may serve commercial purposes but raise concerns about user health and well-being. Such features can contribute to digital addiction, a phenomenon increasingly prevalent in today's society, characterized by constant device engagement, multitasking, and diminished attention to tasks at hand. This chronic digital engagement can lead to heightened stress levels, anxiety, and impaired decision-making. Addressing these issues requires a shift in focus towards prioritizing user mental health and well-being over mere engagement and retention metrics. The Attention Restoration Theory offers a promising approach to mitigate digital addiction by leveraging natural environments to reduce cognitive fatigue and enhance attention. In general, most of the theories have focused on improving user engagement. For example, Gestalt principles or UX honeycomb aims to develop better interfaces where the users will be attracted more. By incorporating insights from various theories discussed, designers can create interfaces that not only engage users but also support their overall well-being in the digital realm. Further, it is recommended to explore more theoretical generalisations of user health and well-being.

CONCLUSION

It is imperative to recognize the transformative impact of the digital revolution, which has vastly simplified human life. This has been achieved by enabling tasks through digital technologies that were once cognitively taxing for humans. This advancement has significantly enhanced efficiency, productivity, effectiveness, reliability, and objectivity across various domains. However, the pervasive use of digital interfaces has been associated with heightened mental fatigue and diminished well-being among users. This study endeavours to address these challenges by exploring avenues to develop improved visual user interfaces that prioritize human-computer interaction in a manner conducive to health and well-being.

The key findings of this research underscore the potential application of the Attention Restoration Theory in mitigating attention fatigue and restoring mental health. Additionally, insights from the Cognitive Load Theory and Fitts's Law offer strategies to optimize content cognitive load to align with user capacity. Gestalt principles, progressive disclosure and UX honeycomb emerge as valuable tools for presenting complex information in a more easily digestible format, thereby promoting balanced cognitive function. It is notable that current commercial interface design objectives predominantly focus on enhancing user retention and engagement, often neglecting considerations of user mental health and well-being. For example, the main streaming services such as Netflix or Amazon Prime Video do not prompt the viewers to take a break when streaming content. Even Microsoft Word did not ask the researcher to take a break when typing this paper.

In light of these findings, this study advocates for a paradigm shift towards designing visual interfaces that prioritize human-centric principles, with a primary emphasis on promoting user mental health and well-being over commercial objectives of constant user retention and engagement. By integrating insights from the aforementioned theories, visual interfaces can be crafted to foster healthier human-computer interactions, ultimately contributing to the overall well-being of users in the digital age. The designers and developers may face challenges in finding the right equilibrium between the level of user engagement and the level of well-being. Over-emphasis on user well-being can lead to poor productivity and user boredom. On the other hand, excessive user engagement can lead to cognitive stress and fatigue, leading to poor health and well-being of the user. This can be a challenge for the developer, as well as the success if managed well.

Apart from this practical contribution, the findings will theoretically contribute to the body of knowledge in human-computer interaction, validating the rigour of the above six theories. Further research is recommended for the empirical validation of the findings.

REFERENCES

Ayres, P., Lee, J. Y., Paas, F., & van Merriënboer, J. J. G. (2021). The Validity of Physiological Measures to Identify Differences in Intrinsic Cognitive Load. *Frontiers in Psychology*, *12*. https://doi.org/10.3389/fpsyg.2021.702538

Chandrasekera, T., & Yoon, S.-Y. (2015). The Effect of Tangible User Interfaces on Cognitive Load in the Creative Design Process. *2015 IEEE International Symposium on Mixed and Augmented Reality - Media, Art, Social Science, Humanities and Design*. https://doi.org/10.1109/ismar-mashd.2015.18

Chapman, C. (2024). *Exploring the Gestalt Principles of Design*. Toptal Design Blog. https://www.toptal.com/designers/ui/gestalt-principles-of-design#:~:text=What%20are%20the%20gestalt%20principles

Disha, N. T. (2023). *UX Honeycomb by Peter Morville : Grow Your Business*. Medium. https://bootcamp.uxdesign.cc/ux-honeycomb-by-peter-morville-grow-your-business-b3da807f7343

Flanagan, J., & NathanRoberts, D. (2019). Theories of vigilance and the prospect of cognitive restoration. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *63*(1), 1639–1643.

Florian Brachten, Brünker, F., Nicholas, Ross, B., & Stieglitz, S. (2020). On the ability of virtual agents to decrease cognitive load: an experimental study. *Information Systems and E-Business Management*, *18*, 187–207. https://api.semanticscholar.org/CorpusID:220511308

Garnett, S. (2020). *Cognitive load theory : a handbook for teachers*. Crown House Publishing.

Habibzadeh, N. (2018). The Effect of Long - Term Computer Use on Health- Related Physiological Perspectives. *International Physiology Journal*, *1*(3), 9–14. https://doi.org/10.14302/issn.2578-8590.ipj-18-2471

Harvard Health. (2020). *Blue Light Has A Dark Side*. Harvard Health; Harvard Health. https://www.health.harvard.edu/staying-healthy/blue-light-has-a-dark-side

Hayes, S. C., & Wilson, K. G. (1995). The role of cognition in complex human behavior: A contextualistic perspective. *Journal of Behavior Therapy and Experimental Psychiatry*, *26*(3), 241–248. https://doi.org/10.1016/0005-7916(95)00024-t

Hoehe, M. R., & Thibaut, F. (2020). Going digital: how technology use may influence human brains and behavior. *Dialogues in Clinical Neuroscience*, *22*, 93–97. https://api.semanticscholar.org/CorpusID:220666146

HSE. (2024). *Work routine and breaks - Display screen equipment - HSE*. Www.hse.gov.uk; Health and Safety Executive. https://www.hse.gov.uk/msd/dse/work-routine.htm#:~:text=Working%20safely%20with%20display%20screen%20equipment

Jiang, R., & Gu, Z. (2020). Current theoretical developments and applications of Fitts' Law: a literature review. *Advances in Ergonomics in Design: Proceedings of the AHFE 2019 International Conference on Ergonomics in Design, July 2428, 2019, Washington DC, USA 10*, 753–760.

Kosch, T., Jakob Karolus, Johannes Zagermann, Harald Reiterer, Schmidt, A., & Woźniak, P. W. (2023). A survey on measuring cognitive workload in human-computer interaction. *ACM Computing Surveys*, *55*, 1–39. https://api.semanticscholar.org/CorpusID:256391214

Kumar, T., Rajendran, V., Dutta, G., Sneha Ambwani, Lal, H., Ram, K., & Raghav, P. (2023). Prevalence of Internet Addiction and Impact of Internet Socialization on Professional, Academic, Social Lives and Sleep Pattern Among Students and Professionals from Various Fields Across India. *Advances in Medical Education and Practice*, *Volume 14*, 1369–1378. https://doi.org/10.2147/amep.s438215

Liang, Y. (2018). Application of Gestalt psychology in product human-machine Interface design. *IOP Conference Series: Materials Science and Engineering*, *392*, 6. https://doi.org/10.1088/1757-899X/392/6/062054

Liu, Y., Zhang, J., Liu, C., & Yang, Y. (2024). A Review of Attention Restoration Theory: Implications for Designing Restorative Environments. *Sustainability*, *16*(9), 3639–3639. https://doi.org/10.3390/su16093639

MacDonald, D., Shiever, H. R., Rekhelman, N., Raza, R., Gerrard, P., & Heacock, D. (2020). Human-Centered Design Is More Important Than Ever. *BCG*. https://www.bcg.com/publications/2020/the-importance-of-human-centered-design

Mattila, O., Korhonen, A., Pöyry, E., Hauru, K., Holopainen, J., & Parvinen, P. (2020). Restoration in a virtual reality forest environment. *Computers in Human Behavior*, *107*, 106295. https://doi.org/10.1016/j.chb.2020.106295

Mental Health Europe. (2022). Report on Digitalisation in Mental Health. https://www.mhe-sme.org/wp-content/uploads/2023/01/Mental-health-in-the-digital-age-Applying-a-human-rights-based-psychosocial-approach-as-compass.pdf

Mohammed, Y. B., & Karagozlu, D. (2021). A Review of Human-Computer Interaction Design Approaches towards Information Systems Development. *BRAIN. BROAD RESEARCH in ARTIFICIAL INTELLIGENCE and NEUROSCIENCE*, *12*(1), 229–250. https://doi.org/10.18662/brain/12.1/180

Morville, P. (2004). *User Experience Design*. Semantic Studios. https://semanticstudios.com/user_experience_design/

Nakshine, V. S., Thute, P., Khatib, M. N., & Sarkar, B. (2022). Increased Screen Time as a Cause of Declining Physical, Psychological Health, and Sleep Patterns: A Literary Review. *Cureus*, *14*(10). https://www.cureus.com/articles/112862-increased-screen-time-as-a-cause-of-declining-physical-psychological-health-and-sleep-patterns-a-literary-review

Nielsen, J. (2006). *Progressive Disclosure*. Nielsen Norman Group. https://www.nngroup.com/articles/progressive-disclosure/

Nijholt, A. (2015). *More Playful User Interfaces : Interfaces that Invite Social and Physical Interaction*. Springer Singapore.

Ohly, H., White, M. P., Wheeler, B. W., Bethel, A., Ukoumunne, O. C., Nikolaou, V., & Garside, R. (2016). Attention Restoration Theory: A systematic review of the attention restoration potential of exposure to natural environments. *Journal of Toxicology and Environmental Health, Part B*, *19*(7), 305–343. https://doi.org/10.1080/10937404.2016.1196155

Ono, E., Nozawa, T., Ogata, T., Motohashi, M., Higo, N., Kobayashi, T., Ishikawa, K., Ara, K., Yano, K., & Miyake, Y. (2011). Relationship between social interaction and mental health. *2011 IEEE/SICE International Symposium on System Integration (SII)*. https://doi.org/10.1109/sii.2011.6147454

Panagiotis Germanakos, & Marios Belk. (2016). *Human-Centred Web Adaptation and Personalization From Theory to Practice*. Cham Springer International Publishing.

Panakaduwa, C., Coates, P., & Munir, M. (2024). Considering HumanCentred System Design in Relation to Cognitive and Educational Theories. *Smart Digital Futures*, Santa Cruz, Madeira, Portugal.

Peper, E., & Harvey, R. (2018). Digital addiction: Increased loneliness, anxiety, and depression. *NeuroRegulation*, *5*(1), 3–3.

Scott, D. A., Valley, B., & Simecka, B. A. (2016). Mental Health Concerns in the Digital Age. *International Journal of Mental Health and Addiction*, *15*(3), 604–613. https://doi.org/10.1007/s11469-016-9684-0

Scott, M. I. (2018). Fitts' law. *The Wiley Handbook of Human Computer Interaction*, *1*, 347–370.

Small, G. (2020). Brain health consequences of digital technology use. *Dialogues in Clinical Neuroscience*, *22*(2), 179–187. https://doi.org/10.31887/dcns.2020.22.2/gsmall

Spillers, F. (2004). *What is Progressive Disclosure? - ED*. Experience Dynamics. https://www.experiencedynamics.com/progressive-disclosure-the-best-interaction-design-technique/

Sweller, J. (2011). *Cognitive Load Theory: A Special Issue of educational Psychologist*. Routledge.

Tanaka, M. (2015). Effects of Mental Fatigue on Brain Activity and Cognitive Performance: A Magnetoencephalography Study. *Anatomy & Physiology*, *s4*. https://doi.org/10.4172/2161-0940.s4-002

Uxcel. (2024). *The best way to learn UX/UI design*. Uxcel. https://app.uxcel.com/glossary/ux-honeycomb

Venu, A. S. (2023). Internet Addiction: Social, educational and health impacts: A case study. *World Journal of Biology Pharmacy and Health Sciences*, *14*(1), 266–269. https://doi.org/10.30574/wjbphs.2023.14.1.0194

Wang, Y., & Chiew, V. (2010). On the cognitive process of human problem solving. *Cognitive Systems Research*, *11*(1), 81–92. https://doi.org/10.1016/j.cogsys.2008.08.003

Whittaker, S., & Springer, A. (2020). Progressive Disclosure: When, Why and How Do Users Want Algorithmic Transparency Information? *ACM Transactions on Interactive Intelligent Systems*. https://doi.org/10.1145/3374218

WHO. (n.d.). *Mental health*. Www.who.int; World Health Organisation. https://www.who.int/health-topics/mental-health#:~:text=Mental%20health%20is%20a%20state

World Health Organization. (2019). *To grow up healthy, children need to sit less and play more*. World Health Organization. https://www.who.int/news/item/24-04-2019-to-grow-up-healthy-children-need-to-sit-less-and-play-more

Yamada, Y., & Kobayashi, M. (2018). Detecting mental fatigue from eyetracking data gathered while watching video: Evaluation in younger and older adults. *Artificial Intelligence in Medicine*, *91*, 39–48.