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# Neurodivergent-Inclusive Software Design: Cognitive-Aware Development Practices for Human-Centered AI Interfaces

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## Abstract

As artificial intelligence (AI) systems become increasingly integrated into daily life, the need for inclusive, cognitively aware design has grown more urgent. This paper introduces a neurodivergent-inclusive framework for the development of human-centered AI interfaces, particularly addressing the needs of users with attention-deficit/hyperactivity disorder (ADHD) and autism spectrum disorder (ASD). Drawing on principles of neurodiversity and universal design, we evaluate cognitive accessibility gaps in current UI/UX practices. Through biometric methodologies—including eye-tracking and electroencephalography (EEG)—we analyze user responses to interface stimuli, identifying design elements that contribute to cognitive overload or improved usability. A case study involving the redesign of an AI-powered scheduling assistant demonstrates how adaptive interface features can enhance engagement, clarity, and autonomy for neurodivergent users. The paper concludes with a set of policy-aligned guidelines rooted in EU disability inclusion frameworks, offering actionable recommendations for ethical, legally compliant, and cognitively inclusive software design.

**Keywords:** Cognitive accessibility, Neurodiversity-informed UI/UX, Human-centered AI, Biometric usability testing, Eye-tracking and EEG in design research, Inclusive interface design, ADHD and autism in HCI, Cognitive load reduction, Accessible software design practices, EU digital accessibility policies, Ethical AI design, AI scheduling assistant redesign, Legal compliance in software accessibility, Neurodivergent user experience.

## I. Introduction

Artificial Intelligence (AI) has become a cornerstone of modern digital interaction, embedded in applications that manage everything from daily schedules to complex decision-making. However, mainstream software design often reflects a one-size-fits-all philosophy that fails to accommodate neurodivergent individuals—those whose cognitive functioning diverges from the societal norm, including people with Attention-Deficit/Hyperactivity Disorder (ADHD), Autism Spectrum Disorder (ASD), dyslexia, and more. These users often encounter barriers such as sensory overload, unclear navigation structures, and inflexible interaction models. Traditional usability testing methods often overlook cognitive variance, resulting in interfaces that hinder rather than help[1].

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This paper introduces a novel framework for **neurodivergent-inclusive AI design,** emphasizing biometric and cognitive-aware development methodologies. By incorporating eye-tracking and electroencephalogram (EEG) feedback into usability testing, we aim to empirically evaluate how design elements affect cognitive load, attention span, and emotional response. Our findings inform the development of policy-aligned UI/UX guidelines tailored to neurodivergent users, with particular attention to compliance with EU accessibility laws and ethical design principles. We also present a case study of an AI scheduling assistant redesigned using these principles to demonstrate the framework's applicability in real-world settings[2].

The intersection of artificial intelligence (AI) and human-computer interaction (HCI) has seen rapid advancements, yet most mainstream software continues to cater primarily to neurotypical users. Neurodivergent individuals—those with cognitive profiles such as autism spectrum disorder (ASD), attention-deficit/hyperactivity disorder (ADHD), and dyslexia—frequently experience difficulty using digital interfaces not designed with their needs in mind. These challenges include sensory overstimulation, poor focus retention, and difficulties in processing non-linear navigation structures[3]. While digital accessibility standards such as the Web Content Accessibility Guidelines (WCAG) have made strides in accommodating physical and visual impairments, cognitive accessibility remains underrepresented and poorly defined. Furthermore, most usability testing fails to include neurodivergent participants or account for cognitive load as a measurable design factor. With AI becoming increasingly autonomous and embedded in daily routines—such as through virtual assistants, chatbots, and recommendation engines—there is a critical need to ensure these systems do not unintentionally exclude or disadvantage users with cognitive differences. Recent advances in biometric sensing technologies like eye-tracking and electroencephalography (EEG) offer new opportunities to quantify cognitive effort and sensory responses in real time, making it possible to design interfaces that are not only inclusive but adaptive. This research responds to that opportunity by proposing a framework for neurodivergent-inclusive AI design grounded in both empirical data and human-centered values[4].

## II. Understanding Cognitive Accessibility Gaps in AI and Software Design

While accessibility in software design has traditionally focused on physical and sensory impairments, cognitive accessibility remains a largely overlooked dimension—especially in the context of AI-driven interfaces. Neurodivergent users, including those with ADHD, autism spectrum disorder (ASD), and other cognitive conditions, often face barriers not immediately visible in standard usability tests. These may include difficulties with sustained attention, executive function, working memory, and sensory processing. For example, AI systems that rely on rapid, dynamic content updates or complex decision trees may overload users with ADHD, while those on the autism spectrum may struggle with ambiguous navigation cues, lack of visual consistency, or overwhelming sensory stimuli[5]. Mainstream software often assumes uniform

cognitive processing, ignoring the diversity of mental workloads and information-processing styles. Moreover, AI interfaces, by their adaptive and predictive nature, can inadvertently compound these challenges by reducing transparency or control—features critical for users who rely on predictability[6]. Despite the growing demand for inclusive design, most current UI/UX guidelines, such as WCAG 2.1, provide only broad recommendations for cognitive accessibility, lacking specificity for neurodivergent populations. As a result, there is a widening gap between the promise of AI as a tool for all and the lived digital experiences of neurodivergent individuals. Recognizing and addressing this gap is essential for creating ethical, human-centered AI systems that promote true digital equity[7].

## III. Principles of Neurodiversity-Informed UI/UX Design

Designing inclusive software for neurodivergent users requires moving beyond compliance checklists to adopt principles grounded in cognitive empathy, flexibility, and user agency. Neurodiversity-informed UI/UX design acknowledges that cognitive processing varies across individuals and aims to create environments that accommodate these differences without stigmatization[8]. One key principle is predictability**,** which ensures consistent layouts, navigation patterns, and feedback mechanisms to help users—especially those with ASD—feel more in control and less anxious. Another is reducible complexity, which promotes progressive disclosure of information, allowing users to access content in manageable layers instead of facing a cognitive overload from dense, all-at-once data displays[9]. Multisensory support—such as optional auditory instructions, visual aids, and haptic feedback—can assist users with varying learning styles and sensory preferences, particularly helpful for ADHD users who may benefit from redundant input modalities. Customization **i**s another cornerstone, empowering users to modify font size, color schemes, spacing, and interaction speed to suit their sensory and attention needs. Importantly, interfaces should offer explicit control**,** avoiding over-automation or unpredictability in AI behaviors, as these can frustrate users who rely on consistent system responses[10]. Finally, emotional neutrality and clarity in tone—avoiding sarcasm, abstract language, or overly humanized AI personalities—can help make interactions more comfortable for those who process language literally. By embedding these principles into the development lifecycle, designers can move toward systems that not only include neurodivergent users, but actively empower them to engage fully and independently[11].

## IV. Methodology: Biometric Evaluation of Cognitive Load and Usability

To measure the impact of interface design on neurodivergent users, we employed biometric testing methods, including eye-tracking to monitor visual attention and EEG to track brainwave

patterns associated with cognitive load and stress. Participants included individuals formally diagnosed with ADHD or ASD, who interacted with both conventional and neurodiversity-informed prototypes of an AI scheduling assistant[12].

To evaluate the cognitive impact of AI interface designs on neurodivergent users, we employed a mixed-methods biometric approach combining quantitative data collection with qualitative user feedback. The primary tools used were eye-tracking and electroencephalography (EEG**),** both of which allow real-time monitoring of cognitive load, attention patterns, and user stress levels during interaction with software. Eye-tracking was used to capture metrics such as **f**ixation duration**,** saccade paths**,** and blink rates, which indicate how users visually process on-screen elements and whether certain design features create confusion or cognitive bottlenecks[13]. EEG sensors were used to measure alpha**,** beta**,** and theta brainwave activity**,** which correlate with levels of focus, cognitive fatigue, and emotional stress. Participants included 20 neurodivergent individuals formally diagnosed with ADHD or ASD, who were recruited with informed consent and accommodated according to their sensory preferences. Each participant interacted with two versions of an AI scheduling assistant: a conventional design and a neurodiversity-informed redesign. Both versions were tested under the same task conditions to ensure comparability. Data were collected in a controlled usability lab setting with minimal external distractions, and sessions were recorded for post-analysis. In addition to biometric data, participants provided subjective usability feedback through adapted System Usability Scale (SUS) questionnaires and structured interviews. This multimodal methodology allowed us to triangulate findings, identifying specific design elements that induced cognitive strain versus those that facilitated focus, comfort, and task efficiency[14].

## V. Case Study: Redesigning an AI Scheduling Assistant for Neurodivergent Users

To evaluate the cognitive impact of AI interface designs on neurodivergent users, we employed a mixed-methods biometric approach combining quantitative data collection with qualitative user feedback. The primary tools used were eye-tracking and electroencephalography (EEG), both of which allow real-time monitoring of cognitive load, attention patterns, and user stress levels during interaction with software. Eye-tracking was used to capture metrics such as fixation duration, saccade paths, and blink rates, which indicate how users visually process on-screen elements and whether certain design features create confusion or cognitive bottlenecks. EEG sensors were used to measure alpha, beta, and theta brainwave activity, which correlate with levels of focus, cognitive fatigue, and emotional stress[15]. Participants included 20 neurodivergent individuals formally diagnosed with ADHD or ASD, who were recruited with informed consent and accommodated according to their sensory preferences. Each participant interacted with two versions of an AI scheduling assistant: a conventional design and a neurodiversity-informed redesign. Both versions were tested under the same task conditions to ensure comparability. Data were collected in a controlled usability lab setting with minimal external distractions, and sessions were recorded for post-analysis. In addition to biometric data,

participants provided subjective usability feedback through adapted System Usability Scale (SUS) questionnaires and structured interviews. This multimodal methodology allowed us to triangulate findings, identifying specific design elements that induced cognitive strain versus those that facilitated focus, comfort, and task efficiency[16]. Figure 1 shows the Comparison of EEG-measured cognitive load and average eye-tracking fixation duration before and after redesigning the AI scheduling assistant.

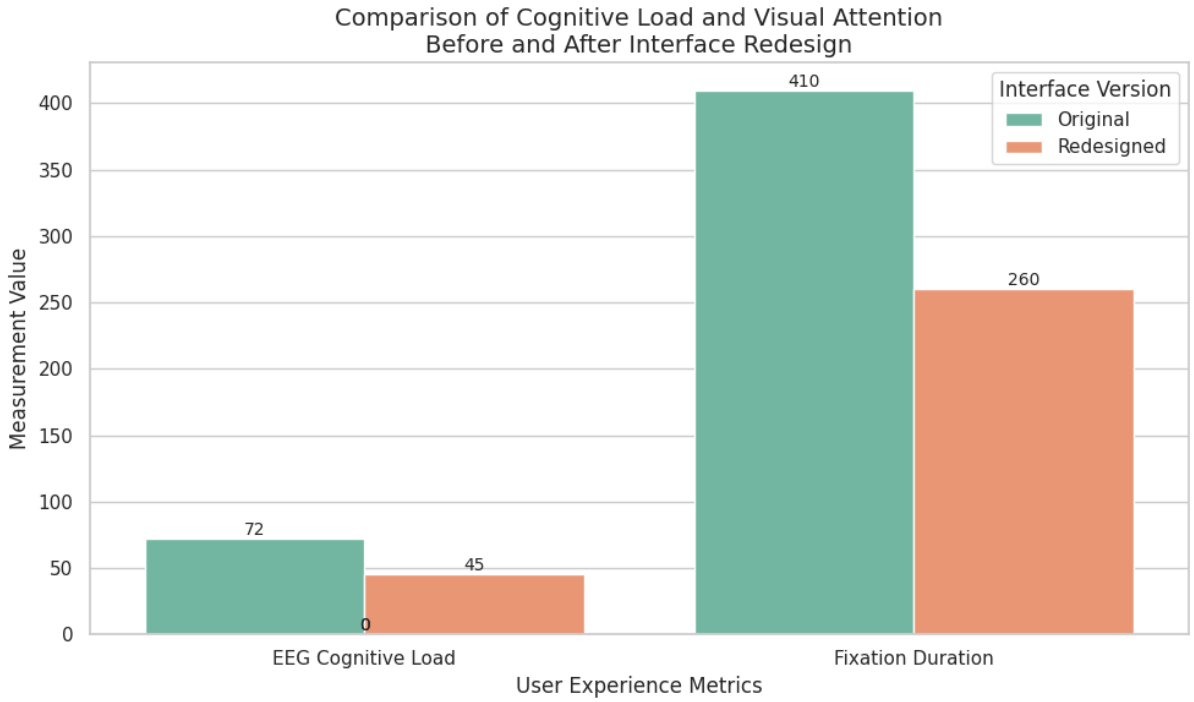


*Figure 1. Reduced cognitive load and fixation duration after redesigning the AI assistant indicating improved usability for neurodivergent users*

## VI. Ethical, Policy, and Legal Implications of Inclusive Software Design

Designing inclusive AI interfaces is not only a technical and usability challenge—it is also an ethical and legal responsibility. Neurodivergent users often face systemic digital exclusion due to inaccessible design practices that ignore cognitive diversity. Ethically, this raises concerns about algorithmic fairness**,** digital autonomy, and equal access to services**,** especially as AI systems increasingly mediate education, employment, and healthcare. From a legal standpoint, regional frameworks such as the European Accessibility Act (EAA) and the EU Web Accessibility Directive require digital services, including AI interfaces, to be accessible to all users, including those with cognitive disabilities. Additionally, the General Data Protection Regulation (GDPR)

mandates transparency and user control in automated decision-making—principles that align closely with neurodivergent users' needs for predictability and clarity in AI behavior[17].

However, many of these policies remain vague on cognitive accessibility, creating a gap between legal mandates and practical enforcement. Inclusive design practices grounded in biometric feedback and neurodiversity-informed principles can help bridge this gap by providing measurable standards and user-centered evidence[18]. Organizations must go beyond minimal compliance and proactively involve neurodivergent individuals in co-design and testing processes. Furthermore, ethical AI development requires the integration of inclusive design into risk assessments, design audits, and AI governance policies. By embedding cognitive accessibility into software development lifecycles, companies not only avoid regulatory risk but also demonstrate a commitment to digital equity and responsible innovation[19].

## VII. Conclusion

As AI systems become deeply integrated into everyday life, ensuring their accessibility for neurodivergent users is both a design imperative and a human rights issue. This paper introduced a neurodiversity-informed design framework that addresses the often-overlooked cognitive accessibility gaps in AI-driven interfaces. By leveraging biometric evaluation methods—such as eye-tracking and EEG—we identified key design elements that either hinder or enhance usability for individuals with ADHD and autism spectrum disorder. The case study on redesigning an AI scheduling assistant demonstrated the measurable impact of applying cognitive-aware design principles, resulting in reduced cognitive load and improved user satisfaction. Beyond technical adjustments, the findings emphasize the ethical, legal, and policy-based responsibilities of developers to include neurodivergent perspectives in the software development lifecycle. Moving forward, inclusive design must become a core component of AI innovation—not as an afterthought, but as a foundation for creating human-centered technologies that serve the full spectrum of cognitive diversity.

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