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Toward a Human-Centered Framework for Digital Health Accessibility Among ASL-Dominant Users

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ABSTRACT

Digital technologies are increasingly important in healthcare; however, ASL-dominant users still face accessibility and usability challenges when accessing English-dominant digital health interfaces. Existing accessibility standards, including Section 508 and the Web Content Accessibility Guidelines (WCAG), primarily emphasize sensory accessibility and technical compliance. Still, they do not adequately address the linguistic, cognitive and interactive challenges that ASL-dominant users face when interacting with English-dominant digital health interfaces. This paper presents the design of an ongoing research study involving ASL-dominant users to develop and evaluate an accessibility framework for English-dominant digital health interfaces: (1) participatory co-design activities involving ten ASL-dominant participants; (2) a planned expert review of the resulting prototype by five HCI, accessibility, and ASL experts; and (3) a planned final independent review of a refined prototype by five ASL-dominant users. In addition to the study design, data and findings from the first stage were reported. Preliminary findings from these initial sessions emphasized key accessibility needs related to simplified language, clear navigation and interaction pathways, reduced cognitive load, visual and multimodal support, ASL-aligned accessibility, and step-by-step procedural guidance, going beyond linguistic adaptation. These preliminary findings provide empirically grounded, Deaf-centered design guidance for creating more inclusive digital health environments that address the linguistic, cognitive, and interaction needs of ASL-dominant users.

Keywords: ASL-dominant users, Digital accessibility, Human-computer interaction, Linguistic accessibility, Health information accessibility, Participatory co-design, Cognitive accessibility, Usability, Text simplification, Inclusive design

INTRODUCTION

Digital health websites, patient portals, and online appointment systems are increasingly important for the consumption of health information and services. However, these systems are predominantly presented in written English with specialized terminology and complex navigation. This may create barriers for many users who rely heavily on American Sign Language (ASL), simplified language, and navigation. Differences between ASL and written English may affect how they understand, navigate, and access English-dominant digital health information.

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Prior research suggests that ASL sentence structure adaptation can improve comprehension, but linguistic adaptation alone does not address navigation, visual organization, or other interface barriers (Farayola & Loksa, 2025; Bragg et al., 2019). To bridge this gap, this paper presents the design of an ongoing participatory study involving ASL-dominant users to identify barriers, develop broader accessibility strategies for English-dominant health interfaces, and evaluate the solutions.

LITERATURE REVIEW

Linguistic and Comprehension Barriers for ASL-Dominant Users

ASL is a fully developed natural language with its own grammatical structure and visual-spatial characteristics (Boudreault & Mayberry, 2006). Consequently, written English is not simply a direct textual representation of ASL, and differences between the two languages can create additional demands when ASL-dominant users interact with English-dominant information.

Research on Deaf literacy indicates that early and sustained access to a first language is associated with later literacy and reading comprehension, while limited language access can affect comprehension of written English (Hartman et al., 2019; Easterbrooks & Beal-Alvarez, 2013). Cognitive accessibility research similarly suggests that complex or unfamiliar linguistic forms can increase cognitive demands during information processing (Gkintoni et al., 2025).

These linguistic considerations are particularly relevant in digital health, where users must interpret written information to locate services, understand instructions, and make decisions. Research indicates that Deaf individuals may experience health-literacy disparities when healthcare communication relies heavily on written English (Dalal et al., 2025; McKee et al., 2019). Thus, the accessibility of digital health information depends not only on whether information is technically available but also on whether its linguistic presentation supports comprehension.

However, linguistic differences alone do not explain the full range of barriers encountered in digital systems. Users may understand individual words or sentences and still have difficulty determining where to begin, locating information, or completing tasks. These broader system-level issues require attention to usability and interface design.

Usability, Navigation, and Cognitive Accessibility in Digital Health

Human-Computer Interaction (HCI) research emphasizes that accessibility is not solely a static technical property; it depends on how interface structure, information organization, and interaction demand align with users' needs (Lazar et al., 2015). For ASL-dominant users, visual processing makes interface clarity, hierarchy, and organization particularly important.

Studies have identified navigation challenges associated with poor information scent and ineffective interface organization, making it difficult for users to locate and interpret information (Aljedaani et al., 2022).

Contemporary digital systems may further increase these demands through layered navigation and complex media structures (Mack et al., 2020). Such design characteristics can increase cognitive burden and reduce usability, particularly in high-stakes contexts such as healthcare.

Digital health systems require users to access, understand, and use health information while simultaneously navigating menus, links, terminology, and information hierarchies. Digital health literacy is therefore influenced by both individual capabilities and system design (Norman & Skinner, 2006; Durmuş, 2024; Levin-Zamir, 2023). Clear communication and trust are also important when users interact with health information, as information quality, website presentation, and user–website interactions can influence users' trust in health information sources (Kim, 2016). Visual design may be particularly relevant for Deaf users, whose information processing can rely heavily on visual cues (Champlin et al., 2021).

These barriers should not be interpreted solely as limitations of individual users. Design choices and poor fit between user characteristics and system structure can also contribute to these difficulties (Shinohara et al., 2018).

Beyond ASL Sentence-Structure Adaptation

ASL sentence structure adaptation may support comprehension. However, text-based adaptation cannot fully represent the spatial and visual characteristics of ASL or address interface design, navigation, or information organization by itself (Bragg et al., 2019). Moreover, simplifying language alone cannot compensate for poor interface design (Moreno et al., 2024). These findings suggest linguistic, cognitive, and interactional dimensions must be considered together (Antonio et al., 2023).

Participatory Design for Deaf-Centered Accessibility

Participatory Design (PD) provides a methodological and conceptual approach for addressing accessibility as a multidimensional design problem. PD involves end users as active contributors to technology development rather than limiting their role to evaluating designs produced by researchers or designers (Sanders & Stappers, 2008; Spinuzzi, 2005). In accessibility research, this approach can redistribute decision-making power and incorporate lived experience into design decisions (Bratteteig & Wagner, 2016; Lazar et al., 2015).

For Deaf-centered design, participatory approaches provide an opportunity for ASL-dominant users to contribute directly to decisions concerning communication, visual presentation, navigation, and interaction. This is consistent with the principle of epistemic justice, which recognizes users as legitimate knowledge holders whose experiences can contribute to the design of technologies intended for their communities (Frauenberger et al., 2015; Bratteteig & Wagner, 2016). Co-design activities such as sketching, prototyping, and collaborative discussion can translate these experiences into concrete design strategies (Ramones & Del-Rio-Guerra, 2023).

PD also presents practical challenges, including recruitment, resources, sustained engagement, and the potential for researchers to retain control over design decisions (Zahlsen et al., 2023). Meaningful participation therefore requires opportunities for users to influence problem identification, strategy generation, and design refinement. This is particularly relevant to this co-design study, where participants contribute accessibility strategies rather than simply rate a completed interface.

Literature therefore supports participatory co-design as an appropriate approach for extending accessibility beyond linguistic adaptation. By engaging ASL-dominant users in identifying barriers and developing solutions, co-design can bring together linguistic, visual, cognitive, navigation, and interactional considerations that are often examined separately.

Research Questions

RQ1. What barriers and accessibility strategies do ASL-dominant users identify while interacting with and co-designing with an English-dominant digital health interface?
RQ2. How can the co-design strategies be incorporated into an accessibility framework and prototype?
RQ3. How do accessibility experts and ASL-dominant users evaluate the framework-informed prototype?

METHODOLOGY

To answer the above research questions, a multistage participatory mixed-methods design is adopted that includes three main components: (1) participatory co-design with ASL-dominant users; (2) a planned expert review of the framework-informed prototype; and (3) independent ASL-dominant users who have not participated in the co-design. Stage 1 has been completed, while stage 2 and stage 3 represent subsequent evaluation stages. Findings from each completed stage will inform the next stages. Table 1 below summarizes the participants and primary purpose of each component of the research design.

Table 1: Overview of the multistage participatory research design.

Phase	Participants	Tasks/Purposes
Participatory Co-Design	Ten ASL-dominant users with limited English proficiency	identify barriers, generate accessibility strategies, and design concepts, and sketches
Expert Review	five accessibility and ASL/ domain experts	assess its practicality, completeness, clarity, and applicability. Recommend refinements.
Independent Prototype Evaluation	five ASL-dominant users without previous session exposure	Assess task performance, comprehension, usability, cognitive demand, and satisfaction

PARTICIPANTS

Participants for co-design sessions and independent review sessions were recruited from the Deaf and Hard of Hearing (DHH) community through Deaf associations, social community channels, local churches, and word of mouth. Participants for the planned independent review will be recruited using similar channels and/or from the reserved pool of eligible participants. Stage 1 co-design participants received $25 upon completing their sessions. Participants in the planned independent-user evaluation (Stage 3) will receive $25, and experts in the planned review (Stage 2) will receive $50.

There are three groups of participants included in the overall study: (1) ten ASL-dominant individuals with limited English proficiency, ranging in age from 18–24 to 55+ years and reporting daily digital device use; (2) five experts who had backgrounds in digital accessibility, usability and UX, Human-Computer interaction (HCI), web design and development, digital health / health information, American Sign Language (ASL), Deaf studies and Deaf culture, and related areas, who will participate in the planned expert review; and (3) five independent ASL-dominant individuals who will be recruited from either the reserved pool or new recruitment, ranging in age from 25–34 to 55+ years and reporting daily digital device use. These independent participants will not have any prior exposure to the co-design process or prototype development. Using separate groups for co-design and final review is intended to reduce the potential influence of prior familiarity with the design.

PROCEDURE

Detailed procedures for the three stages are presented separately below. Stage 1 has been completed, whereas stage 2 and stage 3 describe the planned subsequent evaluations. No ASL interpreter was used during Stage 1 sessions; the Deaf primary researcher communicated directly with participants in ASL. The primary researcher who is fluent in ASL communicated directly with both co-design and independent participants, reducing the need for third-party interpretation during the sessions. SUS and NASA-TLX instruments were adopted and aligned with the linguistic and cognitive needs of ASL-dominant participants, while preserving the intended constructs measured by the original instruments. Artino et al. (2014) and Boateng et al. (2018) discuss principles for questionnaire development and adaptation, including aligning items with the intended constructs and study objectives.

Stage 1: Participatory Co-Design Session

Ten co-design participants attended the co-design sessions in person. To accommodate participants' schedules and transportation needs, the primary researcher used a flexible data-collection method by traveling to locations that were convenient and close to participants, including Deaf churches and schools, with a personal computer (PC) that contained access to the study materials and prototype after obtaining their consent. Other co-design participants showed up on the university's main campus to interact with the prototype and complete the study activities for approximately 10–15 minutes each.

During the co-design session, the participants interacted with the Health Center homepage from a mid-Atlantic university, which served as the existing English-dominant digital health interface for the co-design activities. Participants completed tasks such as locating health information and understanding medical instructions and then discussed barriers, difficulties, and points of confusion they encountered during interaction.

Co-designers then proposed new or additional accessibility strategies based on their reflections and interaction with the existing English-dominant digital health interface. The researcher documented, categorized, and synthesized strategies as potential framework components.

Co-designers also sketched or described how proposed strategies should operate in the interface. These outputs were translated into concrete design concepts, interaction patterns, and a framework-informed prototype developed using the Base44 platform.

Stage 2: Expert Review

Five experts in accessibility, usability, HCI/UX, ASL/Deaf-related, and web design will independently review the framework-informed prototype remotely over a two-week period. The experts will then complete a researcher-developed expert assessment questionnaire that will ask them to rate the appropriateness of the framework-informed accessibility strategies and provide written feedback on whether the prototype is methodologically and professionally sound, practical, complete, and applicable. Researchers will refine the prototype based on experts' feedback or recommendations.

Stage 3: Final Independent Review

Following the expert review and subsequent prototype refinement, an independent group of five qualified ASL-dominant users, who did not participate in co-design sessions, will individually interact with the refined framework-informed prototype in a university HCI lab. These participants will perform the same set of tasks that the expert reviewers will do. They will then complete a usability questionnaire. The primary researcher will collect data on task completion rate, errors, task completion time, perceived usability, perceived cognitive load, comprehension, and overall satisfaction.

Task completion rate will be calculated as the percentage of predefined task components that each participant successfully completes, while errors will reflect their unsuccessful or incorrect actions while using the prototype. Task completion time will be recorded for each task and will be summarized across tasks. Participant perceived usability will be measured using a modified-SUS (System Usability Scale), and perceived cognitive load will be measured with modified NASA-TLX items (Said et al., 2020). Participants' comprehension will be assessed through task-related questions, and participants will be asked to rate their overall satisfaction with the framework-informed prototype.

DATA ANALYSIS

Since stage 1 sessions were conducted mainly in ASL between the primary researcher, who is fluent in ASL, and co-design participants, the analysis extracted meanings from participants' signed responses and took notes in English. The notes were then reviewed to identify statements related to perceived usability, cognitive load, and confidence in using health information. Participant comments and co-design interview responses were assigned initial descriptive codes and analyzed thematically to identify recurring barriers, preferences, and user-generated design strategies. These findings were synthesized across participants into higher-order themes and framework implications. Data to be collected from the following stages will be summarized using descriptive statistics and thematic analysis of comments and recommendations. Considering the small participant sample size, quantitative measures, such as task completion rate, error counts, and task completion time, will be summarized using means and frequency distributions rather than inferential statistics. Qualitative data will be analyzed using thematic analysis to identify any potential improvements needed.

PRELIMINARY FINDINGS

This section presents a summary of co-design findings (stage 1), examined at the participant level based on key barriers encountered when interacting with the existing English-dominant digital health interface. Table 2 presents the co-design findings, framework components, and prototype features, showing how findings from the participatory co-design sessions were translated into framework components and corresponding prototype features. Data from Stages 2 and 3, which are not included in the preliminary findings reported in this paper, will be collected and analyzed in subsequent stages.

Table 2: Co-design findings, framework components, and prototype features.

Co-Design Theme	Key Finding	Design Requirements	Framework Component	Prototype Response
Language & Comprehension	Complex English and medical terms were difficult	Concise and simple/familiar wording	Linguistic accessibility	Short sentences, plain language, ASL-aligned text
Navigation & Access	Users were unsure where to click or begin	Clarify actions	Navigation & interaction	Clear pathways and prioritized services
Information Organization	Crowded pages created information overload	Reduce and group content	Cognitive load reduction / information simplification	Reduced and grouped content
Visual Support	Pictures, icons, and headings supported understanding	Support understanding visually	Visual & multimodal support	Icons, images, headings, short labels

(Continued)

Table 2: Continued.

Co-Design Theme	Key Finding	Design Requirements	Framework Component	Prototype Response
ASL Accessibility	Users wanted visible ASL access	Make ASL access available	Linguistic & multimodal accessibility	Embedded ASL videos / "Watch in ASL"
Task Guidance	Appointment procedures were difficult	Break complex tasks into steps	Navigation & interaction	Step-by-step appointment pathway
Accessibility Access	Users wanted easier access to accessibility features	Provide user-controlled support	User-controlled accessibility	Visible Accessibility button

DISCUSSION, LIMITATIONS, AND IMPLICATIONS

The preliminary results from Stage 1 suggested that language-structure adaptation alone does not address all accessibility barriers. Navigation, visual support, ASL access, and step-by-step task guides should work in conjunction to provide an accessible solution (RQ1).

This study also shows the value of participatory co-design. Participants worked as an essential component in the design process. Not only did they provide feedback on the problems with current design, they also actively contributed strategies and design concepts. Mapping the co-designers' contributions to framework components and prototype features makes the design more transparent to the users. These findings are consistent with previous studies in the literature (Sanders & Stappers, 2008; Spinuzzi, 2005) on the benefits of involving users in the design process.

Unlike traditional practice, this research is designed to extend beyond participatory co-design through subsequent expert review and independent-user evaluation. The planned expert review will assess the framework-informed prototype regarding its practicality, completeness, clarity, and applicability, as well as identifying potential areas for refinement. The final user evaluation is expected to present formative evidence further regarding usability and accessibility. This study contributes to the limited research involving Deaf/ASL-dominant users throughout the design process. It also demonstrates how co-design can help build an accessibility framework and prototype (RQ2). However, the generalizability of the results is limited due to the small sample size. The planned expert and independent user evaluations will be used as the foundation for further framework validation.

Therefore, the findings need to be examined more carefully. Future work should expand the study with a bigger sample size. In addition, more independent coders need to be involved to avoid any biases the researcher may have when coding and analyzing data. More study is also needed to evaluate the framework across digital health contexts.

CONCLUSION

This paper presented a multistage participatory design to investigate accessibility solutions that go beyond ASL adaptation. Preliminary co-design findings emphasized the need to incorporate simplified language, clearer navigation and interaction pathways, visual and multimodal support, ASL-based support, reduced cognitive load, and step-by-step procedural guidance into English-dominant digital health interfaces through participatory co-design. Rather than relying on linguistic adaptation alone, these findings highlight the importance of involving ASL-dominant users in a multidimensional approach to address their linguistic, cognitive, visual, navigational, and digital interaction needs.

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