Towards Sign Language-Centric Design of ASL Survey Tools

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ABSTRACT

Questionnaires are fundamental learning and research tools for gathering insights and information from individuals, and now can be created easily using online tools. However, existing resources for creating questionnaires are designed for written languages (e.g. English) and do not support sign languages (e.g. American Sign Language). Sign languages (SLs) have unique visual characteristics that do not fit into user interface paradigms designed for written, text-based languages. Through a series of formative studies with the ASL signing community, this paper takes steps towards understanding the viability, potential benefit, challenges, and user interest in SL-centric surveys, a novel approach for creating questionnaires that meet the needs of deaf individuals using sign languages, without obligatory reliance on a written language to complete a questionnaire.

CCS CONCEPTS

• **Social and professional topics** → **Assistive technologies**.

KEYWORDS

American Sign Language, ASL

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1 INTRODUCTION

If you know more than one language, you may be able to imagine the challenges that arise when participating in research or taking a quiz in your second language. Now imagine that you are finally able to participate in your primary language, but must use a tool that does not correctly display the characters of the language, does not allow content creators to structure material in a logical way, and requires several minutes to load the content. Communities whose primary language is a signed language have all three of these experiences when taking or designing surveys.

Deaf individuals consistently report a preference for websites that incorporate signed languages [17, 38, 40], regardless of their level of fluency with print languages. Some signers are bilingual or multilingual, with excellent command of one or more signed and written languages (e.g. ASL and English in the US), others have much stronger fluency in their signed language (e.g. ASL), and others have not received sufficient access to language to achieve full fluency but have greater comfort and comprehension in their signed language. Thus, it is not appropriate to assume that all Deaf users are served well by text-centric resources, which has particularly critical impacts in educational and health-related contexts [10, 43].

User interface design conventions and established practices have evolved for print and spoken languages, rather than for signed languages, and as a result, the primary user interface features, structures, and technologies available to American Sign Language (ASL) signers in the U.S. are built for and around English text. This creates a number of hurdles such as attempting to develop technologies in ASL or navigate ASL-videos placed into text-based platforms [38]. Challenges to users include uncertainty and confusion in navigation of multiple videos, the need to manually adjust window sizing and placement of videos, and devising a variety of one-off workarounds to address barriers.

Due to the inflexibility of text-based user interface conventions, design practices, features, structures, and technologies, several hurdles must be surmounted in order to create resources in a signed language. Text conventions do not readily align with the requirements of the linguistic and structural elements of a visual language. In particular, when video-based sign language materials need to

be incorporated into an existing text-centric user interface design, it takes great effort for the designer to build them, for the user to learn to navigate them, and the experience on both ends is far more labor intensive and inferior to that of users creating and engaging with text-based user interfaces.

This problem cannot be resolved by simply uploading sign language videos onto an existing platform and allowing users to access and view them, although this has become increasingly easier and more efficient in recent years. First, high quality sign language videos need to be created. This is not a trivial step, as it requires translation of any content to linguistically and culturally appropriate ASL, as well as a full video production process. Previous work has discussed necessary considerations [7, 24, 27, 38]. In addition to the video creation, significant thought needs to be given to the layout and navigation of the website due to the signed language video content [16]. Aspects of the layout that need to be explored include the number and size of videos on a single screen—there is no definitive recommendation for either. Standard practices also have not been studied or established for differentiating between navigational elements of the user interface and the main content, while these are well-established in text-centric interfaces. Established design conventions for SL-based online resources could ensure that deaf users have the same seamless experience of navigating quickly through resources and easily engaging with site content as hearing users do with text-based user interfaces.

In this paper, we introduce the concept of *sign-language centric design of ASL survey tools* to address the significant hurdles that make *SL-centric research* significantly more time consuming and burdensome than *English-centric research* (or other text-based language). Our goal is to inform the design of high-quality SL-centric surveys for research, education and beyond, by exploring challenges and best practices related to the creation of a questionnaire optimized for and in ASL, without reliance on written language. We explore the design, layout and navigation of a survey that includes common question types, such as multiple choice, Likert scale, and multiple-selection, as well as typical elements, such as "next question", "back," etc.

To take steps toward this, this paper reports on a series of formative studies with the ASL signing community to understand the viability, potential benefit, challenges, and user interest in SL-centric surveys. Our goal is to take steps toward a novel approach for creating questionnaires that meet the needs of deaf individuals using signed languages, without obligatory reliance on a written language to complete a questionnaire.

2 RELATED WORK AND BACKGROUND

2.1 ASL Surveys

Due to the challenges outlined above, signed language research tools and resources, specifically questionnaire tools, have traditionally been organized, shared, and viewed through English-centric UI conventions for layout and navigation. Efforts have been made to translate existing standard questionnaires into ASL, including the System Usability Scale (SUS) and Net Promoter Score (NPS) [7] as well as in the health field [22, 36, 37]. These are delivered in the form of recorded videos. Some prior work focused on demonstrating validity of the translated questions [22, 36] and shared videos of the validated translated ASL questions [7]. Various challenges and considerations are discussed [3, 7, 22], and one paper [22] explained that they provided on-site or remote conferencing with a person signing to compensate for challenges with the translation or technology.

Boll, et al. [9] notes that there are key considerations when creating ASL surveys that are not present in text-based surveys. In particular, because a signer is present in all ASL videos, this can make it hard to represent authorship if there are more than one author, or if the signer is not the author of the questionnaire. The signer's proficiency level in the signed language is important to avoid confusion and increase user trust. In addition, representation becomes a factor that may impact survey results. Future work would need to explore how the visible demographics of the signer impact survey responses. Further, the signer's privacy needs consideration, especially if a survey is going to be reused by others or widely disseminated.

The proposed project builds on this prior work, focusing not on translation, or on video production, but on rethinking the entire user interface design of survey tools to enable simplified creation of custom surveys that are easy and intuitive to navigate and meet the needs and expectations of Deaf and Hard of Hearing signers, and that do not rely on another written language or designs that are text-centric [9, 42].

2.2 Unique Requirements for Sign Language-Centric Surveys

We are interested in studying how SL-centric survey guidelines can be established to provide usable signed-language interfaces to deliver, and navigate signed-language survey questions. Looking beyond surveys, most technology designed for deaf individuals contains video-based content integrated with written language (e.g.http://aslized.org/), and there are only a few existing resources are fully SL-Centric (e.g. https://aslclear.org/ [44]). This is due to the many research challenges faced when creating SL-centric user interfaces of any kind [13].

Engagement and utilization of English-based technologies by Deaf users has been studied in a number of contexts, such as social media and communication [2, 39]. However, user interface design for ASL content has not been studied or discussed thoroughly in the literature beyond specific use cases [28, 39]. Huenerfauth [28] discusses the misconception that technology designed for written languages aligns with requirements for American Sign Language, and specific design aspects of signed-language based user interfaces have been studied, such as search functionality [23], and other forms of representating ASL signs, e.g., via an 'ASL character system' [12]. However, more research and development is needed to better understand effective designs and conventions for displaying SL content [11, 13, 29].

Below, we discuss the unique requirements for sign language-centric surveys. A major difference between signed languages and those in spoken or print form is the complex, layered, and visual nature of linguistic expression. Signed languages are often misunderstood to be expressed via movements of the hands and fingers. However, in ASL, and all signed languages of the world, articulation - more aptly, expression - is simultaneously possible on the face,

hands, and body of a signer [5, 32, 45, 52]. Critical grammatical and semantic content is conveyed by nuanced changes in posture and facial grammar, e.g., shifting the body from left to right, or raising eyebrows. Over-focusing on the finger and hand movements of signers quickly renders any conversation completely incomprehensible. Effective design of any technologies in signed languages necessitates the capacity to render all linguistic information via video of well-lit signers with the upper body in frame and with skin-tone contrasting background. ASL-based guidelines and conventions for quality video production to ensure viewabilty and comprehensibility of social media postings, assessments, publications, website content, and other materials have been developed, published, and iteratively updated by educators, researchers, and developers who are members of the Deaf Community [27]. Our team adheres to best practices and guidelines for video production outlined in previous publication, but beyond that, this is not the focus of our work. Instead, we are examining how to design ASL-based surveys that integrate high quality videos. We exclusively utilize filmed videos of human signers in our work at this time, however interfaces incorporating ASL avatars would require the same careful consideration of the design and layout of video materials that is discussed here.

2.3 Community involvement and design-led research

Deaf community involvement and leadership is particularly important in developing technical tools and platforms [13]. Our interdisciplinary team consists of ASL signers and members of the Deaf community, hearing researchers, and students with expertise in user experience and human-computer interaction research, Deaf education and ASL linguistics. We adopt a user-centered iterative design process with frequent co-operative and co-design sessions to ensure that we are building platforms and prototypes that are useful to users.

We also contribute to the understanding of the process of building a sign-language centric user interface through design-led research, and share our experiences of conducting sign-language centric research to develop usable tools by and for the Deaf community. Design-led research [54] focuses on this means of knowledge development through the process of design [6, 18, 26, 47]. This method has been adopted to reflect on design process for specific applications, specific groups, and accessibility [20, 41] We then offer realised design examples, versions and iterations of SL-centric surveys [21].

3 PRELIMINARY FORMATIVE STUDY: INTERVIEWS

3.1 Preliminary Demographic Survey

3.1.1 Development Process. Aiming to conduct *ASL-centric research*, focused on the ASL-signers, we set out to create a demographic survey in ASL, instead of relying on a text-based English survey. Our goal was to deliver all questions and response options in ASL videos through a standard questionnaire platform (e.g. Qualtrics) that supports video. This process required significant time and effort, far beyond what is needed to create demographic questionnaires in English. After deciding on the questions and content of a survey, creating and finalizing generally takes less than 30 minutes in English while creating and finalizing our ASL-only survey took well over a month.

Our first task was to come to a consensus on the specific background information we thought appropriate and relevant to gather from Deaf ASL-signing study participants. We began by considering questions asked in standard surveys (e.g. What is your age? Occupation? etc.), as well as data most likely to be culturally and linguistically relevant for ASL-centric design. Early and lifelong language experiences impact one's language fluency, beliefs, and ideologies [35]. In ideal circumstances, most people effortlessly acquire a first language, but the picture is very different for deaf people. Language experiences of deaf children and adults are highly variable due to a variety of educational, systemic, medical and social structures, and many deaf individuals do not see or learn a signed language until they enter school, well into adulthood, or in some cases, not at all. As this is a study of user interface design in two specific languages, we wanted to explore the extent to which participants' first encounters and preK-12 educational experiences with ASL and English would impact their comfort level and perspectives on ASL-centric and English-centric design.

Using a scale from 1-7 (1 = not comfortable at all, 7 = extremely comfortable), the questionnaire asked participants to self-report their comfort levels with receptive and expressive sign language as well as English literacy (reading and writing). Participants were also asked whether their parents were Deaf or not (a fairly reliable proxy for a child having ASL input from birth vs. later in life), the types of schools they attended, whether their education was in sign/ASL, and whether they had formal classes in ASL and Deaf Culture.

After agreeing on the list of questions, our team's ASL-signing researchers further refined the questions to align with cultural and linguistic expectations, and then scripted them in ASL. Critical considerations included thoughtful sequencing and framing (e.g., focus on individual/person identity rather than asking questions from a more 'clinical' standpoint).

From there, a significant process of video production began in order to film the questions in ASL. Video production for signed language content is discussed in other publications [24], so we offer a very abbreviated description here. General best practices for creating effective videos in ASL include landscape framing, eye contact, proper lighting, plain background, solid clothing, and appropriate camera settings [4]. Additional, non-technical factors necessary for creating successful videos in ASL include "fluency in sign language and native knowledge of the local sign language [and] knowledge of the deaf culture and the deaf community" [51]. Members of our ASL-signing team bring considerable experience with creating ASL content in video format for academic purposes, which gave us an excellent starting place. However, due to the need to stay current on complicated and continually evolving video production technology, production continues to be a labor intensive process. Standards for ASL materials, ASL signer fluency, video quality, etc, followed previously established guidelines and best practices [24]. Video production required a multi-step process to create a home studio due to the COVID19 pandemic.

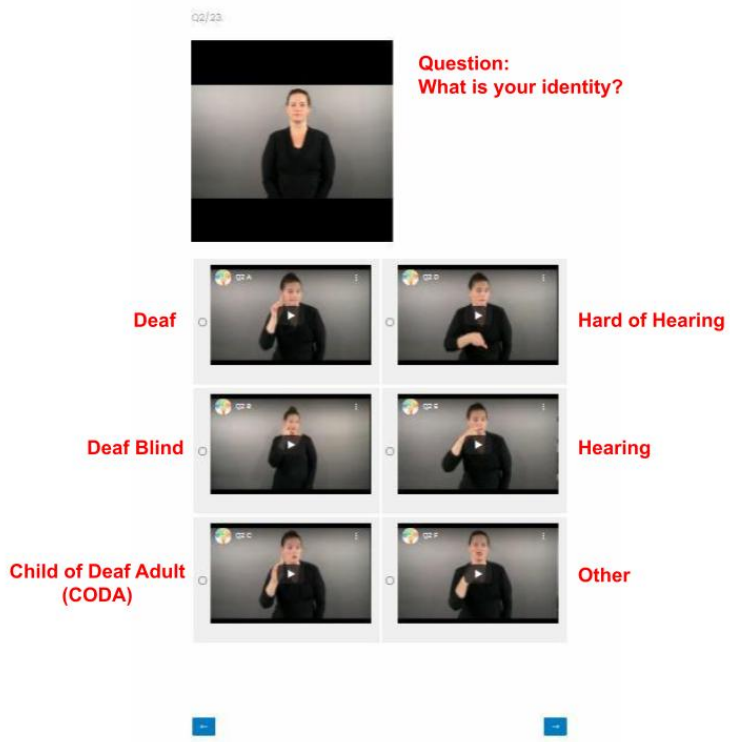


Figure 1: Preliminary Demographic Survey Question Example

3.1.2 Questionnaire Design and Platform. Our aim in this stage was to create a sample questionnaire with an existing tool to explore if any challenges and limitations exist with typical question layouts. The team reviewed potential survey platforms to determine which would both serve our research needs (e.g. collect and analyze data), and deliver questions and answer choices via ASL videos, ideally in a user-friendly manner. We found that it is not currently possible to create a questionnaire in ASL using Google forms, as videos can be uploaded only in the question position, but not as answer choices; by design, all answer choices must be text-based. Qualtrics offers the option of embedding YouTube videos in both the questions and answer choices, without requiring any accompanying English text. However, additional steps were needed to ensure that YouTube recommendation videos did not automatically appear after a question or answer choice video. Qualtrics also offered many powerful features related to data collection and analysis, as well as an established structure for various types of research questions. The survey design was fairly straightforward and simple, using existing templates offered by Qualtrics, and using HTML to resize and format the videos. However, the interaction, layout and ordering of question and answer videos had to be retrofitted, rather than using the standard English question/answer formats available in Qualtrics. In the final design, video questions played automatically on load and then looped, and answer choices played only when clicked. In some questions, the answer choice order was not important, but for questions with sequential answer choices (e.g. age), video tiles of answers were either arranged from left to right in one or more rows, or from top to bottom in one or more columns. Figure 1 shows an example. Ultimately, an ASL demographic survey with 23 multiple choice questions was administered through Qualtrics.

3.2 Semi-Structured Interview Study Design

As this was an exploratory study, a semi-structured interview format was chosen to allow participants to respond more freely, enabling researchers to learn more about beliefs, experiences, and perspectives on ASL-centric and English-centric UIs. Interviews were conducted over Zoom by ASL-signing researchers with ASL-signing participants. One researcher led the interview and a second researcher assisted with technology logistics and occasionally asked additional or follow up questions. Each interview took 1.5-2 hours. All interviews were video recorded using the Zoom recording feature. To create a transcript of the interview for non-signing members of the research team, a live ASL interpreter was also present in the Zoom session.

Prior to the interview, participants completed the demographic survey described in Section 3.1. Interviews began by asking participants to recall an experience using an ASL-centric website, and discuss aspects of it, if they could recall one. Next, participants were asked to select a different web resource designed for an ASL-signing Deaf audience (e.g. website for an organization that serves the Deaf Community) and spend a short time interacting with the resource. The resource selected served as a second technology probe [30], along with the demographic survey, to better understand user perspectives on resource designs that ranged from more ASL-centric

to more English-centric. As participants viewed and navigated each UI, interviewers explored their perceptions and beliefs about the advantages and drawbacks of ASL and English UI designs.

3.3 Participants

Five Deaf participants were interviewed in this preliminary study, who were recruited through social media, email and text messages to a large network of contacts that includes a diverse array of the Deaf community. Due to the audio-centric design of video conference recording, one video only showed the researcher, not the participant, leading to video data loss. The data analyzed by the team therefore comprised of 4 videos, all but one interview participant, and interpreted transcripts of all 5 interviews.

Table 1 provides details on their age, identity, race/ethnicity, and parents' identity (Deaf or hearing). As shown in Table 2, participants experienced a variety of educational placements, and availability of ASL and/or Deaf Culture classes in their K-12 years. Four out of five participants (P102, P103, P104, P105) reported that teachers used ASL videos in their classes for a variety of purposes, including assignment instructions, introducing new vocabulary, storytelling, and movies. Three participants stated that they were introduced to ASL linguistics and ASL literature in their Elementary/Middle/High school years, one participant was not (P106), and one chose not to answer.

Table 3 provides details on participant responses regarding comfort levels with receptive and expressive ASL as well as English reading and writing. It is important to note that a self-report on one's own language capabilities is a subjective measurement. Additionally, it is worth noting that all of our participants first encountered ASL between 0 - 9 years of age, and reported very high comfort levels with both ASL and English. This, along with the fact that all participants have advanced degrees (Masters or higher), must be considered in interpreting our preliminary study results. This group represents a very specific subset of the larger Deaf community, where there is typically far greater variation in early language input, education and comfort levels with both languages. However, the data collected from this group allows us to gain initial insights from this population, and areas that need further attention.

3.4 Data Analysis

We analyzed the demographic survey and the source text videos from the Zoom interviews. The written English transcripts were created from an interpretation of the videos by a skilled interpreter, and further reviewed and revised for accuracy by the ASL-signing members of the research team.

Inductive thematic analysis was used to analyze our interview data with the grounded theory framework. This data-driven approach allowed identification of unexpected themes in the data, rather than solely investigating themes that were fundamentally modeled on our own prior theories or preconceptions [14].

The data was analysed in the following high level phases: 1) *Data familiarization*: team members reviewed the interview videos and read through the transcripts 2) *Coding*: The coders identified and agreed upon initial codes, such as ASL UI Needs: Colors/Visual Cues, ASL UI Needs: Buffering Speed, ASL Video: Content/Length of Video, ASL Video: Speed/Scanning, ASL Video: Playback Preferences and, through discussion, decided on final themes discussed below below.

Eight coders analyzed five interview transcripts. The four coders who were ASL signers analysed both the interview video recordings and the transcripts. The four coders who were not ASL signers analysed only the transcripts, i.e., an interpretation of the interview. We found that viewing participants' ASL responses, expressions, pauses, and other cues that were not reflected in the English transcript were critical to a complete accurate analysis of interview responses. Using both source and interpreted text prevented loss of data due to gaps in language translation and coding of important data such as pauses and moments of confusion. Despite the meticulous translation process by a well-qualified interpreter and additional review of each transcript by the ASL-signing members of the team, the source video revealed a more complete picture, more accurate quotes from participants, and far more nuanced data. Analysing information in both forms helped the team contextualize findings.

Each coder reviewed interview transcripts and/or video recordings and constructed codes that were as descriptive of the participant's experiences and comments as possible. After this, coders met to create a unified code list. Using the new list, coders underwent a second round of coding. Then, themes and sub themes were identified that cut across the responses throughout the interview as defined by Braun and Clarke [14].

3.5 Results

From the process described in Section 3.4, several different main themes were identified, as discussed below.

3.5.1 ASL Content in English-Centric Tools Create Usability Issues. We found that English-centric formats are not aligned with the very different designs and tools required for building surveys in ASL. One cannot simply insert an ASL video into an text-based platform and create an effective, user-friendly survey—significant redesign is required to ensure that ASL-signers are able to engage and respond to questions easily and efficiently. Even a simple multiple choice question, such as 'What is your age (range)?' was difficult for pilot participants to navigate and answer due to layout and video play issues. Because video tiles are much larger than a line of text, and because the Qualtrics layout was print-based, (e.g. downward rows and left- to-right columns), viewing response options often required scrolling through several screens. Moreover, since the survey included a number of high resolution videos, loading time was considerable, adding to the total time required and increasing participant frustration. Participants also mentioned that having a timer or progress bar would be useful in determining how many questions had been answered and how many remained. In addition, even after identifying the correct answer, participants still felt the need to watch all videos, at times more than once, in order to be certain, adding to the length of time they spent on the survey. Lastly, the survey design appeared very different on different sized screens, triggering issues such as user inability to view some videos, and the need to manually resize videos and browser screens.

Participant	Current Age	Race/Ethnicity	Deaf at age	Parents' Identity
P102	25-29	Hispanic	Birth	Both Hearing
P103	35-39	White	Birth	Both Deaf
P104	25-29	Black/African American	5-10	Both Hearing
P105	35-39	White	Birth	Both Hearing
P106	50-54	White	Birth	Both Deaf

Table 1: Semi-Structured Interview Study Design: Participant Demographics

Participant	Age of First ASL Encounter	Medium of First ASL Encounter	Type of School	Deaf Culture or Deaf Studies Classes in school	Courses taught in ASL in College
P102	5-9	Other family	Mainstream School with Deaf program Deaf School signing program,	Yes, High School	Yes
P103	0-4	Parents	Mainstream School with Deaf program	None	No
P104	5-9	Class: K-12	Deaf School signing program Deaf School signing program, Deaf Day School Signing,	Yes, High School	Yes
P105	0-4	Parents	Mainstream School with Deaf program	Yes, Elementary School	No
P106	0-4	Parents	Mainstream School with Deaf program	None	No

Table 2: Semi-Structured Interview Study Design: Participant Educational Background

Participant	*Receptive Sign Language*	*Expressive Sign Language*	*Reading English*	*Writing in English*
P102	7	5	7	7
P103	7	7	7	7
P104	6	5	7	7
P105	7	7	7	6
P106	7	7	7	7

Table 3: Semi-Structured Interview Study Design: Language Comfort Levels: From 1 (not comfortable at all) to 7 (extremely comfortable)

3.5.2 ASL-Centric User Interfaces Are Important. Despite the challenges noted in navigating a survey in ASL, participants consistently commented on the need for online resources designed primarily for Deaf users to be more ASL-centric, and held the perception that current resources for Deaf people are generally more English-centric. Referring to the ASL-centric demographic survey, P102 noted this was a first experience: "Wow taking the survey in ASL really made a difference. It took a while to figure out because I'm so used to doing everything [UI functions] in English. I had to take some time and really look through it, to figure it [layout and where to start] out and then I had to watch the [ASL videos]. It was a very different experience [than taking a survey in English]." P102 also noted "…how much information is available [in ASL]? So if you're someone from a Deaf family, or your English isn't as strong...In that situation, who has access to more information? People who are skilled in English."

Four participants highlighted that websites and resources made specifically for the Deaf community should be better tailored and customized for their audience. For example, referring to a well known university's website, P101 said "All of it is in English, and it's overwhelming, a lot of the English is complex, and it can be confusing. There are lists of information like the names of departments (on campus), but there's nothing visual about it."

When information is presented in ASL, participants consistently reported greater understanding, clarity and impact, and less ambiguity or uncertainty about the material. When asked about how a given language influences understanding of and access to information, referring to the ASL-only demographic survey P103 said "I understood the questions, and it gave me confidence in answering. Sometimes if it's an English, I'm not always sure. Whereas with ASL based multiple choice options, I felt very confident and clear with my answers because ASL is my first language."

3.5.3 ASL-Centric User Interfaces Are Uncommon. Early in the interview, participants were asked to give an example of ASL-based

UIs. Several participants paused for a considerable time and appeared at a loss to name a resource or recall a previous experience with such a user interface. When asked about ASL-centric online resources, and how such resources might distinguish between navigation, search and content features, participants seemed to struggle with the question, or imagine current web-based options that offered such features. For example, P104 stated "(long pause) That's a hard question. ASL? pure ASL? I'm thinking of a few resources.... No, no, I can't think of one." P103 mentioned a couple, but they still require the English-centric website, Facebook: "There are two [resources] that I can think of that are in ASL, [created by] Dack Virnig and Ian Sanborn. Both of their resources are on Facebook and their videos have no captioning or English." P105 responded that "Most ASL websites include some English. If [you mean one] only in ASL, I can't think of one". Similarly, P106 stated, "Hmmm… [a web resource] completely in ASL. That's rare." Four replied they didn't know any such resources that fully meet the criteria. Many participants also at various points discussed the novelty of taking an ASL-only demographic survey as they completed it.

3.5.4 ASL-Centric Survey User Interfaces Have Unique Design Considerations. Layout of an ASL-centric user interface must facilitate engagement with a visual language, and therefore, by necessity, will be very different from print-based layouts. For example, ASL-centric surveys generally will contain multiple videos which may compete for a user's attention if not placed thoughtfully on the page. During the interviews, specifications for layout emerged, including the importance of having a clear purpose for each element, preference for clean and simple page designs, limits on the number of videos per page or screen, thumbnail and icon sizing, video length, and speed controls.

Layout design for multiple ASL videos: When taking the demographic survey in ASL, three participants described how they initially approached the survey from an English framework, scanning from left to right, and when they didn't always get the expected result, wondered if the conventions might be different in ASL. P102 said, "It took a while to figure out [the survey] because I'm so used to doing everything in English." P104 stated, "For some reason, I expected it to go down but when I saw the answers it didn't make sense. So I needed to know which direction to go—and that was a little confusing." P105 stated, "It would be nice to have a scroll arrow. For some reason going down is annoying and going left and right is a better experience, so being able to scroll to the left or right would be nice. And I want the arrow to stay in the center of my screen." Three participants also noted asking themselves if they had to watch every video. P104 explained, "It's important that there's something to let me know what the point of this is. I have to click every video to see what's behind it, I prefer to have a little bit of guidance...so that [my experience] is smooth and it flows. With your survey, I felt like I had to click around [the page] and on it over and over again."

Number of videos on the screen: Preferences for the number of videos on one screen differed among the participants. Answers varied from 3 to 12, with some participants recognizing that it depends on the size of the screen. Ideally, users prefer choices and flexibility. P104 proposed, "I think you should organize videos one by one or provide options. Would you like to see three or six or nine? For me, nine is overwhelming. I think I would prefer to see one at a time. If I had that option, I would pick one or maybe three. It would be easier for me to digest. But if you're asking me for my preference, then I would say less, less is better." P106 suggested, "I think five to ten videos per page works. And this page has 17. I had to scroll four times to get to the bottom of the page, and then if I wanted to see something back at the top, I had to scroll back up. I know that it depends on the shape of the screen I have, and whether the orientation is wide or narrow. And then there's mobile, where the design is completely different." Additionally, P105 stated, "The spacing between videos was an issue. Sometimes there was only one video on the page, and I had to scroll. I prefer to be able to see all of the videos on one screen. You know, rather than – I wasn't sure whether to look down, to the left, or right."

Video Size: Participants also mentioned that video size is vital to understanding and viewing the content, with individual differences in the preferences.

Video length: Participants generally preferred shorter videos over longer ones. P103 also said, "it would be helpful to know how long the video is."

Video Speed Controls: Participants recognize that users might have different language abilities and allowing them to set their own pace is important. P102 notes "I think the [choice of] speed is based on that person's confidence and ability." Other factors were the viewer's time constraints versus the viewer's goal: P102 stated, "If...I'm pressed for time, I might increase [the speed] to 1.5, for example. If you're curious to know how people explain something or you're learning ASL you might slow it down a bit." P102 noted that opting to increase or decrease video speed had linguistic impacts: "But when you increase the speed, you don't necessarily catch everything about their facial expressions and their body language."

Video Clarity: Video lighting and quality should be clear and uniform unless it is different for a specific purpose. Variations due to video production issues may be seen as a deliberate UI design choice intended to guide users, highlighted by P105's observation, "sometimes the lighting is bright, sometimes it's dark. I wonder if there's any reason for that." Deaf users often pick up on subtle visual differences, and may then wonder if they are meaningful, or part of a pattern.

Efficiency and Scanning: All five participants felt that the survey took too long to complete and that skimming or scanning content was much easier and quicker in English than in ASL. P102 stated, "I want the opportunity to skim because we are very used to having the information presented quickly and if it's not there we get impatient. P106 said, "[when scanning information] I would probably stay with English. For example [scanning] a signed video might take two minutes, while a transcript I could skim in 10-15 seconds." These preferences may shift for users with different levels of bilingualism and/or fluency with English print.

Navigation: P102 and P104 observed that navigating an ASL-centric interface felt unfamiliar and challenging, and noted the importance of well-designed instructions and support to assist users in getting acclimated. P102 suggested additional visual cues that could help them navigate more easily.

3.6 Summary and Takeaways for ASL-Centric Surveys

ASL surveys are an example, or a specific case of SL-centric UIs. Through this preliminary exploration we found that participants thought SL-centric user interfaces for resources are necessary and important. However, there is a lack of such resources in general and significant challenges in expanding the number of them as enumerated above. This makes the case for studying SL-centric surveys even stronger, and signifies that much more research is needed. The interviews highlighted that building such resources requires studying new user interface paradigms and best practices, since SL-centric surveys have unique considerations. The interviews also uncovered some initial findings about survey design, based on the demographic survey that the participants completed. However, there were many areas that we found needed further exploration. The participants had completed the preliminary demographic survey on their own, followed by the interview. As we moved toward redesign of the survey components, we wanted to go a bit deeper to understand what aspects caused confusion and frustration and which were accepted, and eventually arrive at best practices for the design of various survey question types.

4 THINK-ALOUD USER STUDY

From our preliminary study, it was clear that SL-centric surveys need to be explored further. Our next step was to refine the survey design based on the preliminary study, and then explore user experience challenges in the updated demographic survey prototype through a think-aloud user study.

In a think-aloud study, participants are asked to complete a task while simultaneously explaining their thought processes, their actions, and choices. The goal is for researchers to understand why users behave in certain ways in order to identify usability issues, get user feedback on specific components, and inform future designs. [19, 31, 50].

Think-aloud studies are considered especially helpful and beneficial for specific applications, and user interfaces such as for accessibility [8, 15, 48, 49]. However, the standard think-aloud practices needed to be adopted to better suit Deaf participants. Sharing thoughts and comments in ASL requires that Deaf users stop interacting with the interface temporarily, as their hands cannot be engaged in both commenting in sign, and navigating the survey simultaneously. Knowing this in advance, we modified the standard protocol, asking participants to interact with the user interface for brief periods, then pause and comment on 'what you did, why you did it, what your next step is going to be and why.' This allowed participants to reflect on the events immediately and express their opinions, as well as share their planned next steps.

4.1 Questionnaire Design and Development for Think-Aloud Study

This survey was designed to explore the specifics of the layout issues and designs raised in the formative study (Section 3.5). The goal here was not to build a full demographic questionnaire. Instead, we wanted a subset of real-world questions that covered several standard question types included in most survey tools (e.g. multiple choice, multi-select, matrix, etc.) so that we could begin to understand challenges and considerations related to each question type. We also did not want to overwhelm the participants with an extended survey, and so the think-aloud approach allowed us to efficiently explore many possibilities and identify those with the most promise. We chose to include an assortment of design options across the question types, giving us an opportunity to learn the participants' thoughts and reactions related to each design choice (e.g. icons, color, etc.). It was not feasible or necessary to create the same question with every design option, since the goal was not to do direct formal comparisons in this formative stage as might be done in a later summative evaluation.

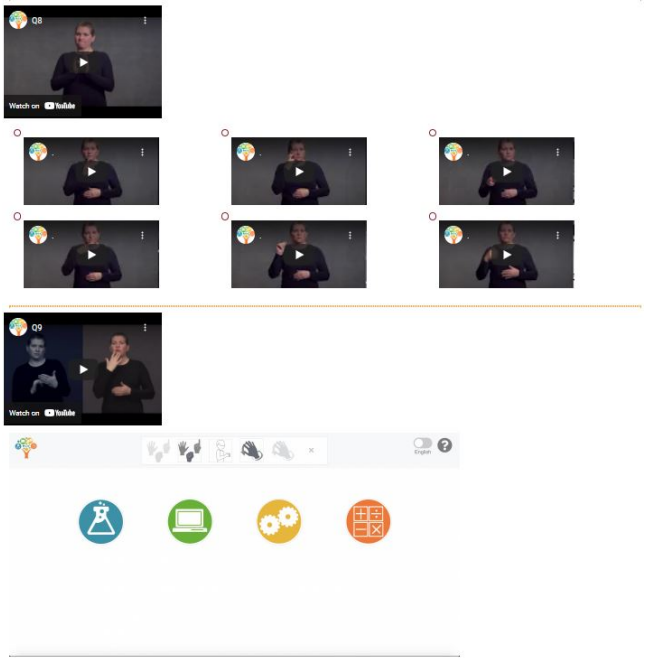
We used an iterative procedure to develop this questionnaire. The first step was question selection. We selected basic demographic questions. We carefully paired the question types we wanted to evaluate with the question. Refer to Table 4 for the complete list of questions and types. The aim was to make a sample questionnaire with an existing tool to be able to assess the capabilities and features available in the tool to build an ideal ASL-centric survey.

Like the previous demographic survey (Section 3.1), this survey was also designed and created using Qualtrics. We made decisions on video size, and question layout based on expert feedback from within our team and testing the survey on different desktop sizes and models.

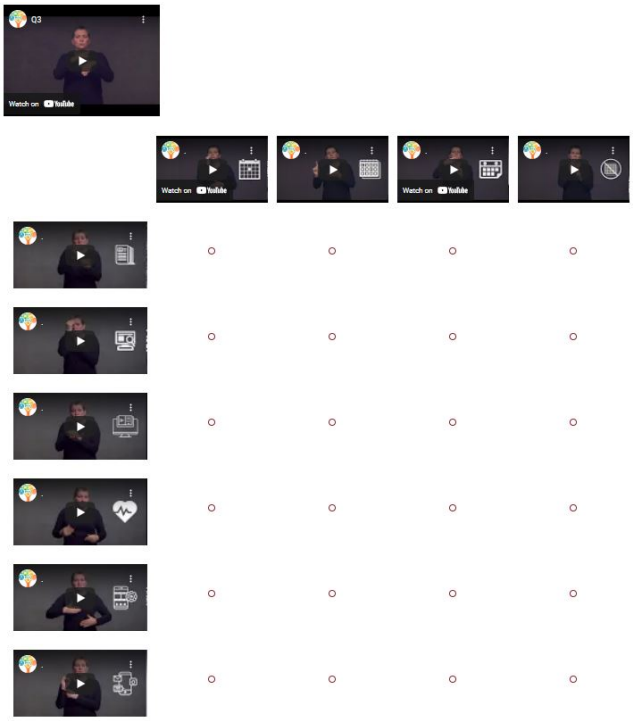
To address some of the feedback from the interviews recommending more navigation guidance and design for scanability, this questionnaire included more visual features than the demographic survey used in Section 3.1. Icons have been shown to improve English-based user interfaces, for example, by reducing errors [33]. Icons have also been used in ASL-centric user interfaces [25, 44], but have not been studied for their effectiveness. We wanted to investigate whether icons and/or freeze frames (a snapshot of an ASL sign that makes it possible for a user to identify the sign) might be used to denote the contents of the video, and reduce or eliminate the need for participants to rewatch entire video clips. Examples of the icons can be seen in Figure 2b. These elements can be time consuming to add to individual videos, but if shown to enhance user experience, more time and resources could be directed to creating tools that allow users to add them more quickly and easily. In this prototype, icons were included only in Q3 (Table 4), and freeze frames were added to select videos, with image displayed when a video was not playing. In Q3, Q4 and Q5 in the question video, after the signer was done signing the question, the image turned back and white and a still of the video was moved to the side. A freeze frame image was selected that represented a sign, to examine whether participants could then anticipate what the sign would be, or if they used that information in a meaningful way. We wanted to test if this feature helped users distinguish between questions such as the question "How comfortable are you with ASL?" and the instruction "Choose your level on a scale of 1 to 7". We implemented this feature in Q5 and Q6.

4.2 Think-Aloud Study Design

Think-alouds were conducted in ASL, virtually over Zoom. The survey started with an introductory video describing the think-aloud protocol, and a demo of a think aloud in progress, which was viewed by each participant. Once again, the think-aloud protocol



(a) (Q7) Multiple Choice Question Type (above) and (Q8) Hotspot Question Type (below)



(b) (Q2) Matrix Question Type with icon

Figure 2: Questionnaire Designed for Think-Aloud: Example Screenshots

was modified to align with the language of Deaf users, and the participants were asked to share their thinking and comments in ASL just after or before each action as they took the survey. Participants were asked to comment on the structure, layout, and their experience of taking the survey instead of focusing on answering the questions. Once the think-aloud concluded, a brief demographic survey was given to the participants in English, which was not part of the think-aloud study.

4.3 Participant Demographics

We conducted think-alouds with seven participants, who did not participate in the earlier interview study. They were again recruited through social media, email and text messages to a large network, including a diverse array of the Deaf community. Table 5 provides details and Table 6 provides details on participant responses regarding comfort levels with receptive and expressive ASL as well as English reading and writing. Again, all participants reported very high comfort levels with both ASL and English.

4.4 Data Analysis

Similar to the data transcription process followed in Section 3.4, interpreters voiced over the think-alouds in English. We then used auto transcription for developing written English transcripts. To analyze the think-aloud results, we created usability aspect reports (UARs) that captured positive and negative events that occurred during the session. We then consolidated these UARs into categories.

4.5 Results

4.5.1 Video Size, Quantity, Quality and Control are Important. P202 and P203 played many of the videos in full screen and commented that the videos should be larger. They attempted to watch some of them at the default size, but stated multiple times that they were too small to see. This highlights the importance of considering larger video default video sizes for some users, or providing options for setting preferred video sizes before beginning a survey. P203 adjusted the quality of the video during Q1, stating that it looked pixelated and of low quality. They did not like that they had to click play to start each video and suggested that a gif may be a better option. One participant also commented that they would want to adjust the video speed depending on the context of a video, especially for more complex topics, confirming that speed control options are valued by users.

In addition, when numerous videos are required, it can cause challenges or long wait times when loading questions. The longest loading time was for the matrix questions. In addition, the participants had to adjust their browser windows often, to full screen and maximally zoomed out, in order to to view all the videos. These questions took up the most screen space and did not work well on smaller screens. Sometimes, on a small screen, Qualtrics would reformat the matrix to a vertical format. While that may work well with text, it was very problematic for participants viewing video questions and answers.

Q No	Question Type	Question	Answer Options
1		Introductory video	
2	Matrix	For each item specify how frequently you use them in ASL (Current Events/News, Research Information, Education/Learning, Health and Wellness, Entertainment, Social Media)	-Rarely -Once a Month -Once a Week -Not Applicable
3	Matrix	The above question was repeated for English	
4	Multiple Selection	Select all of the resources for which you would like to see more availability in ASL	-Current Events/News -Research Information -Education/Learning -Health and Wellness -Entertainment -Social Media
5	Likert Scale	When thinking of an ASL-based Use Interface, how important is it to be able to adjust the speed of the video? ASL-based User Interfaces refers to electronic media that is primarily in ASL, rather than written English for example	-Extremely Important -Extremely Unimportant
6	Likert Scale	How comfortable are you with ASL?	-Extremely Comfortable -Not Comfortable
7	Short Answer Type Question	What is your current age? Please type in a number	
8	Multiple Choice Question	Which of the following best indicates how you identify yourself?	-Deaf -DeafBlind -Hard of Hearing -Hearing -Child of Deaf Adult -Other
9	Hotspot	What do you like or dislike about the following webpage? Click once on the area if you like it, click twice if you do not like it.	*Screenshot of ASL-centric website*

Table 4: Details of the questionnaire used in the think-aloud user study

Participant	Deaf at Age	Age of First ASL Encounter	Medium of First ASL Encounter	Race/Ethnicity
P201	Born	15	Parents	White
P202	Born	5	Class: K-12	Black/African American
P203	Born	0	Other family	White
P204	5-10	38	Class: K-12	Latino
P205	Born	22	Other	Black/African American
P206	Born	0	Parents	White
P207	1-4	5	Class: K-12	Black/African American

Table 5: Think-Aloud: Participant Demographics

Participant	*Receptive Sign Language*	*Expressive Sign Language*	*Reading English*	*Writing in English*
P201	7	7	7	7
P202	7	7	6	5
P203	7	7	7	7
P204	6	7	6	6
P205	7	7	7	7
P206	7	7	5	5
P207	7	6	6	4

Table 6: Think-Aloud: Language Comfort Levels: From 1 (not comfortable at all) to 7 (extremely comfortable)

Since our Qualtrics survey made use of YouTube to upload videos, all of the standard YouTube features were included such as increasing size to full screen, adjusting speed and quality. These built-in features are useful, but there are also some challenges with using an existing platform. The large play button was at the center of the video which blocked the signer, as well as the carefully selected freeze frame that we selected to represent the video when it was not being played. YouTube also includes the title of the video at the top of the video, introducing English which we tried to avoid. (We worked around this by naming each video with the "." character only, to make the video title less noticeable in the survey. This also created challenges when organizing videos that all share the same uninformative name). P203 stated that YouTube was not ideal for this survey, but did appreciate that with YouTube the speed of the video can be adjusted.

4.5.2 It takes a long time to go through all of the videos for each question. P201 commented that it took a long time to go through the survey since they had to watch every video. They wanted to make sure they were not missing any information but were unsure if others would take the time to go through every video. P202 said the survey was too long and was overwhelming. While written text can skimmed, videos cannot, which makes the survey take longer since each video must be watched in entirety. In addition, participants need to remember the content of each video to make a selection, or they have to watch the videos again. To address this, it would be helpful to incorporate better icons to represent the content and combine videos where possible.

4.5.3 Instructions and guidance are necessary with novel survey question design. With ASL versions of survey questions, it became clear that more guidance and instructions are needed due to the unfamiliarity of the format. The multiple choice, multiple selection and short answer questions were understandable without instructions. However, the matrix, Likert scale and hotspot questions need further attention.

The matrix question type caused the most confusion, and appears overwhelming as there are a lot more videos than in the other questions, and it takes up a lot of screen space. There are numerous videos to watch and it is not immediately clear how they correlate with each other. Participants did not always know what to do next after they watched they matrix question video. They did not know which video to watch next since there were several videos arranged below the question video in rows and columns. The radio buttons weren't recognized by some participants at first, since the videos were quite far away from the buttons, unlike in the case of English-based interfaces, where the text is right next to the buttons. P203 was confused by the matrix and was not sure how to answer it. They felt lost and did not understand the question until after watching all of the videos in the matrix, but due to this had to then rewatch them. P205 and P207 were also confused by the matrix and did not understand how to answer it. P207 eventually figured out how to answer the question once watching all the answer choice videos.

This demonstrated that simply adding videos to a text-centric design for matrix questions is not going to be acceptable. It is important to limit the number of videos included in the answer choices of the matrix. It would also be helpful to make the top row "sticky" so that it can always be seen when users are looking at the vertical column so they can better match their answers.

A similar issue was raised in the Likert scale questions. We intentionally had only two videos depicting the extremities on the continuous scale. However, participants were thought that the videos in the middle were missing. P204 was initially confused on how to approach the Likert scale question. They also commented that they felt the video was incomplete or cut off, which further confused them. P205 was not clear on the instructions provided to answer this question. From the sessions, it is clear that the ends of the scale need to be clearly labeled or each option choice should have its own label. This can be explored further in future work.

Another area of concern was the hotspot question, Q8. (Refer Fig 2a). P201 did not understand the question and did not attempt to answer. P202 did not realize they could click on the image and had to be prompted by the interviewer. They also did not understand the question. P205 was confused as to the point of the question and did not know what the resource was in the screenshot for the hotspot. P204 and P206 did not realize there were multiple areas to click on in the hotspot. P203 only thought the icons were clickable, but not other areas of the image. P207 did not understand how to answer Q9. They had to rewatch the question video but were still confused. This type of question is not common, even in text-based surveys, so it was not surprising that there was confusion. However, since this type of question can be particularly useful for user interface surveys, it is recommended that any questions of this type also has clear instructions and explanation of what type of feedback is being requested.

4.5.4 The background and signer can affect the clarity of the videos and information being conveyed. P202 noticed that the background in the videos of the signer changed from tan to brown, which confused them. It is recommended to choose a background that is not distracting and make sure the signer can be clearly seen at all times.

4.5.5 Not everyone has the same vocabulary of signs and some signs may be regional, which should be taken into consideration when making a survey. Participants commented on the language and signs used, as well as aspects of the signer. On the positive side, P202 said that the signer has very clear ASL and that it was not "Englishy." They said they are a good language model for people who want to learn. They said the signer's emotional tone matched the comments. On the other hand, there were instances where the confusion was related to the sign used. P201 commented that Q2 was vague, that they had to rewatch Q5 video to understand the question, and that Q6 feels as if information is missing from the question and is too vague to answer. In addition, they noted that Q9 was too confusing to understand so they did not answer that question. P202 seemed to misunderstand the survey and did not answer the questions. P202 was also confused on what the questions were asking. P202 asked for clarification of what a sign meant in the Q1 video. They also commented that the sign used for resources was new to them and was a sign they had recently learned as they had originally thought it meant something else. They suggested examples were given to clarify what some of the signs are. In addition, it is important use well-known signs and add in examples or explanations in the videos rather than signing a single word, which could be misunderstood.

4.5.6 Icons and freeze frames can be helpful but need careful design. P203 stated that the icons give a rough idea of what the video will say. However, P209 expressed that the icons were unclear and did not align with the video. Unfortunately, most participants did not notice the carefully selected freeze frames due to the YouTube play button which covers the center of the video, obscuring the signer. However, P206 said that the freeze frame being displayed after the video had played made her feel like the video was incomplete.

5 PROTOTYPING SESSIONS

The results above made it clear that using an English-centric tool is not ideal for delivering SL-centric surveys. Such a use would make the survey inaccessible, time consuming, and clunky. The limitations included fixed templates, platform logos and and overall lack of video related features, such as auto-plays, or hover play. Based on the results from the interviews and think-alouds, our team began iteratively protoyping aspects of a SL-centric survey tool built from the ground up.

We conducted co-designing prototyping sessions as a team [46]. The group consisted of researchers, user experience students, user experience experts and members from the Signing Deaf Community. We conducted brainstorming sessions and co-designed a prototype that would offer solutions to the above stated issues. This phase started with brainstorming and hour long group discussions. As a next step, a team member created a demonstrative, animated video as a high fidelity prototype to show the layout and navigation of four answer videos inside the question video frame. These demo videos were used as a starting point by UX students to create more designs using AdobeXD software. AdobeXD is a design tools which allows users to create low and high fidelity prototypes. The final phase was discussion and feedback from Deaf experts from the team on the prototypes. This feedback was structured in the form of one or two presenters demonstrating their idea, highlighting the main features and allowing everyone to try the design on their own systems. We discussed likes, dislikes and also new ideas in these sessions. The last phase was conducted iteratively.

In this section, we describe the main design features of our prototype. These designs serve as design recommendations for a user-friendly SL-centric survey tool.

5.1 SL-centric survey tool design

We decided to move away from Qualtrics due to it's limited functionality. We present new prototype layouts for the question types described in questionnaire used in the think-alouds (Section 4.1). We propose different layouts for the multiple-choice question and multiple selection questions (Figs. 3a, 3b, and 3c). For the Likert type question we propose two layouts (Fig 3d and Fig 3e).

5.1.1 Interactive videos. As noted in the results of the preliminary formative study interviews in Section 3.5 and think-alouds in Section 4.5, too many individual videos can be overwhelming, messy and take too much time. We propose using interactive videos that allow users to click on the video itself to answer survey questions. The proposed interactive video consists of a main question video that breaks up into smaller clickable video frames within the main video frame (Fig 3a and Fig 3b).

5.1.2 Adding visual cues for navigation. Participants also noted the lack of visual guidance in the previous surveys. Several new features can be to address this concern.

- Progress bars: Fig 3d shows an example of how users will be able to see their current progress and also use that as another way to navigate or skip to a particular question.
- "Next Page" markers: Fig 3d and Fig 3e show page turning icons as visual cues for navigating to the next question. Having one question per page will be ideal to avoid having too many videos on the screen as participants pointed out.
- Auto-playing certain videos: With the matrix type question, there was confusion on what to do next with several participants. We addressed this problem in our design by auto-playing certain videos.

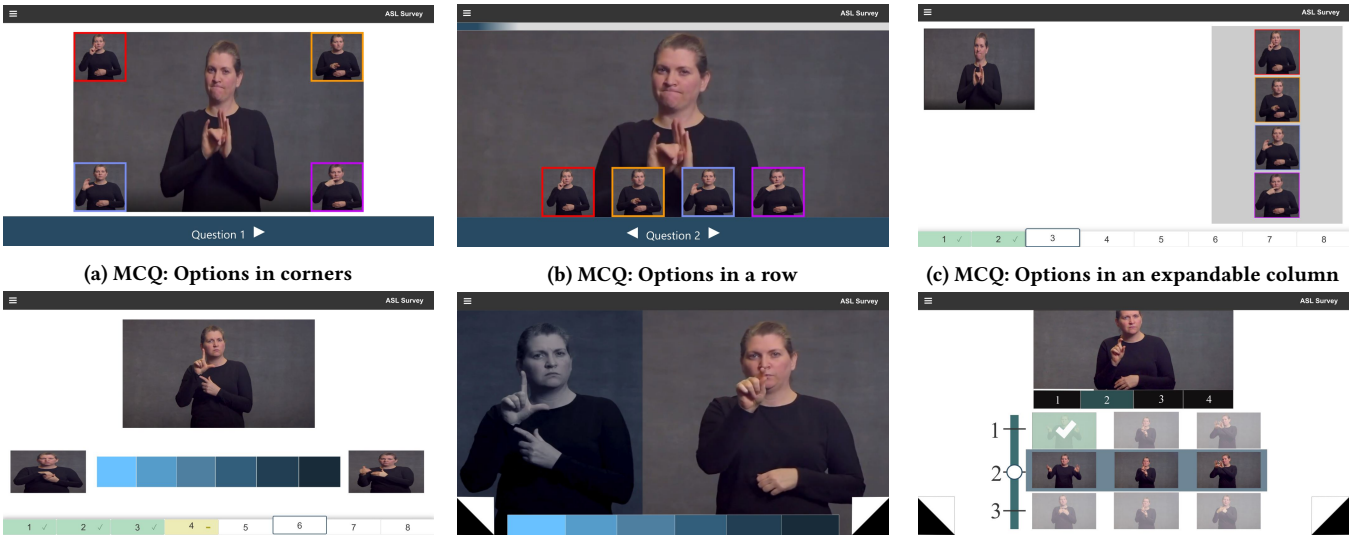
5.1.3 Role of Colors.

- Background: Participants in the think-aloud noticed when the background of the signer changed. We can use signers' background as an additional information source and convey different information with different colors. 3e shows a still of the signer signing the question on the left and the signer giving instructions on how to answer the question on the right. These two have different colored backgrounds.
- Border: A colored border can not only indicate that it is a clickable entity, but also help differentiate between different information.
- Other UI elements: Fig 3d and Fig 3e show the use of gradation of colors to denote increase on a Likert scale. The two videos on the ends in Fig 3d only show the signer signing the extremities, however, in case of a scale on numbers, for example: 1 to 7, the colored scale can be used without any videos. Fig 3c and Fig 3d show progress and navigation bars, in this case we use color to denote the completion of a question.

5.1.4 Freeze frames. When well chosen, the freeze frame of the video, or the cover image of the video, that is displayed when the video is not playing can be utilized to denote the question. This information can help users anticipate the question, and avoid having to replay the whole video again in case the forget what the question is. For example, in Figs. 3a,3b,3c the question is "Which of the following best describes your identity?" and the depicted freeze frame is an image of the sign "identity". This helps the user anticipate what question is going to be.

5.1.5 Icons. In the questionnaire for the think-aloud user study, we used icons in Fig 3d. Participants found this helpful, but also led to some confusion. Icons can be added on the video freeze frames to serve a similar purpose. However, the icon design needs to be detailed and well-structured. It is important to design icons that are well-matched to the signed content and to also utilize commonly used icons for common concepts.

5.1.6 Hover Playing. Participants in the think-aloud mentioned that they had to click a lot of times to get through a question. A simple but effective way for reducing the number of clicks would be by enabling mouse hover play, this will make the UI smoother. In our proposed tool, we use mouse hovering to not only autoplay videos,



(a) MCQ: Options in corners

(b) MCQ: Options in a row

(c) MCQ: Options in an expandable column

(d) Likert Scale, Progress bar Navigation

(e) Page turner Navigation

(f) Matrix Question

Figure 3: Prototype for SL-centric Survey

but also for other navigation. For example, the design in Fig 3c has a separate panel with the option videos. This panel expands when the users hover over it. This design is clean, but auto-zooms and expands for better visibility.

6 DISCUSSION

6.1 Novelty of SL-Centric User Interface Design

Section 3.5.3 shows that most participants had little to no experience with, and therefore understanding of, ASL-centric UIs. This is evident in the responses of participants when asked to name an ASL-centric resource they had heard of or used. Many took a long time to respond and when they did reply, they often referred to mainstream video hosting sites or video organizing tools, e.g., YouTube, vlogs, or a Google/Excel spreadsheet containing links to ASL videos. Guidelines and conventions are not yet available for sign-language (SL) based UI design, nor is there adequate technology for video-based UI design. As a result, there are no solid examples of ASL-centric UIs that organize, structure and label ASL content via ASL widgets and features in an effective, efficient, intuitive and sustainable way. This lack of available ASL-centric examples leaves our study participants and more generally, ASL-signing users, at a loss to even imagine an effective ASL-centric UI. It is also difficult to conceptualize the veracity, design, usefulness, and potential applications of a technology that doesn't yet exist. Therefore it is a stretch to ask Deaf ASL-signers to consider potential advantages, visualize designs, and comment on design standards for ASL UIs.

6.2 Changing Perspectives on SL-Centric Design

When asked about SL UI conventions, the signing community will often refer to and discuss standards for comprehensible and quality ASL videos. While this is one small step in the right direction, offering some benchmarks for the content of an online resource, SL video standards will not shed much light on the topic of UI design standards. We found that when participants are asked about ASL-based UIs, they imagine ASL video content, but not entire pages and user interface elements. Often, they imagine what they've seen to date, e.g. a page containing long videos of content that are not embedded in the types of user-friendly layout, navigation or search elements that facilitate engagement with online content.

However, while engaging in one brief experience with one application with an ASL-centric UI, initial perceptions of participants about the value, applications and usablility of ASL UIs were observably refined and altered. Participants also expressed interest, curiosity and enjoyment navigating and engaging with an ASL-centric application. Engaging with the ASL-centric site also impacted their perceptions and expectations in subsequent interactions with websites geared for deaf ASL-signing audiences, which ranged from fully ASL-centric to fully English-centric.

6.3 Individual Differences in Preferences

Participants who acquire ASL from birth or at a very young age, or acquire English first, may tend to prefer English online resources for learning and referencing. The method and age of language exposure might also be a contributing factor. Even in our small participant pool, we could observe that the participants' background and demographics affected their preference between English and ASL. Despite considerable, in some cases equal, fluency in ASL and English, they mentioned many contexts in which they prefer to interact with resources in their first language (ASL). Responses in some cases related to the age at which participants acquired ASL and the confidence level they had in ASL. Participants also consistently felt that members of the Deaf Community who are not comfortable with English would greatly benefit from ASL-based UI designs and resources.

With the diverse language exposure experiences and preferences, we acknowledge the value in a bilingual or hybrid survey for some users, as well as the useful role of captions and transcripts. Ultimately, we imagine having the ability to select the preferred language. However, with that option, this research ensures that the SL-centric version meets the needs of the individuals that need or prefer that and uncover a set of guidelines for developing good user interfaces.

6.4 SL-Centric Research

Our aim is to build SL-centric tools by carrying out *SL-centric research*. By this, we mean that the study materials and procedure were in ASL to the extent possible. This meant rethinking some common research practices and we discuss below some of these challenges. In particular, this paper focuses on the challenges associated with ASL-centric questionnaires and surveys. We also uncover several adjustments needed for the interviews and thinkaloud user studies. In think-aloud user studies with hearing participants, participants are instructed to talk/speak aloud as they interact with the prototype. We modified this, to fit to signing participants to "Sign all your thoughts". Participants were asked to go through a question or a video, pause and sign their thoughts. Due to the auditory nature of the term "think-aloud" and the action that it implies, we also needed to coin a sign that was linguistically and conceptually accurate for "think-aloud." After several iterations by the deaf and signing members of our team, we landed on signs that would be better translated to English as "THINK COMMENT." This process is indicative of how currently existing research practices have to be modified in order to appropriately fit with members of the Deaf community.

6.5 Qualitative Data Analysis of Signed Language data

Along with rethinking study designs to be ASL-centric, we also encountered challenges with qualitative data analysis of the signed language data. Even though a thorough and meticulous process was followed to translate the interview videos: live voice over, and auto transcription, language translation can cause loss of data and this was especially observed by the team at several instances when the translation of interviews from ASL to English did not entirely capture other social cues, such as pauses, moments of confusion, and other expression changes. Thus, we want to emphasize the importance of carefully considering the original ASL video content, and not relying on transcripts, which can omit important aspects of the data.

For example, when asked if they had seen an ASL-only resource on the internet before, nearly every participant had to stop and think, indicated by long pauses and shifts in body posture, in order to answer the question. In the video, this long hesitation is abundantly clear while in the transcript, the text would indicate that the answer was seamless and prompt. Another example includes when participants would express some level of surprise at an ASL UI, signing what would be interpreted in English as "oh" but that, in ASL using specific sign choices, facial expressions, and body positioning, was really a more extreme level of shock or surprise than the transcript would allow one to recognize.

7 FUTURE WORK

Building on the work presented here, we plan to continue to refine the design of SL-centric survey tools, develop functioning surveys based on the prototypes, and do more in-depth studies. In addition, there are several related areas that will enable this work to have wider adoption.

7.1 Creator Side of Survey tools

Our ultimate goal is to make creating high quality ASL surveys as simple as text-based surveys. Such a tool could enable researchers to upload a video of a signer signing the question and answer options and select from commonly used question types, such as multiple choice, Likert scale, multi-selection, in an optimized manner. Navigation (e.g. “next question”, “back,”) could all be done without reliance on written language. This would mean creating tools where the question and answer videos are uploaded and then the questions are properly formatted based on best practices, in the same way that Qualtrics or Google Forms do this. We would hope to use the same SL-centric principles on the creator side of the survey tool as well to help signing researchers create surveys without relying on English. This will include but is not limited to, SL-centric video upload pages, and data storage and analysis tools in visual formats.

7.2 Open Resources

We envision building repositories of commonly used questions and answer videos that are high quality to further reduce the barriers related to creating new video content. However, this raises privacy concerns for the signers and interpreters in the video itself.

7.3 Automatically Generated ASL Avatars and Dynamic ASL Text

Automatically generated ASL avatars have also been explored [1, 34] and could potentially be used when filmed videos are not readily available. However, careful consideration needs to be made to know when avatars are appropriate as cautioned in the joint statement from the World Association of Sign Language Interpreters and the World Federation of the Deaf [53] and the specialized technologies and skill sets needed are prohibitive for the average user interested in developing signing avatars and other tech enhancements [11]. Dynamic ASL text systems have also been introduced and can be used for word-level searches and representations, but may not be practical for full texts in their current state. In addition, it requires training to understand and utilize dynamic ASL text systems, such as si5s [12] and ASLphabet (http://www.asl-phabet.com), much like it takes years of learning to read in order to comprehend print. One these barriers related to avatars and dynamic ASL text are eliminated and designs improve to the point that singing avatars are comprehensible and preferred by deaf users, these approaches do have the potential to improve the scalability and lower the cost of creating ASL surveys.

8 LIMITATIONS

We recognise that our participant size is small and these participants represent a particular segment of the wider Deaf Community, but

we see this work as being an exploratory technological probe and interview to highlight future directions.

Our team continually works to address the challenges described above by developing and sharing prototypes of ASL-centered design, assessments, and resources with ASL-signers, and in this case, studying a completely novel UI design that provides the experience of navigating an online resource in the the first language of our participants for the very first time. This study is unique in that participants were asked to review and discuss perspectives on a UI design of a type they've never seen or experienced before.

9 CONCLUSION

In this paper, we propose *SL-centric* surveys as a novel tool for SL-signing individuals. This work was inspired in part by our own team's efforts and challenges related to conducting research with and for the Deaf community in the US. We found it difficult to meet our own goal to conduct research fully in American Sign Language (ASL) and remove the potential barrier of requiring English proficiency to participate in our studies.

To conduct the exploratory user study described in this paper, we created a demographic survey in ASL using Qualtrics. Although this took over a month to create, the results still did not meet our standards, expectations and needs. This is in contrast with the process of creating a demographic survey in English, which can often be accomplished in 30 minutes or less using existing tools, such as Google Forms or Qualtrics. A formative study was conducted with the initial prototype, in which we interviewed five Deaf ASL-signing participants in ASL about their user experience with the questionnaire. This resulted in extensive feedback about both the benefits and difficulty of engaging with and responding to the ASL survey, including comments about layout, navigation and interaction challenges, the signers, the platform and more. The novelty and rarity of ASL-centric user interfaces was also uncovered in this study as well, as none of the participants could recall a completely ASL-based user interface (as opposed to a website or app that had some ASL videos, but then used English as well).

With user feedback, we created revised versions of ASL-centric survey questions, and focused on creating prototypes of common question types in English-based surveys (multiple choice, multi-selection, matrix). This took several rounds of prototyping, expert feedback, and video filming and editing. There were several limitations with the existing survey platform, which prevented us from having full control of the layout and structure of the survey. With revised survey questions, we conducted a think-aloud study (adapted to be conducted in ASL) with seven deaf and hard of hearing participants. This resulted in feedback about videos, formatting, interactions, signer considerations, and more. This evaluation also highlighted the limitations of using an English-centric tool to create a survey in a signed-language.

Through the results of both iterative formative user studies, we characterize challenges individuals face with existing survey tools with English-based UIs to build sign-language based surveys. We identify features, opportunities and considerations for a SL-centric UI for an inclusive survey tool. Participants commented repeatedly that the experience of seeing all questions and answers in ASL was affirming, increased their certainty about the intent of the questions, and gave them confidence in their response selections. Our findings also provide initial insight into preliminary designs of other SL user interfaces and inform future studies. We also document our *SL-centric research* approach and challenges where further work is needed.

With this work, we take steps toward flexible SL-centric survey tools for deaf and hard of hearing people who use sign language. Our vision is to enable quick, simple creation of high-quality, SL-centric questionnaires for research, education and beyond.

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