Intervention Design at the Intersection of Accessibility and Digital Wellbeing

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Abstract

Web browser extensions are used by individuals to customize and improve websites via targeted interventions. These browser extensions are developed in two similar research areas—accessibility and digital wellbeing—but their overlap and similarities have not yet been discussed. This paper integrates recent accessibility guidelines and digital wellbeing design aspects to propose ten web browser interventions which bridge cognitive/learning disabilities and attentional needs for digital wellbeing. The interventions are designed for two use cases—single-page web apps and web form submissions—and are classified and analyzed according to their interaction strategy (additive/subtractive/redesign) and their use of adaptive functionality. This paper contributes a new set of intervention designs which are theoretically grounded in both digital wellbeing and accessibility, opening new pathways for digital wellbeing research to address inclusive design and web experiences that support a wider range of users and needs.

CCS Concepts

• **Human-centered computing** → **Accessibility design and evaluation methods**; **HCI design and evaluation methods**; **Interaction paradigms**.

Keywords

Digital wellbeing, WCAG, accessibility, web browser extensions, cognitive disabilities, learning disabilities, digital self-control tools, digital overuse, persuasive technology

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1 Introduction

Accessibility research and practice have evolved over the past three decades to capture increasingly high-level design requirements: the December 2024 WCAG (Web Content Accessibility Guidelines) [1] version 3.0 draft now captures concepts such as deception, unnecessary content, and unambiguous language. Compared to the WCAG 1.0 version, which focused on technological interface design questions such as syntax use and presence or absence of features, the expectations for an accessible web experience have transformed from a question of functional requirements to a question of user-centered design.

Digital wellbeing (DWB), a research area in Human-Computer Interaction (HCI) which focuses on technology design to promote effective, sustainable, and non-addictive use, is a relatively new research area which has most recently focused on how to make leisure technology such as shopping sites, social media, and video sites less addictive and deceptive and more instrumentally aligned with user goals [2].

In these two research areas—both accessibility and digital wellbeing—there is a consistent use of web browser extensions to intervene on the existing user web experience and improve the way web content is presented [2, 3]. These interventions, rather than creating an interface from scratch, modify existing web interfaces in an attempt to establish a user experience more aligned with user goals.

Previous research has indicated significant overlap between DWB and accessibility design frameworks: this overlap is particularly notable in WCAG 3.0 (2024-12-12 draft), in the WCAG focus on cognitive and learning disabilities, and in the digital wellbeing areas which focus on deception and attentional needs [4]. These commonalities would suggest potential overlap in web intervention design, opening up opportunities for accessibility and digital wellbeing research to address broader populations and technologies. Of particular interest is extending beyond a traditional accessibility focus on additive/redesign interventions and a traditional digital wellbeing focus on non-adaptive/leisure-oriented use cases.

This research opportunity is studied in this paper by means of two research questions:

1. What novel web browser interventions can be designed at the intersection of accessibility and digital wellbeing frameworks to satisfy both accessibility and digital wellbeing user needs?

2. By what means do these proposed interventions interact with web content (additive/subtractive/redesign) and to what extent do they support adaptive functionality?

This paper adopts a design approach informed by previous research conducted in [4], which classifies the intersection of the WCAG 1.0, 2.2, and 3.0 (2024-12-12 draft) frameworks and the digital wellbeing aspects noted in [2]. By using two user stories (accessibility and digital wellbeing focus areas) and two use cases (single page app and form submission), we design 10 proposed interventions to support both accessibility and digital wellbeing, noting connections to existing frameworks. We further classify these proposed interventions in terms of their interaction with the user interface

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(additive/subtractive/redesign) as well as their use of adaptive functionality. We also design "FriendlyLens", a prototype interface/web browser extension containing these interventions.

The proposed research has several potential impacts:

- By integrating accessibility principles, this research extends digital wellbeing—traditionally focused on leisure use cases and non-adaptive interventions—to a wider range of systems (e.g., productivity tools, government portals, educational platforms) and user populations, including those with cognitive or learning disabilities.
- The proposed interventions illustrate how adaptive mechanisms can simultaneously support accessibility and digital wellbeing needs, promoting interfaces that adjust to users' attentional, cognitive, and perceptual contexts.
- By grounding interventions in shared frameworks (e.g., WCAG 3.0), the research contributes to scalable design strategies that can be standardized across web environments and potentially inform future revisions of accessibility guidelines.

2 Background

2.1 Accessibility and WCAG

The Web Accessibility Initiative (WAI) of the W3C describes web accessibility as "that websites, tools, and technologies are designed and developed so that people with disabilities can use them" [5]. The WAI also notes that positive secondary effects for other users can be caused by accessible design [5]. Accessible technology design has been improved by the implementation of the WCAG (Web Content Accessibility Guidelines), which are also hosted by the W3C: these guidelines have been developed over the past 26 years, and have undergone one major revision, from WCAG 1.0 to the WCAG 2.0/2.1/2.2 series [6–9]. The revision from 1.0 to 2.0 is marked by better conceptual justification for requirements, an increase in the number of requirements, the application of the WCAG to mobile devices, and a broader conceptualization of disability including cognitive and learning disabilities [6, 7]. The most recent version of the WCAG guidelines, WCAG 3.0, is currently in draft form, and expands the number of requirements, the level of user-centered design used in the requirements, and the application areas of the WCAG (including Internet of Things and wearable devices) [1].

The WCAG is widely applied in its current 2.0/2.1/2.2 version both in public-sector and private-sector websites, indicating strong desire to create applications that can be effectively used by individuals with disabilities [10, 11]. However, limitations of existing websites have also spurred the development of accessibility web browser extensions to further improve the web browsing experience for users, or to compensate for non-accessible design [3].

2.2 Digital Wellbeing

Digital wellbeing is a research area which aims to align actual use of technology with intended use of technology, focusing on helping users "live a life that is good for a human being in an information society" [12]. The area spans HCI research, focusing on avoidance of manipulation and deception, user empowerment, alignment of actual time spent on devices with desired time spent, and promoting a positive effect on the environment, among other topics [2, 13]. The digital wellbeing research area strongly intersects with positive psychology, self-determination theory, and studies of behavior change [14, 15].

Much current research in the digital wellbeing area has focused on technology to reduce user time spent in the leisure sphere, focusing on video sites/apps such as YouTube, social media such as Facebook or Twitter, and shopping sites/apps such as Amazon.com [2, 16]. Digital wellbeing technology often consists of standalone phone applications, as well as web browser-based extensions or computer apps [2]. The DWB research area also includes educational activities to improve understanding of digital wellbeing [17].

2.3 Web Browser Intervention Design

A research theme shared in both accessibility and digital wellbeing technology development is the use of web browser extensions as a means to provide targeted interventions for users. These web browser extensions can be installed in computer browsers such as Google Chrome and provide an additional software layer which interacts with existing web content or generates completely new web pages. In the digital wellbeing research area, a previous systematic literature review conducted by Monge Roffarello and De Russis in 2023 outlined various interventions and theories in the digital wellbeing space, considering 45 tools which implemented digital wellbeing interventions [2]. The digital wellbeing intervention space was classified into various digital wellbeing aspects, themes, and strategies, including an analysis of theories used. In the web-based accessibility research area, a literature review conducted by Borina et. al in 2022 identified qualitatively tested software specific to the cognitive disability domain (including design for dyslexia, intellectual or developmental disabilities, cognitive impairment, the elderly, and severe autism) [3]. The web-based software identified in this literature review included both websites and interventions.

In both digital wellbeing and accessibility intervention design areas, two ways of understanding intervention functionality/risk and potential effectiveness are by measuring whether interventions are additive, subtractive, or redesign-based, and whether the interventions are adaptive or purely manually-controlled.

2.3.1 Additive vs. subtractive interventions. Intervention designs either add or subtract content from an existing webpage (or in the case of combined additive and subtractive functionality, redesign the webpage). The choice of approach can affect the risk profile and capability of interventions: subtractive interventions, being based on the recognition and classification of existing elements, can rely on filter lists which make them easier to implement than additive interventions [2]. However, subtractive interventions can also cause user anxiety when previously existing functionality is removed [18]. Additive interventions offer more control and new features, yet can also annoy users [19]. Redesign interventions, from light modifications to complete transformations, allow interventions to change parts of the interface by moving, editing, or replacing content (a mix of additive and subtractive methods). While potentially more effective and comprehensive, redesign interventions may also require additional user training [20]. The intervention method selected has an effect on outcome measures, potentially leading to higher efficacy at the expense of higher user attrition [2, 21].

In the digital wellbeing research area, some interventions such as the removal intervention in Lyngs et. al 2020's Facebook study

[19] or the removal intervention in Lukoff et. al 2021's study [22] leveraged a strictly *subtractive* method, by only removing content. Other interventions, such as the goal popup from the same study by Lyngs et. al [19] or the measurement screen from the TimeAware study [23] can be considered to be *additive* interventions (providing additional functionality without removing functionality). Further, some extensions such as Lukoff et. al 2021's "Show more videos" button [22], the "switch" created for SwitchTube [24], or LocknType [25] would be considered *redesigns*, due to the simultaneous addition and subtraction of content (or rearranging of content).

In the accessibility space, interventions for cognitive and learning disabilities such as the WebHelpDyslexia tool [26], the Firefixia tool [27], the 2020 Berton et. al. tool [28], and the Easy Reading framework [29] provide web page overlays which offer buttons to help users modify the page. As such, these interventions should be considered *redesigns* of the existing webpages, as they modify content via new (additive) controls.

2.3.2 Adaptive interventions. Adaptive interventions are interventions which change based on some level of system initiation, directed towards a goal state. Levels of adaptivity are classified in Lavie et. al's 2010 paper [30], defining four levels: manual (non-adaptive), user selection, user approval, and fully adaptive. The user selection, user approval, and fully adaptive levels represent increasing levels of system initiation and control. Increasing adaptivity in interventions can reduce the amount of user attention that needs to be paid towards the intervention, benefiting both digital wellbeing use cases and individuals with cognitive disability [2, 29].

Within the digital wellbeing research area, HabitLab offered an interface including random shuffling (cycling through interventions for a specific website based on an initial site selection) [20]. Both a *user approval* level and *fully adaptive* level were implemented in different experimental conditions. Experimental results indicated that users were more likely to maintain use of the tool if informed that the interventions were randomly changing over time (as opposed to having the interventions simply change randomly) [20]. The HabitLab extension did not include an evaluative component to measure the effectiveness of these changes, and thus did not automatically select interventions based on a targeted goal state (the goal state was supported only by the user). Previous research notes a need for more adaptive interventions in digital wellbeing: many interventions in DWB only work with a limited set of predefined websites, and only use predefined interventions [2, 16, 24].

Within the accessibility research area, the Easy Reading framework used an adaptive intervention system, improving the displayed interventions via a recommender system which surfaced decisions to the user (*user approval* level). Input data for the recommender system included physiological data such as eye tracking (focus/cognitive load), heart rate, and heart rate variability (stress). This adaptive system presented low-complexity decisions to users which were intended to improve the overall capability of the system to reduce cognitive load and stress [29].

2.4 Overlap between Accessibility Guidelines and Digital Wellbeing Aspects

Digital wellbeing and accessibility have been previously noted to overlap in the use of the grayscale option on mobile devices (originally designed for accessibility purposes) as a means to reduce the attentional draw of the device (for digital wellbeing purposes) [31]. Recent work by Schwartz et. al. has also demonstrated the overlap between digital wellbeing aspects from [2] and the WCAG 1.0, 2.2, and 3.0 (2024-12-12 draft) versions [1, 6, 9], highlighting the increasing shared relevance of design for cognitive and learning disabilities and design for digital wellbeing.

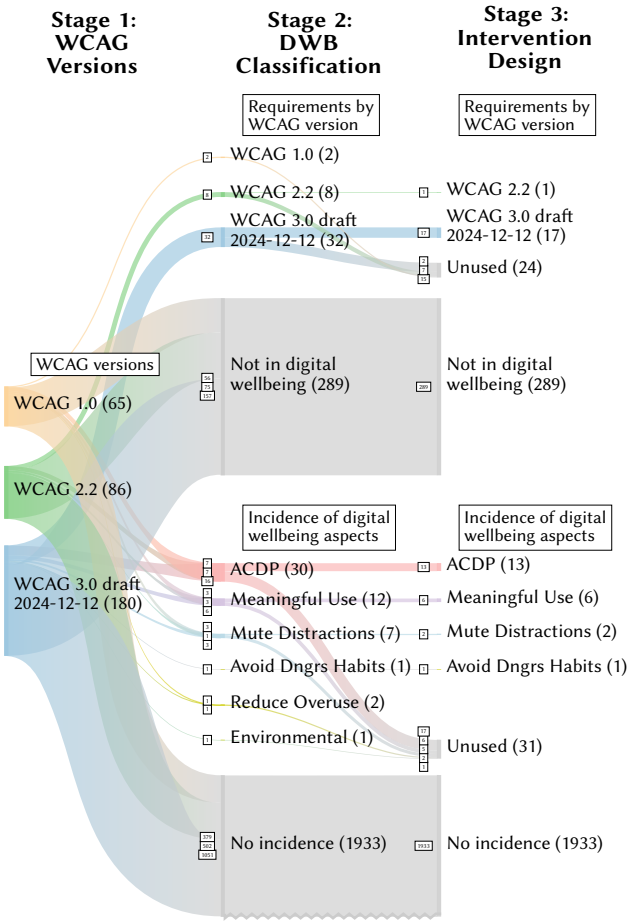

Figure 1: Sankey diagram showing flow of WCAG versions and digital wellbeing aspects. In Stage 1, the WCAG 1.0, 2.2, and 3.0 2024-12-12 draft versions were considered [1, 6, 9]. In Stage 2 (conducted in [4]), only WCAG requirements were saved (upper portion) which intersected with digital wellbeing aspects (lower portion). In Stage 3 (current study), proposed interventions were designed which encapsulated both WCAG requirements (upper portion) and their incidence in digital wellbeing (lower portion) from Stage 2. In total, six digital wellbeing aspects from [2] were analyzed across 331 WCAG requirements, resulting in 1,986 possible incidence cases.

The 2025 work by Schwartz et. al consisted of two stages: an initial requirements collection and a classification stage. In the initial stage, the authors collected the WCAG 1.0, 2.2, and 3.0 (2024-12-12 draft) requirements, totaling 331 overall requirements [4]. These requirements were classified among six digital wellbeing aspects from [2] and 11 attention-capture dark patterns from [32] by three coders, resulting in 53 incidences found of digital wellbeing aspects among 42 WCAG requirements. 45 incidences of attention-capture dark patterns (ACDPs) were also found to be potentially affected by the WCAG requirements. The research work indicated particular overlap in the areas of cognitive/learning disability and digital wellbeing, while noting that much of the overlap occurred in the WCAG 3.0 (2024-12-12 draft) version as opposed to the 2.X or 1.0 versions [4]. However, no research work has yet conducted design at the intersection of digital wellbeing and accessibility.

3 Methods

Based on the overlap of various WCAG requirements and digital wellbeing as conducted in [4] (Stage 1 and Stage 2 in Figure 1), web browser interventions were ideated and designed in this study (Stage 3 in Figure 1) to promote accessible web browsing for cognitive/learning disabilities as well as for digital wellbeing. The interventions, presented in a prototype user interface, leverage the intervention paradigm used in previous web interface research literature (such as the Easy Reading accessibility tool or HabitLab digital wellbeing tool) [20, 29]: a raw (unmodified) webpage is analyzed and modified to promote specific goals by the proposed intervention before the webpage is shown to the user, as opposed to other tool types which provide a standalone interface only such as [33] or mobile-phone based interventions such as [34]. The web-based intervention method, as opposed to a ground-up or "greenfield" design method, allows user control after existing webpages are designed, but does not support direct user participation in the original webpage design process.

3.1 User Stories

Two main **user stories** were proposed, which led the design of the interventions:

1. *As a person who has a cognitive or learning disability, I want to be effectively able to use a complex webpage so I can complete a simple task.*

2. *As a person who wants to support their digital wellbeing, I want to be able to make the page more aligned with my instrumental needs so I can complete my task without distraction or manipulation.*

Secondary personas, as mentioned by WCAG, can also include users who are non-native language speakers, users who are stressed/tired, or users who are unfamiliar with technology [35].

3.2 Use Cases

The proposed interventions were designed by the researchers around two **use cases**:

1. A single-page app (such as a video site like YouTube or a tool like Gmail or Google Docs).

2. A form submission (such as a questionnaire for creating a new account, unsubscribing, or ordering a product or service).

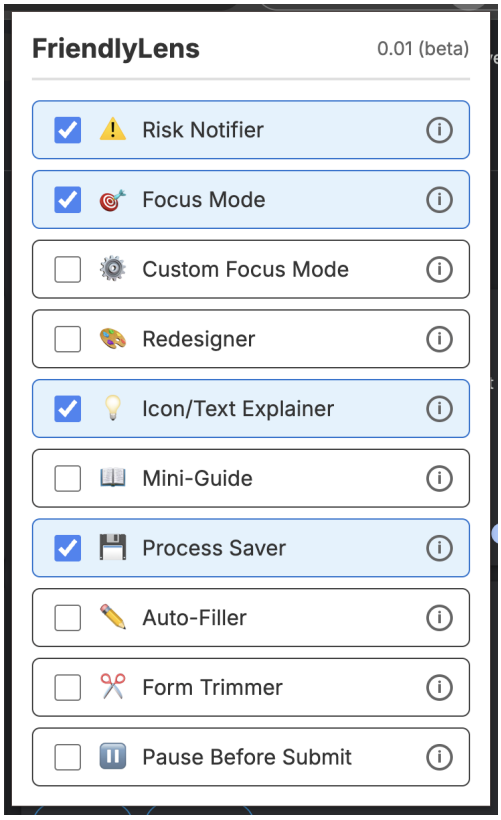

Figure 2: Screenshot of proposed FriendlyLens web browser extension control panel, containing the 10 proposed interventions.

These use cases are based on previous literature referencing digital wellbeing and accessibility application areas [2, 3, 36].

3.3 Intervention Design

The design of the tool interventions (Stage 3 in Figure 1, also in Figure 2) was accomplished via an ideation process, completed by examining the total of 42 requirements from WCAG 1.0, WCAG 2.2, and WCAG 3.0 (2024-12-12 draft) classified under digital wellbeing during Stage 2 from [4]. An ideation session was conducted among the authors to design the intervention functionality, conducted via an initial round of idea generation and a secondary round of selecting the most relevant and potentially impactful intervention concepts. This final group of interventions was modified based on shared feedback between the two authors. The group of interventions was also classified by their additive/subtractive/redesign functionality, as well as their adaptive functionality. After the intervention ideation and selection session (Stage 3 in Figure 1) was completed, the design for the FriendlyLens prototype was created collaboratively.

4 Results

The design process completed in this study resulted in 10 interventions (Table 1), reduced within the Stage 3 process from an initial

Table 1: Web browser interventions ideated and designed in this study, and their mapping to WCAG requirements classified as intersecting with digital wellbeing in [4].

Intervention name	Intervention description	WCAG reference(s)	Digital wellbeing aspects
Risk Notifier	Adds a notification of risks of a site's use, such as manipulative pricing or scamming, sourced from reviews, dark pattern scans, or other users.	WCAG 3.0 (2024-12-12 draft): Risk statements	Avoiding dangerous habits
Focus Mode	Blocks advertising popups, distracting recommendations, or removes advertising that causes the user to wait.	WCAG 2.2: 2.2.4 Interruptions, WCAG 3.0 (2024-12-12 draft): 2.9.3 Optional information, 2.10.1 Obscuring primary content	Avoiding ACDPs, Muting distractions to promote productivity
Custom Focus Mode	Collapsible panels/customization for varying levels of focus: explainer for different options.	WCAG 3.0 (2024-12-12 draft): Optional information	Avoiding ACDPs
Redesigner	An adaptive interface is created using simple preference testing to meet design conventions (capturing quick user approval without needing to dive into details).	WCAG 3.0 (2024-12-12 draft): 2.3.4 Control location, 2.3.4 Conventions, 2.12.3 Transform content	Avoiding ACDPs, Supporting meaningful use
Icon/Text Explainer	Adds hover tooltips over complicated words and all icons.	WCAG 3.0 (2024-12-12 draft): 2.2.4 Unnecessary words or phrases, 2.2.4 Sentence voice, 2.2.3 Unambiguous text, 2.12.3 Transform content	Avoiding ACDPs, Supporting meaningful use
Mini-Guide	Small table of contents/process summary, providing contextual information.	WCAG 3.0 (2024-12-12 draft): 2.7.4 Section purpose, 2.7.3 Current location, 2.9.6 Inform at start of process	Avoiding ACDPs, Supporting meaningful use
Process Saver	Prevents redirection away from the page; caches responses if the form is not filled completely and a change of context occurs.	WCAG 3.0 (2024-12-12 draft): 2.9.4 Deceptive controls, 2.9.4 Redirection, 2.9.4 Misinformation	Avoiding ACDPs
Auto-Filler	Prefilling known information to the extent possible.	WCAG 3.0 (2024-12-12 draft): 2.9.3 Optional input	Avoiding ACDPs
Form Trimmer	Removing or de-emphasizing optional entry items in a form.	WCAG 3.0 (2024-12-12 draft): 2.9.3 Optional information, 2.9.3 Optional input	Avoiding ACDPs
Pause Before Submit	Create a summary screen before submission actions in case the summary screen doesn't already exist.	WCAG 3.0 (2024-12-12 draft): 2.10.2 Clear agreement	Avoiding ACDPs

list of 12 interventions. Specifically, 2 interventions were removed because their impact on the user stories for the two specified use cases was estimated to be limited. The 10 interventions were classified into a mix of additive/subtractive/redesign functionality and adaptive or not adaptive (Table 2).

To provide a seamless and simple interface, access to interventions within a proposed Google Chrome browser extension titled "FriendlyLens" was proposed by triggering specific interventions on and off via a context menu that can be opened using the toolbar in the web browser (Figure 2).

4.1 WCAG Requirements

The distribution of WCAG requirements by WCAG version in Stage 3 (Figure 1, WCAG 3.0 draft 2024-12-12 being the most prevalent at 17 requirements, followed by WCAG 2.2 at 1 requirement, followed by WCAG 1.0 at 0 requirements) also mirrored the ordering of the WCAG version requirements in Stage 2 and Stage 1 (Figure 1). Of the 42 requirements noted in Stage 2 as being relevant to accessibility and digital wellbeing, 18 were used in Stage 3.

4.2 Digital Wellbeing Aspects

The digital wellbeing aspects captured in Stage 3 (Avoiding ACDPs at 13 instances, Supporting meaningful use at 6 instances, Muting distractions to promote productivity at 2 instances, Avoiding dangerous habits at 1 instance, and Reducing digital overuse and Creating a positive environmental footprint at 0 instances) mirrored the order of the distribution of Stage 2 digital wellbeing aspects, with the exception of Reducing digital overuse (Figure 1). Of the 53 wellbeing aspects relevant in Stage 2, 22 were used in Stage 3.

4.3 Interventions

Interventions (Table 1) were designed for the two use cases of the single-page app and form submission: the Risk Notifier, Focus Mode, Custom Focus Mode, Redesigner, and Icon/Text Explainer interventions are suitable for both use cases, while the Mini-Guide, Process Saver, Auto-Filler, Form Trimmer, and Pause Before Submit interventions are targeted towards the form submission use case specifically (although potentially applicable if a form is used as a part of a larger interface).

Interventions were motivated by novel or existing functionality or research and were ideated using an approach which integrated the accessibility and digital wellbeing dimensions.

- Risk Notifier, motivated by previous work in Dark Pita [16], elaborates a standardized risk notification framework (as mentioned in the WCAG 3.0 2024-12-12 draft), which supports adaptive identification of dark patterns as in [29], and which uses co-production by leveraging other users' feedback.
- Focus Mode, instead of using the "block" intervention method proposed in [37] undertakes a more complete redesign of the page, identifying not only the portions to remove but also which portions to promote.
- Custom Focus Mode, inspired by previous work in SwitchTube [24], proposes removing and promoting portions of the page on an adaptive basis to create multiple versions, potentially including "light focus" or "heavy focus" modes.
- Redesigner, motivated by the Easy Reading Framework [29], adopts the user approval yes/no adaptive method to standardize site navigation and presentation, aligning sites with design conventions and reducing unnecessary time spent to find information or achieve the user goal.
- Icon/Text Explainer, motivated by previous work in Dark Pita [16] and glossary design conventions used in existing websites such as [38], attempts to speed up site navigation and reduce manipulation by providing contextual information which enables users to understand site content presentation.
- Mini-Guide provides contextual information to reduce the dark pattern of Attentional Roach Motel [32], yet extends this same methodology to form-based content in general (such as unsubscribe or signups) as standardized in WCAG 3.0 (2024-12-12 draft).
- Process Saver, motivated by dark patterns in web interfaces [32] and user abandonment of forms and working memory limits in accessibility research [39, 40], attempts to increase likelihood of completion of the original task by reducing distractions and saving previously entered information.
- Auto-Filler, motivated by [41] yet providing a simpler interface to reduce cognitive load, provides an adaptive approach to recommending potential form contents based on the user approval yes/no adaptive method in [29].
- Form Trimmer, inspired by existing approaches to web content filtering in [42] and WCAG 3.0 (2024-12-12 draft) requirements to identify optional content [1], attempts to deemphasize manipulative or unnecessary content in forms.
- Pause Before Submit, motivated by reflective interventions in [20] and the desire to *shift* usage as mentioned in [24], aims to slow down the user experience before completing a submission, also providing an explanation of the submission to improve user autonomy before submission as mentioned in WCAG 3.0 (2024-12-12 draft) requirements [1].

Table 2: Intervention classifications for additive/subtractive/redesign and adaptive functionalities.

Intervention name	Additive/subtractive/ redesign	Adaptive
Risk Notifier	Additive	Adaptive
Focus Mode	Subtractive	Adaptive
Custom Focus Mode	Redesign	Adaptive
Redesigner	Redesign	Adaptive
Icon/Text Explainer	Additive	
Mini-Guide	Additive	
Process Saver	Additive	
Auto-Filler	Additive	Adaptive
Form Trimmer	Subtractive	
Pause Before Submit	Additive	

6 interventions were classified as additive, 2 as subtractive and 2 as redesign (Table 2). Using the framework presented in [30], 5 interventions were classified as adaptive (Table 2), while the remaining 5 interventions were classified as not adaptive.

5 Discussion

The resulting set of 10 web interventions bridges recent digital wellbeing and accessibility frameworks, providing benefits which can be traced back to each framework (Table 1). Similar to existing grayscale mode functionality which bridges the accessibility/digital wellbeing areas [31], users of these interventions could include both individuals with cognitive/learning disabilities and those who have attentional needs (digital wellbeing area), although some interventions may be more effective towards one group or the other group. The core concept behind these interventions is to use the scalability, cognitive load reduction, and generalization methods in accessible design, combined with new intervention techniques and classification patterns in digital wellbeing, to simplify the user experience, increase autonomy, and reduce time wasted during the web browsing activity.

The overall impact of these interventions is designed to be measured instrumentally using the two user stories in subsection 3.1: suitable scales for measurement of effectiveness could include both system metrics (potentially time spent, repetition of use, and trigger-action rule compliance/non-compliance) as well as psychological scales (stress or sense of autonomy).

5.1 Additive, Subtractive, and Redesign Functionality

Six of the 10 proposed interventions were classified as additive (Table 2), indicating that they add new content to an existing web interface. Additive interventions (compared to redesign interventions) can be effective, relatively simple to implement, and potentially less risky because they do not carry the risk of removing or changing

necessary content. However, such interventions are more visible to users (potentially leading to increased user desire to uninstall them), may cause additional cognitive load, and may require training to use them, which are negative attributes for users with cognitive and learning disabilities [35]. Previous research suggests that the Risk Notifier, Mini-Guide, and Pause Before Submit interventions may be more effective and tolerated by users if accompanied by explanations describing their functionality [20].

2 of the 10 proposed interventions were classified as subtractive (Focus Mode and Form Trimmer, Table 2). Subtractive interventions of this type are likely to be highly simple to implement and more easily extensible to more websites, yet carry the risk of potentially removing necessary content. In the form context, it is useful to recognize that optional inputs often serve to give space to users to provide helpful additional information: implementation and testing of the Form Trimmer functionality may be effectively paired with a classification function that attempts to understand the utility of optional form entry items before removing them.

2 of the 10 proposed interventions (Custom Focus Mode and Redesigner) were classified in the redesign category, which is the most complex category of intervention but may lead to higher user acceptance [24]. This category entails a more complete adaptation to the existing webpages, and is potentially more prone to failure as underlying webpage content changes. However, the use of targeted accessibility attributes on a page and/or classification functions can help interventions adapt to changes in the underlying webpage content [43].

5.2 Adaptive Interventions

5 of the 10 proposed interventions (Risk Notifier, Focus Mode, Custom Focus Mode, Redesigner, and Autofiller) are classified as adaptive interventions, indicating some level of autonomous control of the intervention. The expected benefit of these interventions includes improved ability to align usage with the user profile (increasing effectiveness or reducing attrition) as well as better flexibility when applying interventions to different websites [44]. These outcomes align with the "multimodal" design theme presented in accessibility research [45] and the "adaptability" challenge noted in previous digital wellbeing research [2]. A notable challenge of adaptive web browser extensions is their ability to effectively manage and support changing interface behavior, which has been accomplished in the past by crowdsourcing data inputs [46] or by using just-in-time recognition [42].

6 Limitations

The current group of proposed interventions and the FriendlyLens web browser extension are still in development and have not yet been tested with users: this limitation means that the functional success of the tool is not yet validated although the interventions have a strong theoretical basis. An additional limitation is that the interventions in place may not effectively promote all of the relevant digital wellbeing aspects identified in Stage 3 (Figure 1): some aspects may be favored or disfavored in the practical implementation of the software interventions.

The WCAG 2.0 requirements have been subject to criticism regarding their coherency and testability due to the "expertise effect" [47] which may also be a factor in the actual success of the implemented interventions in promoting accessibility for users. The WCAG 3.0 series is also still in draft form, meaning that the newest version of the WCAG standards has not yet been finalized.

Additionally, it is likely that the work completed in [4] represents an incomplete list of digital wellbeing aspects which apply to the non-leisure area of study, particularly noting that [2] studied the leisure area of study only. Similarly, the proposed interventions in Table 1 do not fit well within the leisure digital wellbeing intervention categorization of Lyngs et. al [37] of block/removal, self-tracking, goal-advancement, and reward/punish. These limitations indicate that a broader conception of digital wellbeing aspects may be necessary in order to correctly capture digital wellbeing in the non-leisure space.

7 Future Work

Future work in the accessibility/digital wellbeing shared design space may include more participatory design or participatory redesign with users, specifically focusing on the attrition rate of the FriendlyLens interventions, user sense of agency, and long-term user acceptance of the tool. This research may also be useful in planning future versions of standards in accessibility and digital wellbeing. One unexplored technical area in the digital wellbeing space is the integration of technical infrastructure or use of existing form languages/structures to improve element-by-element (just in time) recognition or transformation of interface contents. This technical challenge is particularly relevant to the ability of the next generation of web interventions to move away from pure crowdsourcing of intervention rules and towards more autonomous and adaptive intervention behavior.

8 Conclusion

This research study proposes ten web browser interventions which are ideated and designed at the intersection of cognitive/learning disability and digital wellbeing. Combining these two disparate research areas can bring potentially mutually beneficial effects: the standardized approach to accessibility can help digital wellbeing design capture a wider range of systems and interfaces, and the analysis of digital wellbeing features in the accessibility context can help improve and clarify the design of requirements for the upcoming WCAG 3.0 guidelines.

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