



# User Perceptions and Preferences for Online Surveys in American Sign Language: An Exploratory Study

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## ABSTRACT

In order to gather data from the signing deaf community, efforts have been made to create online surveys in American Sign Language (ASL), despite a lack of user studies and UX/UI design guidelines informing the development of online survey tools featuring ASL. In this paper, we present *SL-Surveys*, an ASL-centric survey tool prototype showcasing a set of potential designs for multiple-choice, scalar, and multi-select questions. *SL-Surveys* was developed in an iterative process expressly for an exploratory think-aloud study investigating user experiences and perceptions of the designs. This preliminary study was conducted with seven deaf ASL-signing participants using a computer. The new design process, prototypes, user study and results make important strides towards a future where designs are not constrained by existing standards and practices based on written languages.

## CCS CONCEPTS

• Human-centered computing → Accessibility design and evaluation methods.

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## 1 INTRODUCTION

Surveys and related tools, such as questionnaires and assessments, are essential for gathering data from individuals and groups. Conducting surveys in the language of a given community is culturally and linguistically appropriate, and important for ensuring full participation [19]. Signed languages (SLs) are the primary language of millions of deaf people worldwide. Providing surveys in American Sign Language (ASL) in the U.S. makes it possible to engage the deaf ASL-signing community ethically, respectfully, and reliably [22, 39]. This is borne out in studies that show increased response rates [48] and increased confidence in responses [41] among deaf participants when surveys are provided in ASL [30].

Developing a text-based survey takes very little time because established conventions, templates, designs, and free or low-cost platforms are readily available to guide and support users through each step of development [15, 35, 47]. However, creating surveys in a visual signed language means that existing platforms must also support designs that facilitate streaming and sharing of video materials online [33]. Simply adding ASL video content to text-based survey tools may initially seem a much less labor-intensive approach than building an application for ASL from scratch. However, researchers, developers, and others have invested significant time, and computer programming skills to retrofit existing text-based survey tools for SLs with unsatisfying, mixed, or unstudied results [41].

Multiple significant usability issues are exposed when attempting to add ASL video content to existing text-based tools, and the resulting difficult-to-navigate designs have been shown to leave survey-takers stymied and frustrated. Participants in one think-aloud study reported that retrofitted surveys are clunky, non-intuitive, confusing, and difficult to navigate, despite significant effort by the developers to appropriately integrate ASL [41]. Barriers included the

misalignment of size and layout for text versus video elements, non-intuitive navigation of video content, and lack of video-based designs, options and features. Prior work described in-depth iterations of designs of ASL surveys using existing survey tools (Qualtrics) and brought awareness to the significant limitations and need for further study and redesign from the ground up. After showing that an ASL survey cannot be effectively delivered through text-centric platforms, Mahajan et al. [41] presented a survey design where all of the ASL-content could be in one video using overlay features to keep the content in one place to avoid excessive clicks, scrolling, and confusing layouts. However, this was a non-interactive video demonstration of the design and they did not test or evaluate the use of such a survey tool with users. More work is needed to generate and study additional design options and to collect data to build understanding of user expectations and preferences. This is particularly important since SL-centric design is novel and therefore unfamiliar, even to ASL signers.

As an initial step toward developing user expectations, standard designs, and guidelines, this paper explores elements including size and placement of videos, amount of content per video, layout, video play, user interactions, and answer selection methods. Our team iteratively designed, developed, and evaluated online elements to determine how well they aligned with and supported ASL video web resources - a process we refer to as *ASL-centric design* [41].

Several designs for standard survey question types are introduced in an interactive ASL-centric prototype expressly and iteratively created to study user experiences as participants responded to three types of survey questions in ASL on a desktop or laptop computer. The prototypes were created through an iterative design process by our team of Deaf, ASL-signing, and hearing non-signing user experience researchers, linguists, and user interface design experts. Three question types and five designs were presented to Deaf ASL-signing participants. Researchers observed user interactions with the five prototype survey question designs in ASL, elicited think-aloud commentary, and conducted semi-structured interviews in order to evaluate preferences and usability related to layout, design, and interactivity. This study was not an exhaustive comparison of all possible options—rather it was an initial exploration of a set of interface designs aligned with ASL video content to see what patterns emerged from user interactions with the interface. This was intended to be a first step toward creating increasingly effective, user-friendly, and respectful survey designs in ASL [8, 41]. The ultimate goal of this work is to support and develop platforms that offer an array of templates for creating user-friendly surveys in SLs that allow users to respond to items quickly and easily.

## 2 RELATED WORK AND BACKGROUND

Surveys and survey-like resources are especially helpful tools in data collection, and can be used for a wide range of purposes, including gathering demographic information [43], building vocabulary datasets [9, 11], evaluating the relationship between language deprivation and mental health [27], and assessing ASL language knowledge [23, 24, 29]. Further, tools for developing surveys in ASL would promote accessible user research [5, 39, 50].

Recent research has highlighted the need for and importance of ASL-based platforms in education, the workplace, and social

media [6, 10, 40]. Adding signed content in user interfaces has been increasingly discussed as technology has made this more possible [2, 13, 18, 32, 34, 44]. Among other benefits, ASL-signers can experience critical access to a wide range of content in their first language [2, 13, 18, 32, 34, 44].

Previous research has investigated parts of ASL survey design and user experience. A user experience study was conducted while developing a bilingual (ASL/English) version of the online Health Information National Trends Survey in American Sign Language (HINTS-ASL) [38] which led to the addition of visual aids, images that clarified the intent of some survey questions. A Likert Scale survey in ASL implemented in one study presented questions and answer options in both ASL and English [48], and a standard multiple choice questionnaire was translated from English to ASL then an interface was designed to present the English and ASL versions alongside one another [21, 37, 38]. Tran et. al. evaluated user experiences with ASL content shown at varying video quality levels [48]. They also designed a video interpretation of survey questions and 5-point Likert scale. One questionnaire allowed users to view questions in ASL by clicking on a list of links, but not to interact directly with the videos or enter responses in a developed video platform [7]. In this case, answers were marked using paper and pen. Kacorri et al. [36] conducted a survey in-person with a human signer asking questions in ASL on a laptop screen and a paper answer sheet.

Most of these survey-like resources were designed to present both ASL videos and English text in a bilingual format, with varying levels of interactivity for users [17, 20, 28, 31, 38, 42, 45, 48, 49]. While much previous work has focused on translating the content and making linguistically and culturally appropriate ASL question videos [7, 8], limited efforts have been made toward standardizing the format, layout and the overall design of the interface that contains the questions and answers.

Published descriptions and images of assessment and survey interfaces in either bilingual (ASL & English text) or ASL-only designs show a wide range of design choices, with considerable variation in layout, interaction features, video design, and the type and amount of content available in ASL. The few cases found in the literature that discuss interactive ASL-only interfaces were created for K-12 American Sign Language assessment purposes [14, 24–26, 29, 46]. Therefore, the small number of deaf individuals who have encountered ASL in an online interface are unlikely to have encountered the same design more than once. As a result, deaf users cannot develop shared expectations and intuitions when engaging with ASL in the interface. Instead, each deaf user is likely experiencing a learning curve in each interaction with online materials in ASL. Studying the responses and preferences of deaf users is needed to design effective guidelines and conventions for development of ASL content.

Inspired by these existing efforts to build ASL surveys, in this paper, we take steps towards designing survey question types by incorporating visual, interactive elements and evaluating our designs with ASL signers. Ultimately, our goal is to enable the development of a general-purpose tool where end users can focus on the question-and-answer content, and then utilize the tool to generate an ASL-centric survey containing that content, similar to what

exists for text-based languages. Thus, we are focused on understanding the most effective designs for the general-purpose aspects of a survey that would be common across surveys in many different contexts.

### 3 DESIGN CONSIDERATIONS FOR QUESTIONS AND RESPONSE OPTIONS

*SL-Surveys* is a set of prototypes created to study and support the creation of signed language surveys. We began by prototyping common question types that users could interact with and respond to in ASL, without reliance on English, with the first being the most common survey question, the multiple choice question type.

In the design of each question type, we explored various options and considered how each choice might guide or obstruct survey taker. Our research questions included the following: How might an array of video frames be distinguished by size, shape, or other design elements to guide and structure the attention and actions of survey takers? How is a survey question divided into multiple videos presented on a screen differently than the single video containing an entire question and all answer choices - as is the customary design of many bilingual surveys? When content is divided into multiple videos, how might layout, shape, and video borders impact user actions? Will some design choices allow users to more easily locate and review specific information, e.g. answer choice C, than others? Can design alone prompt users to interact with the survey effectively, or are instructions needed for novel UIs? What features might facilitate faster scanning of pages of video content, reducing the time-intensive requirement to click or hover on each clip? How might changes in size, placement, and video shape impact user choices and perceptions of content?

While many of the visual design elements in the prototypes (e.g. shape, color, white space) are considered in general website design, we set out to explore applications in the specific cultural context of the ASL signing community.

#### 3.1 Content Structure Design Elements

Different design choices are made for different question types in print surveys; the layout and design of a multiple choice question is different than that of a Likert scale question in a standard survey template, such as Google forms or Qualtrics. The question type also impacted a number of UI design choices, features, and elements in *SL-Surveys*. In some cases our team opted to design novel elements, and in other cases, we explored whether familiar elements from text based surveys might serve as a prompt for users, e.g. circular shaped videos for multiple choice response options to reflect the radio buttons used in most multiple choice text-based surveys. Design choices are often interdependent and may impact other aspects of the interface, so we found it necessary to consider these elements both individually and holistically.

**3.1.1 Presentation.** In all *SL-Surveys* designs, one survey item is presented on each page, i.e., the question and all possible answer choices are viewable without scrolling to a new page. This allows users to focus on one item at a time, and all information needed to answer each question is shown on a single page. A previous effort to build an ASL survey by Mahajan et al [41] showed that either placing multiple questions on a single page, or requiring users to

scroll through several pages to respond to a single question, caused loading issues, slowed down users, and led to increased frustration and decreased motivation to complete the survey.

**3.1.2 Amount of content per video.** When designing *SL-surveys*, there are several ways to divide the question and answer content. The choice often made by survey developers is to place a single video containing a question and all answer choices next to the survey question in English text. *SL-Surveys* displayed individual videos of each question and each answer choice. This latter choice is also the one most often seen in previous work by teams led by Deaf and ASL-signing individuals developing assessments and surveys [24, 29, 38].

**3.1.3 Number of videos per page.** While determining the amount of content to share in each video, a concurrent decision needs to be made about how many videos can be comfortably viewed per page, and how to differentiate between the array of videos through design and/or instructional videos. In *SL-Surveys*, users viewed either two or five videos per page.

**3.1.4 Video viewing size.** Video viewing sizes (or video frame size) can be as varied as the platform and programming skills of the design team allow. To explore whether users see different video frame sizes as a prompt, in *SL-Surveys* questions were displayed in larger video frames and answer choices in smaller frames. Similar choices are noted on previous work [24, 38].

**3.1.5 Freeze Frames.** In ASL, one possible way to differentiate one video frame from another in an interface is to 'label' them with an image that shows an ASL sign at a recognizable moment, also referred to as a 'freeze frame.' Henner et al. published the first discussion of freeze frames in an ASL user interface [26] developed for the American Sign Language Assessment Instrument by Hoffmeister et al. In *SL-Surveys*, we studied whether freeze frames may offer an innovative way to facilitate interactions with an SL interface, such as scanning, ruling out options, and quickly finding previously viewed content.

#### 3.2 Action-Related Design Elements

In *SL-Surveys*, our design team created innovative user interface options, layering elements into and around video frames to create interactive components, while keep the cultural and linguistic norms of the ASL-signing community at the forefront. Action-related design choices are described below.

**3.2.1 Video Shape.** Our designs explored whether the shape of a video may allow users to differentiate or identify content, and prompt them to interact with the video in a given way (Figure 1).

**3.2.2 Video Border.** We wanted to investigate different methods to distinguish a 'currently playing video' from a 'currently selected answer'. Video borders were used in several designs to indicate either which video was playing or a selected answer. Designs for the video border included a full border around the entire video and a partial border highlighting just one edge of the video pane (Figure 2).



**Figure 1: Three video shapes used in *SL-Surveys***



**Figure 2: Different video colored-border designs used in *SL-Surveys*. The green color either surrounded the entire video, or appeared on the right side of the video.**

**3.2.3 Hover to Play.** Video play was triggered on mouse-over/hover, allowing users to more quickly scan and view videos without clicking or hitting a play button.

**3.2.4 Click to Select.** Answer selections were made by clicking directly on a video. This allowed users to make answer selections quickly and without triggering unwanted video replay.

### 3.3 Layout-Related Design Elements

Layout of content on a page guides and structures user interactions, and impacts the relationship between video elements. Choices related to layout may affect user experience more in ASL video-based resources than in text-based resources. Layout designs and considerations in *SL-Surveys* are described below.

**3.3.1 Screen Orientation.** Question designs in both landscape and portrait orientations were shown in *SL-Surveys* to explore whether either option improved presentation, ease of video viewing, video spacing, and participant engagement with the survey.

**3.3.2 Video Positioning and Placement.** Users respond to positioning and placement of content on a page. Although conventions in English print are to read content left to right, viewing of ASL content online may follow other patterns. Videos in *SL-Surveys* were organized in both vertical (top to bottom) and horizontal (left to right) positioning in an effort to explore how each might prompt users to scan the page differently.

**3.3.3 White space.** Spacing between content can make an interface more comfortable, comprehensible, and visually pleasing, or make it feel cluttered, complex, and difficult to navigate. Page designs in *SL-Surveys* attempted to strike a balance: building in sufficient white space to make viewing comfortable while also providing sufficient content to facilitate speed and ease of survey taking and reduce excessive scrolling or clicking.

## 4 SL-SURVEY DESIGN PROTOTYPES

Of the wide variety of potential question type options, the *SL-Surveys* prototype focused on three common survey question types: 1) Multiple Choice Questions (MCQ) 2) Scalar Questions (SQ) and 3) Multi-select Questions (MSQ). As an initial exploratory step, we included a discrete set of design choices for those question types. Again, our aim was not to conduct an exhaustive compare and contrast study, but instead provide prompts for users to reflect on to gain formative insight for future development and study. To that end, we designed *SL-Surveys* entirely in ASL without any reliance on text, and asked users to interact with the survey as independently as possible while viewing the ASL videos and selecting their responses.

The prototype was created using Adobe XD and included two designs of the multiple choice (MCQ) and scalar question types (SQ), and one design of the multi-select question type (MSQ). For each of the prototypes, we also implemented them with several sample questions that were used in the study. We designed, developed, and tested the survey design prototypes on a desktop or laptop. Designing for touch screens and other screen sizes/resolutions will

have distinct considerations that will be studied in future work, but these were beyond the scope of the current work. Below, we describe the full system that was used in our study, including the questions, and the various question and answer prototypes, noting the decisions made around content structure, actions and layout.

#### 4.1 Example Question Content

To demonstrate the designs that will be described below, we created videos that have question and answer content. The team opted for basic, neutral survey questions, so as not to distract participants from reporting on their user experiences with the design and interactivity of the *SL-Surveys* prototype. The full list of questions has been translated to English from the original ASL and listed in the Appendix. Our process was to select, draft, edit and finalize questions entirely in ASL, rather than translating existing survey questions from English to ASL. All survey content was developed and signed by Deaf native ASL-signers and the team's cultural and linguistic diversity was critical to creating appropriate survey items in ASL [7, 21].

In addition to creating questions, we also carefully selected "freeze frames" for each question and answer as discussed in Section 3.1.5. For example, in the MCQ1 question, "Which of these colors do you like best?", the question video 'froze' on a snapshot of the ASL sign for Color and answer choices displayed freeze frames of the signs Red, Blue, Green, and Purple.

#### 4.2 Common Design Elements

All designs had the following elements in common for exploration in the formative study: 1) One survey item was shown on each page; 2) Content was divided into separate videos for the question and answer choices; 3) Five videos were displayed per page; 4) Question video viewing sizes were larger than answer options; 5) Freeze frames labeled the question and answer choice videos, reflecting the topic of each question, and each single-sign answer option. All designs also featured two action-related elements: 1) Videos were set to play on hover; 2) Responses were selected by clicking to select directly on a video frame.

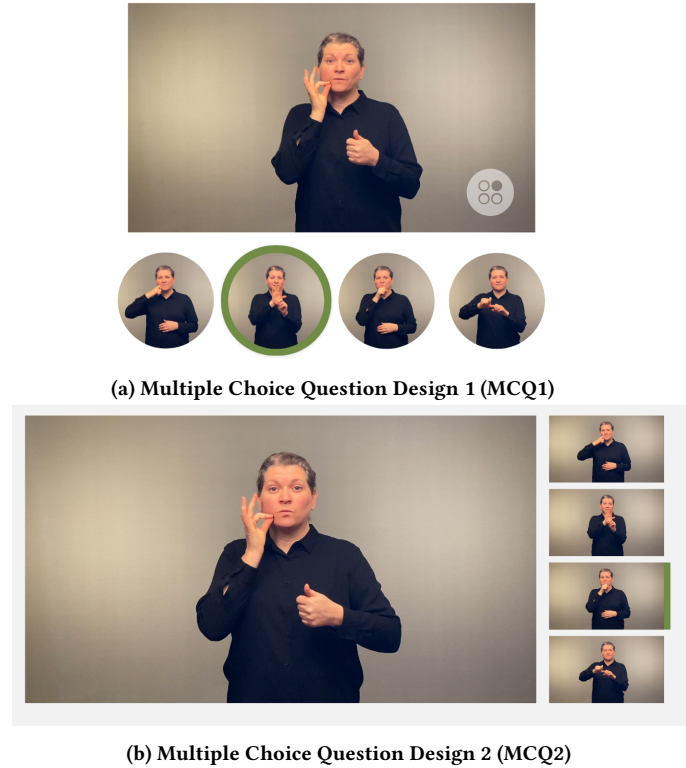
#### 4.3 Multiple Choice Question Designs (MCQ)

Two designs for the multiple choice question type (MCQ) are shown in Figure 3. MCQ1 and MCQ2 contrasted two *content* elements: 1) video shape, 2) video border. The two designs also contrasted all three inter-related *layout* elements, 1) screen orientation, 2) video positioning, 3) white space.

**4.3.1 Multiple Choice Question: Design 1 (MCQ1).** MCQ1 featured the following design elements (Figure 3a).

**Content Structure / Action - Video shape:** To explore whether familiarity helped users to interact with the novel MCQ design without instructions or prompting, we presented answer choices in circular videos, to reflect the circular radio buttons used to indicate multiple choice responses in text-based platforms. Participants also clicked directly on the circular videos to select an answer choice, mimicking the action of clicking on radio buttons.

**Action - Video Border Color:** Clicking on an answer video caused a green circular border to appear around the entire frame of the circular video, to indicate the selected answer choice. A border



**Figure 3: Multiple Choice questions and responses: Two different designs varying in layout, video shape, video borders, screen orientation, video positioning and white space**

outside the frame allowed participants to view the video content, whereas filling in the circle - as happens in radio buttons in text surveys - would have obscured the video content.

**Layout - Orientation, Placement and White Space:** MCQ1 was presented in a portrait layout. The question video was placed above the circular answer choice videos, to explore whether this would lead participants to view the question first. Displaying video tiles in two shapes, rectangular and circular, created more white space between tiles than in the design of MCQ2.

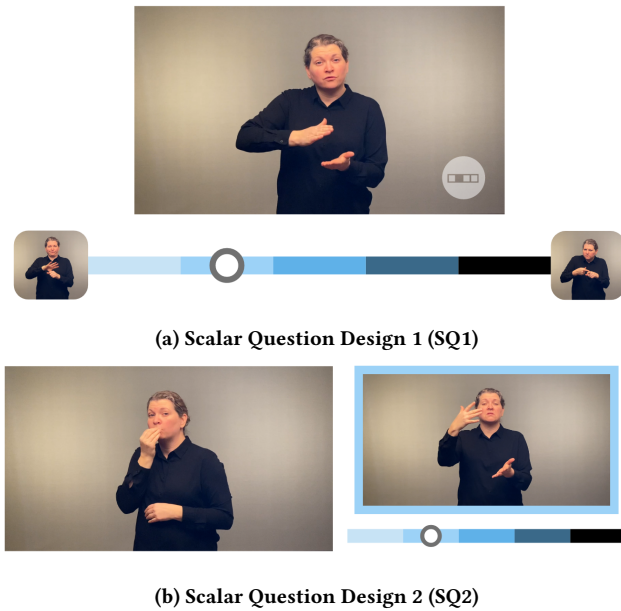
**4.3.2 Multiple Choice Question: Design 2 (MCQ2).** MCQ2 featured the following design elements (Figure 3b).

**Content Structure - Video shape:** All five videos were rectangular shaped, so there was no distinction in shape between the question and answer choices.

**Action - Video border color:** Clicking on an answer choice video caused a green border to appear on the outside right edge of the rectangular frame, to indicate the currently selected answer choice.

**Layout - Orientation, Placement and White Space:** MCQ2 was presented in a landscape layout. The main question video was placed to the left, and rectangular answer choice videos to the right. Because the videos were all rectangular, it was possible to position the video tiles closer to each other, with very little white space between them.





**Figure 4: Scalar questions and responses in *SL-Surveys*: Two different designs varying in the amount of content per video, number of videos per page, video shape, video border.**

#### 4.4 Scalar Question Designs (SQ)

Two designs for scalar questions are shown in Figures 4 and 5. SQ1 and SQ2 contrasted four *content* elements: 1) amount of content per video, 2) number of videos per page, 3) video shape, 4) video border. The two designs also contrasted all three inter-related *layout* elements, 1) screen orientation, 2) video positioning, 3) white space. In addition, in SQ1, where the end points are labeled, there is less information contained than in SQ2, where each point in the scale is labeled.

**4.4.1 Scalar Question: Design 1 (SQ1).** SQ1 featured the following design elements (Figure 4a).

*Content Structure - Amount of content per video; Number of videos per page; Video shape; Video border:* In this design, the question was shown in one video, and each answer choice extreme was shown in a single video, for a total of three videos per page. The shape of the question video was rectangular, and the answer choice videos were rounded-edge squares, differentiating them from one another.

*Action - Click to Select; Video Border.* Participants clicked on the scale bar to select an answer, rather than clicking directly on video frames. No borders appeared around any of the three videos when interacting with the question or answer choices.

*Layout - Orientation, Placement, White Space:* SQ1 featured a portrait layout, with the question video placed above a blue-to-black color-coded horizontal scale bar. The bar was designed like a text-based item, with ASL videos on either end labeling the extremities, e.g. amateur / expert.

**4.4.2 Scalar Question: Design 2 (SQ2).** SQ2 featured the following design elements (Figures 4b and 5)

*Content Structure - Amount of content per video; Number of videos per page; Video shape; Video border.* In this design, the question was shown in one video, and answer choices corresponding to each of the five points on the scale were viewable in a single video, for a total of two videos per page. The question and answer videos were rectangular-shaped. The answer choice video displayed a full border on all four sides. As participants clicked across the scale bar, the blue-to-black border color automatically updated to match the color of the segment currently selected on the scale (Figure 5).

*Action -* As shown in Figure 5, clicking on each point of the scale activated video play of the ASL option corresponding to that point of the scale (e.g. amateur, limited skills, moderately skilled, highly skilled, expert). Clicking on the bar also allowed users to select their answer.

*Layout -* SQ2 featured a landscape layout, showing the question video on the left side of the page, and the answer choice video placed to the right, directly above the scale bar.

#### 4.5 Multi-Select Question Type Design (MSQ)

One design was presented for this question type, featuring the following design elements (Figure 6).

*Content Structure - Video Shape:* Answer choices were framed in rounded-squares, with the goal of reflecting the standard design of check-boxes in text based surveys.

*Layout - Orientation, Placement, White Space:* In a portrait layout, the question video was placed above the rounded-edge square answer choice videos, and separated by a thin row of white space.

*Action - Video Border Color:* Clicking on an answer choice video caused the entire border of the rounded-square to turn green, to indicate the currently selected choice(s). As this was a multi-select question, borders appeared around all videos clicked on by participants. In questions with the answer choice of 'none,' border colors disappeared from the other choices previously clicked on when 'none' was selected.

### 5 USER STUDY

The primary goals of the user study were to:

- Conduct a formative study to begin to understand user perceptions of features for ASL-only video components integrated into three question types in the *SL-Surveys* prototype.
- Gather participant feedback, opinions, and perceptions about overall design, content structure, actions, and layout in an interactive ASL-centric user interface on a computer screen.
- Explore the impact of, and opinions about, an ASL survey with deaf participants, and whether *SL-Surveys* may have broader applicability.

Each session was 1.5-2 hours. The study was approved by WPI's institutional review board.

#### 5.1 Methodology

A holistic approach was taken to study the prototypes. As participants engaged with *SL-Surveys*, researchers observed and noted their responses and interactions, elicited think-aloud commentary and asked follow-up questions. This approach 1) made it possible to note whether and when participants were able to intuitively interact with each element of the prototype, 2) allowed participants



**Figure 5:** In our SQ2 design the video above the slider changed to denote the corresponding answer. In this figure we show three options as the slider slides from light blue to medium blue to black.



**Figure 6:** Multiple-Select question (MSQ) and responses in *SL-Surveys*

to comment freely in the moment, and 3) provided some structure in terms of the specific questions asked by researchers.

To conduct a think-aloud style study with signing participants requires careful thought and redesign as hands are required for both the interaction and the signing communication. We take a slightly different approach from prior work [16] that had participants first sign what they will do and then do it. In our study, participants shared thoughts both before and after they interacted with each question. They also were asked to pause and express thoughts as they had them. In ASL, we referred to this method using signs that essentially mean "THINK COMMENT" as described in our previous work [41]. However, the term 'think-aloud' is used throughout the paper as it is more broadly understood in English writing.

Sessions were conducted remotely on Zoom. We requested and verified that all participants used a computer, and not a touch screen or mobile device. However, we did not limit the screen resolution or screen size. In each session, one participant and 2 to 3 signing researchers were present. One researcher took the lead, asking questions, prompting, and when needed, clarifying the design for participants. A second, and sometimes third, researcher observed with cameras off, provided technical support, took notes, and asked

follow-up questions only when necessary. One researcher shared their screen displaying the prototype and then gave the participant remote access to interact with it.

Interviews were video recorded using the Zoom recording feature upon receiving participant consent. To create interview transcripts for non-signing members of the research team, ASL interpreters translated the interview recordings into English, and the resulting audio files were used to create transcripts using the auto-transcription software, Otter.ai. Transcripts were then reviewed and revised for accuracy by the ASL-signing members of the research team. The interview was divided into the three phases described below.

**5.1.1 Introduction.** In this first phase, the researcher introduced the study to each participant, reviewing the consent form, study structure, and overall research goals. Participants were told that the team's goal was to design an online interface that would allow users to take surveys in ASL, without obligatory reliance on English, and to that end, we were evaluating several designs for standard survey question types.

Participants were then told that we were not studying the ASL content of the survey, and asked to focus their evaluation, discussion, and input on the interface components. The team had scoped this study to focus on the interface components and exclude the content of the ASL survey videos, e.g., the grammatical structure of the questions, or vocabulary used in *SL-Surveys* questions, as the translation and development of ASL content for online resources has been examined in other work.

Given the rarity of surveys in ASL, our team assumed that participants would be unfamiliar with these designs and therefore, we were prepared to clarify and prompt when needed. However, we did not give explicit directions on how to answer each question, in order to collect think-aloud data that could uncover initial mental models the users had when they saw the survey question designs. This will help to inform any instructions in the future that we may deem necessary, and also show where instructions may not be needed at all, despite the novelty. While there were no instructions included in the prototype, the researcher explained hover play to the participants.

In the introduction, participants were also alerted that the prototype *SL-Surveys* had the following limitations:

- *SL-Surveys* did not record their answers.

- The help button was not currently functional.
- *SL-Surveys* was designed for the deaf signing community, and was unlikely to be fully accessible to the Deaf-Blind community.

**5.1.2 Demonstration and Interaction with Prototype Survey Questions.** Following the introduction, the researcher shared their screen and began showing the participant the prototype. The participant was given remote control access so that they could control the prototype. Each participant was asked to interact with two multiple choice question designs, two scalar question designs, and a single multi-select question design. Participants were able to view and respond to four questions in each design before moving on to the next. This allowed us to observe how participants interacted with each design and gather opinions about each design independently.

After participants had interacted with MCQ1 and MCQ2, they were again asked to compare, comment and reflect on the differences and their preferences, this time with both designs in mind; this was repeated after participants viewed SQ1 and SQ2. Finally, participants interacted with, commented on, and responded to questions about the single MSQ type design.

During and after responding to questions in a particular design, participants were asked to comment on their experience, likes and dislikes before moving on to the next. As participants were thinking ‘aloud’ in ASL, they were using a signed language while also using their hands to manipulate the interface, so their comments were made just before or after viewing, mousing over, selecting, and engaging with the survey. This is an adapted think-aloud approach with deaf signing participants, while participants using a spoken language are generally expected to offer continuous and simultaneous think-aloud commentary as they engage with the interface.

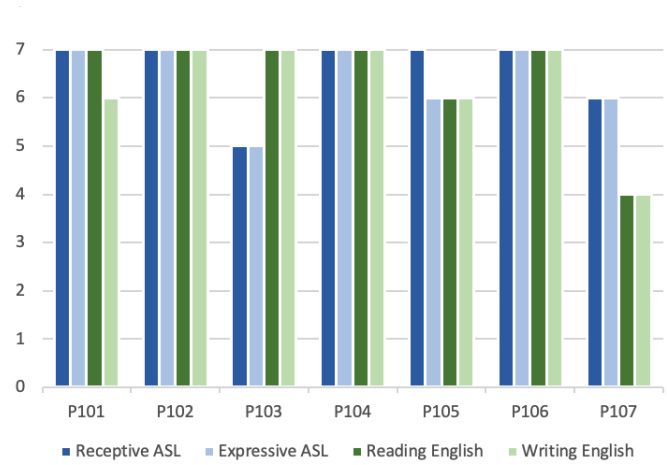
**5.1.3 Questions about Design Elements Across SL-Surveys.** After the participant had viewed, interacted with, and shared initial perspectives on the prototype designs, they were asked general questions about design elements such as video size, video shape, actions and layout, as well as the learnability, usability and applicability of *SL-Surveys*. Finally, participants were thanked and compensated.

## 5.2 Participants

Seven Deaf ASL-fluent adult participants were recruited for this study through social media, email, and text messages sent to a large network of contacts that includes a diverse array of the Deaf community of all ages. The resulting participants included individuals in their 30s, 40s, and 50s. Participant demographic information is shown in Table 1. Table 2 refers to participants’ age of ASL exposure, parentage, and method of acquiring or learning ASL. The bar graph in Figure 7 shows participants’ self-rated level of comfort and fluency in ASL and English.

## 5.3 Data Analysis

In alignment with our goals, we analyzed our think-aloud and interview data and observational notes. All members of the team reviewed the interview videos and read through the transcripts, which were time-aligned and coded in Atlas.ti. Following this, the non ASL-signing team members individually and independently



**Figure 7: Graph showing participants’ self-rated levels of comfort in: Receptive ASL, Expressive ASL, Reading English, Writing English. Six out of seven participants rated their ASL receptive and expressive ratings equal to or higher than their English reading and writing skills.**

completed a round of coding on the English transcripts to identify topics in participant responses that cut across the data, while the ASL-signing team members individually and independently coded and analyzed both the ASL video recordings and English transcripts, which allowed them to capture more complex data on emotions, affect and frustrations. This data-driven approach allowed identification of unexpected categories in the data, rather than solely investigating themes modeled on our own prior theories or preconceptions. Finally, through discussions we were able to agree upon a coding scheme and identify major categories.

## 6 RESULTS

Given that the five designs presented were quite novel, it was expected that participants would have had no previous experience with the ASL video components featured. The think-aloud approach allowed us to access the speculations and guesses of the participants, and demonstrated how deaf users look for visual patterns in the UI design that may help them interact more efficiently and effectively. Among users, a range of tolerance for uncertainty and exploration may be expected, and that was noted in our results. From the processes described in Section 3 and Section 5.3, the main topics identified are discussed below. Please note that the quotes below are English translations of the original ASL comments.

### 6.1 Usability and User Experience

**6.1.1 Learning Curve.** Comments about the learning curve participants experienced and overall usability were of particular interest, and analyzed throughout all five designs. A key moment arose when participants viewed the first design (MSQ1), as each participant shared that taking an ASL survey was a new experience, and they were uncertain how to engage with all of the ASL video components described above. Five participants explored the interface



**Table 1: Participant Demographic Information**

Participant ID	Age	Gender	Academic Degree	Field of Study
P101	40-49	Female	Masters	Major in ASL/Minor in Linguistics
P102	50-59	Male	Bachelors	Education related field
P103	50-59	Male	Masters	Not specified
P104	30-39	Female	Masters	Education related field
P105	40-49	Female	Masters	Not specified
P106	30-39	Female	Masters	Education related field
P107	40-49	Female	Associates	Mathematics related field

**Table 2: Participant Sign Language Background Information**

Participant ID	Age of First Exposure to ASL	Parentage	Deaf at Age	Method of Learning Sign Language
P101	0-4	Deaf	At birth	Family (Deaf parents)
P102	15-19	Hearing	At birth	Class: Post-secondary
P103	15-19	Hearing	At birth	Class: K-12
P104	5-9	Hearing	At birth	Class: K-12
P105	0-4	Hearing	At birth	Family (non parental) or Friends
P106	0-4	Deaf	At birth	Family (Deaf parents)
P107	25+	Hearing	Middle childhood	Class: K-12

briefly, moving their cursor and clicking on the ASL video components, and then progressed quickly through the MCQ1 and MCQ2 questions, entering responses for each. P101 said: “This is tricky. I thought that I had to click on the videos, but it does seem as though they play in sequence. And perhaps the circle appears around them when they’re playing?” P104 remarked “I felt the design was clear visually. I could intuit what to do. Seemed pretty easy.” For those five participants, the learning curve was short, as reflected in P106’s comment immediately after interacting with MCQ1 “At first I was a little uncertain and then over time I got more used to it.” P105 said: “No, I mean, I’m very familiar, for instance, with Google Surveys, but this was a little bit of a learning curve. So, okay, great, I’m thinking – This is something new. How’s it gonna work? How is it set up? The first time, whenever I’m using something new, I have a little bit of a hesitation. I’m a visual person, I need to see something visually to learn what that is. And once I see how it functions, then it’s usually pretty smooth sailing for me. This experience was still good - I liked it.” Two participants struggled with MCQ1. P103 commented “So, okay, so all I see is the main larger rectangular screen and then 4 smaller circles below. It would seem to me that there should be some type of instructions included as to what I should do next. And there are not any. It’s hard to know what to do next.” However, P103’s confusion was likely exacerbated by the fact that the prototype was not working correctly, “Oh, I see. I see. So, I can click on one of the four circles, which I did at first, but the video didn’t play. But then when I went back to the larger rectangular video, it did play. It would be nice if I were told to click on the larger video first and then watch the smaller videos after that. Second, it’s a little confusing. The size of the video is confusing or the layout. I’m not sure what to do next.” Despite the challenges and confusion, even P103 was able to figure out what was expected by the third question in the first design, “Wait Wait, wait, let me go back. Oh, I see. I think I understand now. Going forward, I know

what needs to be done.” Two participants expressed the need for a quick visual tutorial or video demonstration on the survey tool to understand how to use it without having to spend time figuring it out themselves. P103, suggested “Oh! Actually, I have another idea! There should be an example slide first, before somebody starts to try to complete the survey. Like a tutorial. It could say something like, ‘This is the larger video and it’s the question.’ Like a walk-through of the steps.” Only one participant demonstrated difficulty grasping and responding to more than one question type, but even that participant was much clearer by the SQ2 design, noting “This is a good layout. Ah, this is more clear - much more clear than the previous design. That was more frustrating.”

The only question type design that all seven participants were not able to understand the purpose of without prompting was the final multi-select question type (MSQ). Two indicators were built into the design to cue users that it was a multi-select question: 1) a rounded edge square answer choice video shape, and 2) a green border appearing and remaining around all answer choice videos users clicked. These indicators were not sufficiently clear, and sometimes misunderstood before the researchers clarified the purpose of the question. Several participants assumed the video border appeared because the video was playing, not because it was a selected answer choice. As these indicators were not enough to indicate a MSQ, the researchers found it necessary to prompt each participant to try selecting more than one answer choice video before it was understood.

At the end of the interview, when asked about the overall experience, P101 shared that it felt quite positive and enjoyable: “I often find ASL versions of online resources to be a real challenge. They are a usually lot of work, and they’re not user friendly. In this experience, I felt good about the fact that this [survey] was in my first language, and it felt kind of smooth and easy, even though there were some glitches. I’ve never seen another design that beats

this, really, I haven't seen anything out there like this. So this is the first time I've seen something that works and feels quite so good and and I would definitely recommend it. I would say, if you want an ASL friendly survey, use something like this."

## 6.2 General Design Elements

Participant responses to content-related designs that were consistent across all question types are reported in this section.

**6.2.1 Amount of content per video.** Six of the seven participants did not comment on the amount of content in each video. However P102 felt that it would be more efficient for users if the answer choices were included in the question video (signed immediately following the question), while also being shown in and selected by clicking on individual answer choice videos, "I would like to change the format, so that the video with the question includes the possible choices for answers right there. And then have the answer choice videos repeat each separate response."

**6.2.2 Video Viewing Size and Number of Videos per Page.** All seven participants expressed the need for larger answer choice videos in four of the five designs, and several participants observably moved closer to the screen to view them. To balance out the layout and enlarge the answer videos, P101 and P105 suggested reducing the question video size and increasing the answer video sizes, while still maintaining an obvious size difference to distinguish between the two. P105 commented, "because the question is very clear and large, maybe you can re-balance a bit, sharing the screen more equally between the question and the answer videos." P106 and P107 suggested adjustable sizing, so users could expand the video while playing and shrink it back when done viewing. While responding to MSQ1, P106 noted "if I were able to enlarge the videos, it would be a more comfortable viewing experience." After interacting with MCQ1 and MCQ2, P107 wondered "But what if...[the answer videos] were able to pop out, so that you can view them a bit larger and then minimize them again when you are done with them...you could even have an icon of a magnifying glass, so that someone would know to click on it to expand - or not click on it if they were happy with the size it was at." Video viewing size in the second scalar question design (SQ2) (Figure 4b) was the only one reported as comfortable by all participants. This design featured only two videos per page - as opposed to five - with the answer choice video updating automatically in the rightmost video frame as participants clicked on segments of the scale.

**6.2.3 Thumbnails/Freeze Frames.** Despite the fact that showing freeze frames of ASL signs is a novel interface feature, six of the seven participants, without instructions or prompting, noted and/or utilized the freeze frames to scan and select answer choices. All six participants selected responses using only the freeze frames, i.e., made a selection without viewing the answer choice videos. P101 noticed and commented on the freeze frames immediately upon viewing the first design (MCQ1): "Oh, there are frozen images of the signs - that helps me to predict what the signs are!" P102 selected their first answer choice by looking only at the freeze frames, rather than watching the videos, but did not seem consciously aware of the feature until directly asked by the researcher. At that point, P102 said "I didn't notice it until you brought it up. So after you

sign the question, there are the response videos with frozen images, showing you the sign of the response choice available. I like that! That's cool. I get it." P102's final comments about the design were strongly affirmative "Don't change anything! Having that frozen image of the sign there, being able to click on it if you want, and being able to see that it's 'apple' or 'banana' right there is really visual. Having [the sign] frozen until you click and play - I would keep it that way." P103, viewing the second design (MCQ2), said "At the bottom I can kind of see what the answers are without having to click and play the videos. Like I can see that the sign is frozen for 'boat' and the second one - hmmm, not sure what that one is. The third one is 'hiking.' I can tell that the fourth one looks like - like, um, swimming. The second sign I'm not sure what it's - oh, okay 'camping' I think." P104 commented "I appreciated that the signs became frozen, so that I could recognize what was meant in a certain video without having to watch the whole video, for example, the colors that she was signing. I didn't have to click on the video to be able to know what color she meant and I appreciated that. That was good. They're like thumbnail pictures in these circles...". The participants clearly used the ASL freeze frames to more quickly scan, review, and select answers.

**6.2.4 Video Play on Hover and Click to Select.** The prototype was set to play all videos on hover, reducing the number of clicks required to complete the survey. This also served to distinguish the action required to select and submit responses, which was to click directly on answer videos. However, the prototype's hover to play functionality was slower and not as responsive as a fully built tool due to limitations in the software, which unfortunately caused frustration and uncertainty about whether a click was required to play. P101 said "I wonder if it's possible to have videos play immediately when you hover in the area of the answer choice - because I could imagine that people would be impatient with having to wait for the hover play to activate - it takes too long. The hesitation in the hover play - the lag time - was frustrating and a little problematic for me. I wanted it to speed up."

Despite glitches with the prototype, six participants clearly preferred the hover option over clicking to play videos. P102 shared that "It [hover to play] gave me an opportunity to view a video again easily," and P104 commented, "Sometimes I would just mouse over and the video would start playing and I thought that was really good. I liked that. It was nice that I didn't have to click as much." P106, the one participant who preferred click to play, said, "I would rather if [the video] not play until I click on it. But maybe that's just a personal preference." P102 also appreciated being able to click directly on a video to select an answer choice, "I like that it allows me to click on the videos to choose my answer."

Two participants suggested that some videos should play automatically, rather than in response to a user's actions, for different reasons. P101 commented "I think it's important to guide the user to view the question. That's the first piece of information that they need to watch." P107 noted "If the layout doesn't require as much clicking and plays videos more automatically, it takes less memory and it's a better user experience." Every participant said no when asked if all videos on a page should auto-play or loop, as they felt that would be an overwhelming amount of content to view all at once.

**6.2.5 Video Shape.** Perceptions on video shape related to each design are discussed in more detail below. However, a theme that emerged was that rectangular-shaped videos were not appealing to any of the participants; their descriptors of this video shape included “rigid”, “eye-fatiguing”, and “not engaging.” All of them stated the beveled rounded-edge square shape was much easier on the eyes and “warmer.” Six participants also stated that they found the circular video shape much more appealing and interesting than the rectangular shapes.

## 6.3 Multiple Choice Questions

**6.3.1 Content Structure.** Video Shape and Video Size: P101 immediately caught that the MCQ1 answer choice video shape reflected standard text-survey design, noting that “it seems better to have circular answer choice videos, to kind of align with the multiple choice idea.” As noted above, six participants noted the circular-shaped answer choice videos, sharing that they were “pleasant,” “better,” and “preferred”. However, all seven participants also felt that the circular answer choice video viewing size was too small for comfort, and “pretty straining on the eyes” (P101). P102, even after expressing a clear preference for the circular videos after seeing the second design commented, “[In the MCQ2 design] all the videos are larger and I like that. I feel like it’s almost like we’re zoomed in on them and they’re easier to see. The circle videos are a little small. If you can enlarge them, I feel like that would be better.” P101 was very clear that “the circular videos needed to be larger. If you want to keep that circular shape, you need to enlarge the size. Watching those circular-shaped videos was pretty straining on the eyes.” Thus, we found that the overall design concept was favorable, but that sufficient video size is important. Future work will revise the design to enlarge the answer choice videos and determine the video size that is acceptable.

**6.3.2 Action.** Video border: In the multiple choice question type design one (Figure 3a) when the user selected their answer by clicking on one of the circles, a green border appeared around the entire circular video frame. All seven participants preferred the entire border turning green. P102 commented “I prefer the first one with the circle shapes for the answers and the green border that goes all the way around the circle.” P101 felt that the full border was sized just right, “No, I think that that’s a good size. If it were any thicker it might be too distracting, if it were any thinner it would be hard to see.” In MCQ2 (Figure 3b) only one side of the selected rectangular video green, which all participants found too subtle and easy to miss, as reflected in P104’s comment “...just focusing on the green border that’s on one side of the rectangle - it’s different from the border around the circle. I prefer to see that full border, like you had with the green circle, versus a border just on one of four sides, like in this current design. It’s not as clear here - having it just on one side is more subtle. I prefer the full border around the circle. Perhaps with this design - if you had a full border around the rectangle, that would be preferable.”

One participant also felt the border color choice might affect survey taker motivation, remarking “My brain maps green to a positive experience or something good. It doesn’t tell me whether my answer is correct or incorrect, but green typically is correlated with correctness, and goodness. I don’t know if you did research

on what color to use, but I believe there has been research showing that people will continue using a survey if they see the color green, because they feel like they’re doing well. If I were to see red, I might feel differently - I might feel less positive. I can’t see anyone having an issue with green, and, for example, stopping a survey because of that color.”

**6.3.3 Layout.** Six of the seven participants expressed a clear preference for the portrait layout, with the question video on top and answer options laid out in a row below. One participant preferred the landscape layout showing the question video on the left and answer options to the right. Several also mentioned that videos were well-spaced and placed, with sufficient white space between them.

## 6.4 Scalar Questions

**6.4.1 Content Structure.** Video Shape: Despite the overwhelming preference for the layout and design of SQ2, all seven participants preferred the rounded-corner video shapes in SQ1 over the more traditional rectangular shaped videos in SQ2.

**6.4.2 Action.** A similar comparison was made between dragging and clicking for the scalar question. Participants could either click on the scale to advance the circular pointer, or drag the circle itself to answer the question in both designs. P101 felt it was useful to have both options, “I think actually it is easier to click (on the scale segment) rather than sliding the bar back and forth - you could make it possible to do either, so that people can do whichever they choose, rather than having to figure it out, because they’re restricted to either slide or click.”

In SQ2 (Figure 4b) as participants clicked or dragged across the color-coded scale bar, the video border color also changed from light blue to black to match. The role of this color-based feature was to associate and establish connection between the scale and the ASL video. It was noted and appreciated by almost all of the participants.

Responding to the scalar questions was quite different from the multiple choice and the multi-select, so participants spent a lot more time talking about it. Two participants were confused about the way ratings were represented by bar segments with a circle landing in the middle of each segment. For example, Figure 4b shows the circle in the center of the lightest blue color bar segment. P101 expressed a preference for distinct points on the scale: “Because this is a segment, I feel like I’m choosing the kind of middle ground of a choice, rather than making a specific choice (on the scale). If I had a line with a discrete dot, that would feel more definitive, more confirmed. For me having it (the dot) right in the middle of a longer colored-in bar feels like I’m being a little bit vague. I’m not quite sure if I’m, you know, doing 1.5 or something like that.” Others wanted to have a wider spectrum of options, with the ability to select points between discrete ratings by clicking on a mid-point or on the border of two colors. These options will be further investigated in revised designs.

**6.4.3 Layout.** In the scalar question type, all seven participants indicated a strong preference for the landscape layout, which placed the question video on the left and the scale on the right (Figure 4b).

As shown in image (Figure 4b), this design includes two larger video frames, with the answer choice video updating for each point along the scale as participants clicked their cursor. In the other design (Figure 4a), there was one large question video, and two much smaller videos for the furthest points on the scale. Participants identified two benefits in this design: the ability to view an answer choice for each of the 5 points on the scale, and ease of viewing the larger-sized answer videos.

In SQ1 (Figure 4a), P104 commented that guessing at what the middle ratings might represent was "stressful." Four participants said that ASL answer options for all five ratings in the side-by-side layout provided an ideal amount of information and increased confidence in their choices. This option co-occurred with the shift to two larger video frames, which was also highly rated, increasing their overall satisfaction with SQ2 (Figure 4b) considerably.

Despite feeling strongly positive about this design, one participant noted that the layout separated the question from the answers, and suggested a way to keep the scale bar below the question video without compromising video size. The design suggested was to embed circular answer videos in the scale bar with a responsive sizing feature, so videos enlarge as users hover across the bar for ease of viewing.

## 6.5 Multi Select Question

**6.5.1 Content Structure.** Our team explored whether presenting the answer choice videos in a rounded-edge square shape would trigger an association with the multi-select design of text based questions, in which the check boxes next to text answers are often that shape. However, that was not a strong enough clue for any of the participants to immediately understand the purpose of the question. P101 caught on most quickly "Again, I liked the full frame border, and at first thought it was a neat way to indicate which video was being viewed, but then quickly figured out that it meant a selected answer choice." In this design, the first to feature rounded-edge square shaped videos, we noted that all participants reacted very positively to that video shape.

**6.5.2 Action.** When users clicked on the rounded-edge square answer choice videos, a green border appeared and remained until they clicked the video again; this was true regardless of how many videos they selected, unless the answer 'none' was selected, which caused the border around all other selected responses to disappear. Neither of these design features was enough to clearly indicate that the question allowed them to choose more than one answer. At first, the border appearing was misunderstood to indicate active video play by several people. P104 wondered about ways to clarify that it was a multi-select question, "The way it is now, I thought it was multiple choice. But if you were to add some type of design to emphasize that it's multi-select...then I might be able to catch it...perhaps layout or colors?" However, after understanding the question type, P103 clicked on multiple answer options then commented "Oh, that's a good one. When you choose none, the other three [borders around the] options disappear."

**6.5.3 Layout.** The portrait screen orientation for the multi-select question type was similar to MCQ1, with the question on top and the answer options on the bottom. P102 responded positively to

this design, "What you've come up with is cool. I would say keep it as is. Keep the orientation of the videos horizontal on the bottom."

## 7 DISCUSSION

Our team has prioritized the development of surveys in ASL to respectfully and ethically collect demographic and other research data with deaf ASL-signing participants. Considerable investments of time, effort and expertise have been required, as broad conventions and standard tools do not exist for designing ASL surveys. While previous research has explored the viability of adding ASL videos to existing text-based survey apps and templates to create a survey in ASL [41], as well as usability considerations for interacting with ASL and English on interfaces, such as viewing videos with captions [3, 4], most basic elements of online survey interfaces in ASL have not been studied. Many unresolved technical and design challenges have been identified in prior efforts, but there is also a need for careful exploration of factors influencing the user experience in this context.

Below, we discuss our findings on user perceptions and preferences related to online surveys in ASL, including design elements that they found to be effective and areas that need further refinement. In addition, we discuss user comments related to the applications of ASL-centric survey tools, and the potential influence of language preferences and comfort.

### 7.1 Effective Design Elements

*Usability and Learning Curve:* Given the rarity of ASL-only online interfaces, it was surprising to note how quickly six participants grasped the purpose of the multiple choice and scalar question designs, and began interacting as hoped to view and respond to the questions. The participant who struggled may have had more difficulty due to learning ASL as an adult upon moving to the U.S.; this individual's first and second languages were the signed and then written languages of another country.

*Presentation:* The fact that none of the users commented or reacted to the presentation choice of one question per page may indicate that this was effective in focusing their attention and knowing how to proceed with viewing the content. Asking participants about this explicitly in future studies will make it possible to confirm whether this was the case.

*Amount of content per video:* Only one person shared the desire to view the question followed immediately by the answer choices in the same video to save time in the MCQ and MSQ designs, while the remaining six participants seemed to feel comfortable about viewing the questions and answer choices in separate video clips. What is indicated by the lack of comments about that choice merits further exploration.

*Number of Videos per Page:* The choice to feature five videos per page for four designs, and two videos in one design was not remarked upon by the users. However, they were clear that the layout and placement required consideration, to ensure that the number of videos were best distributed across the page to ensure adequate and comfortable video viewing size.

*Video Viewing Size:* The question videos in all five designs, and the answer choice video frame in the SQ2 design were all confirmed to be set at a comfortable viewing size.



*Freeze Frames:* Scanning an array of videos is much more challenging than scanning lines of written text, a factor that can make ASL-only interfaces frustrating, time-consuming, and demotivating for deaf users. Even the frozen video frame can be used to cue users about content, rather than presenting multiple images of signers at rest, with hands at their side. Our team was struck by how quickly and accurately - and in several cases seemingly unconsciously - participants capitalized on the ASL freeze frames to select, scan, and review content, sometimes before or without even viewing the ASL video. This novel design choice, previously noted in one publication [26], warrants further investigation and potentially much wider application.

*Hover to play:* Hover play was overwhelmingly the preferred choice for video play. Most participants indicated that if the software glitch were resolved, they would prefer *hover to play* and *click to answer* over *click to play* and *click again to answer*. The one person who preferred click to play also seemed least comfortable interacting with the survey overall. The suggestion offered to consider auto-play of primary video content to focus attention and guide users is worth future exploration as well. However, it was very clear that participants felt comfortable viewing one video at a time, which should be taken into account if videos are set to auto play on loop, for example.

*Click to select:* Most participants quickly moused over the interface and then attempted to click on a video to see what would happen. The video border appearing around the frame seemed to be a sufficient indicator that they had clicked to make a selection. From that point on, all participants seemed to understand the functionality was built into *SL-Surveys*, and easily and naturally clicked directly on video tiles to select answers.

*Video Shape:* The strong preference all participants showed for the circular shape, and even stronger preference for the curved-edge square shape, was quite striking. Designers of interfaces featuring ASL need to consider how the simple choice of video shape may either attract and engage or demotivate deaf users.

*Video Border:* Clear visual designs to indicate or confirm video interactions were also valued by the participants, as shown in the preference for a border around the entire edge of a video to indicate selected responses, as opposed to the more subtle, harder to see border on one edge of the rectangular video. Several of the participants also found the responsive border color in the SQ2 design, which updated as they moved along the scale, a useful, related, and clear indicator of where their cursor was on the scale.

*Layout:* Although one may assume that the left to right nature of reading text would lead to a preference for a landscape or side by side layout, there was a very strong preference among six participants for the portrait layout, displaying the question video at the top of the page, and answer choice videos arrayed below.

## 7.2 Considerations for Further Refinement of Design Features

*Usability and Learning Curve:* In the study, we did not provide instructions for answering the questions since we were interested in observing the extent to which the design was understandable by new users. Formal instructions would have provided helpful orientation for at least two participants, although others reported

that figuring out what to do on their own was enjoyable. P103 suggested “I think in the first question, in the large video on top, the signer should tell us that there are 4 answers available below, so that people will know that the 4 smaller videos below are answers.” In addition, despite our efforts to cue users with unique design and feature choices for the multi-select question, the struggles all experienced made it clear that instructions would have been helpful in that case.

*Amount of content per video:* Even though only one person shared the desire to view the question followed immediately by the answer choices in the same video to save time in the MCQ and MSQ designs, this area merits further exploration.

*Video Viewing Size:* As every participant felt strongly about either enlarging the smaller videos or adding a responsive sizing feature, it is very clear that ASL, as a visual language, requires developers to carefully consider how to design for sufficient video viewing size, considering how amount of content per video and number of videos per page impact and relate to video placement and overall layout.

*Freeze Frames:* When participants were viewing an unfamiliar sign, or when the video viewing size was too small, the freeze frames were much less effective as a scanning tool. Ensuring that videos, and therefore freeze frames, are large enough to view comfortably is important. In addition, it may be useful to add visual images when the freeze frame represents less frequent signs or signs that vary from one region to the next (i.e. ‘pineapple’).

*Hover to play:* The hover to play feature was not set to activate at an appropriate margin around the video, and it was glitchy, which caused participants to assume videos were set on click to play and inadvertently select answer choices. The issues with hover to play also contributed to frustration and impatience. Further study is needed to know what the best margin is for hover to play to activate and how to reduce or eliminate glitches with this feature.

*Video Shape:* The strong negative reaction all deaf participants expressed about the sharp-edged rectangular video shape came as a surprise to the research team, given the standard nature of this shape and its prevalence in many designs. Their perceptions that this shape was rigid, demotivating to users, and eye-fatiguing are important to consider when designing ASL video frames in an interface.

*Video Border:* Clear visual designs to indicate or confirm video interactions were also valued by the participants, as shown in the preference for a border around the entire edge of a video to indicate selected responses, as opposed to the more subtle, harder to see border on one edge of the rectangular video. Several of the participants also found the responsive border color in the SQ2 design, which updated as they moved along the scale, a useful, related, and clear indicator of where their cursor was on the scale.

*Layout:* Based on the input received in this study, it is clear that video frames must be laid out in a balanced way on a web page to ensure that each is presented in an adequate and comfortable video viewing size.

## 7.3 Applications of ASL-Centric Survey Tools

Participants saw many potential applications for survey tools in ASL, including in medical and legal situations where concepts and

terminology are often quite complex. Contexts such as the workplace and even stores also came up, as employees and customers are often asked to take satisfaction surveys. Two participants saw a range of ways that ASL surveys could be used in education. P104 imagined using an ASL survey “for gathering data, names and dates - I would be able to enter and track what’s happening with my students better. And students would understand how to use survey forms better with these explanations in sign language...I think the next step would be to add data collection tools for researchers like you, for teachers, for people in different roles who need to gather and share data, and their findings.” Different educational possibilities came to mind for P106, “I can definitely see it in educational settings like schools. I used to be a teacher...I imagine that especially in elementary and middle school, they would really enjoy having ASL instead of English for...say a science test. Instead of having to read through all of these complicated unfamiliar words, you can see it in ASL and answer more correctly if you know the information, and also learn more that way, versus getting instruction only in English.” Our study participants were also mindful of the challenges faced by deaf people who experience language deprivation in their early years due to lack of comprehensible input, and how much they may benefit from such tools. To make the experience even more fun, P104 said: “I really want to gamify it!” For P105, the impact went well beyond personal gain, “I’m not doing this for myself. I’m doing this for our future generations of deaf kids. I want to see them be successful.”

## 7.4 Influence of Language Preferences and Comfort

Our participants’ varying levels of comfort in both ASL and English is often seen within the deaf ASL-signing community, although the group’s overall self-rated ASL fluency likely skews higher than average. Three participants self-rated fluency in ASL higher than English, three were equal (selecting the highest rating of 7 in both languages), and one participant self-rated their English fluency as higher than ASL. Previous work often portrays the need for more signed language online resources to meet the needs of deaf people with limited English proficiency. However, we noted with interest that deaf study participants with high levels of fluency in English and ASL also expressed appreciation and greater confidence in their responses when taking a survey in ASL. This demonstrates that users likely derive benefit from interacting with resources in their native and stronger language, whether that language is signed, spoken or written. Despite differing levels of comfort and fluency with ASL, all participants expressed the importance of and need for more signed-language centric surveys, and the desire to see more interface elements and designs that align with ASL video components to effectively, visually, and responsively convey information.

## 7.5 Limitations

As noted earlier, this is not an exhaustive exploration of the design space, and further studies are needed to further build a foundation for research tools that support the inclusion of SL signers. In addition, designing for touch screens and other screen sizes/resolutions

will have distinct considerations that are not explored here. This initial think-aloud data from a small number of participants is intended to be a step towards identifying design preferences for ASL-centric survey tools. With this small sample, it is important to acknowledge that the background, demographics and ASL fluency will have an impact on the results. Many of our participants had Masters degrees and all were over 30, so future studies would need to involve participants from a broader background. Additionally, our participants rated their ASL and English skills both very high. However, despite the equal or only slightly higher ASL rating, all participants believed ASL-only survey and resources were important and fulfilled a need.

Furthermore, we focused only on three question types, which were non-dynamic and had a fixed number of answer options. To ensure generalizability, future studies could be conducted to explore questions with more than 4-5 answer options and to adopt these designs for other question types. Some findings need more exploration since they appeared to be impacted by the dependency between the video length and combining the answers and its question in one video, and the size of the answers videos and the screen size. The insights gained in this work into user experiences, perceptions, and levels of effectiveness of a given set of ASL survey design elements also left us with additional research questions and themes to be explored in revised prototypes and further studies to provide stronger design recommendations. We also note that we did not calculate or compare the time users needed to get through the survey at this stage since our goal was to explore the design space for the survey design elements. However, we would like to investigate the efficiency and usability of the refined designs in the future.

Using Adobe XD to create the prototypes also created some challenges and limitations. It was difficult to quickly edit and customize content, action, and layout elements in alignment with the preferences of the Deaf design team members, and the prototype was not as responsive as a fully built tool.

## 8 FUTURE WORK

From the findings of this study, further refinement of the designs can be made, and then developed into fully functioning tools for ASL survey creation and administration. Creating a full-featured survey development platform for ASL that is user-friendly for developers and survey-takers requires an online interface that allows users to upload, design, edit, view, interact with, and respond to survey questions presented in ASL via video.

To reach this goal, additional cycles of design prototyping and user evaluations are needed to establish effective design principles and platforms that support the development of survey tools in ASL. Given the limited number of participants in this study, quantitative research to collect user data from wider audiences is needed to confirm whether the themes and findings from this study are consistent across the ASL-signing deaf community. Diversifying the age, level of education, and language fluency of future study participants will enable new insights and concerns to be exposed from the broader community. In particular, we are interested in deeper study of participants who prefer ASL over reading English, as their abilities and preferences for UI elements are likely distinct

from those who prefer English as has been shown in other contexts. Future prototypes should also consider additional design elements, possibly including letters, numbers or icons to indicate multiple choice options. Additional exploration is also needed to better understand user experiences with fundamental design elements, such as amount of content per video, number of videos per layout/screen, minimum and maximum video sizes, responsive video sizing, video scanning features, impact of video shapes, and interaction with video elements. In addition, eye tracking studies with deaf and signing users would shed light on ideal placement and design of the many visual and video elements in ASL interfaces [1].

Further study is also needed to evaluate ASL survey designs with signing DeafBlind users, and align interface elements with their experiences and needs. We recognize that the designs included video features, visual elements and border colors that were likely problematic and inaccessible for DeafBlind users. In addition, further attention will be given to addressing other perceptual limitations, such as color blindness, following Web Content Accessibility Guidelines (WCAG) [12].

As noted earlier, we designed, developed, and tested the surveys on a desktop or laptop. Further study on other form factors, such as touchscreens, as well as other screen sizes and resolution would be needed.

## 9 CONCLUSION

This paper introduced several novel designs for ASL-centric survey questions and answers that could be integrated into new survey tools. The interactive prototypes were iteratively created and evaluated through think-alouds and interviews with study participants. Our team prioritized careful engagement with the Deaf community. The study was conducted in ASL by native signing researchers on our team. The think-aloud protocol was modified to best suit signers, and the data analysis also included looking at signing videos of participants in addition to the translated English transcripts. The thorough design process documented here serves as an example for future *ASL-centric research* that aims to meet the needs of the Deaf community in other contexts.

The formative study of the prototypes revealed several design considerations for effectively providing deaf ASL-signing users access to online surveys and questionnaires in various settings. Every participant reaffirmed that such tools are needed, and several mentioned immediate applications in their fields and places of employment. Participants felt more empowered and confident answering questions in their natural language. While some remarks on aspects of the user interface appeared to be personal preferences, other topics were common across all users. This highlights the need for customizable user-friendly ASL-centric survey platforms.

While our results are exploratory, we believe that they are generalizable. Due to the novelty of ASL-centric interfaces, many open questions about what video sizes and structures are preferred remain. In addition, individual user interface components need to be further compared and studied to verify findings, and establish guidelines and standards for creating ASL-centric surveys. Because all signed languages are visual rather than sound or print based, many of our findings are likely relevant for signed languages other than ASL, just as findings regarding spoken and print content have

broader implications beyond the specific language being studied. However, it is important to consider whether there are unique features of some SLs that may make this work less applicable. In those cases, further study would be required.

Hence these findings serve as a starting point when considering the design of surveys, and other SL-centric platforms. We acknowledge that feature preferences are interdependent and future research needs to answer these questions. However, we take steps towards identifying and creating designs that serve as an example of possible variations, and provide insight into what users thought of each of these variations. This will build a foundation for future tools that enable the creation, administration and deployment of effective online surveys in ASL that include and engage the deaf ASL-signing community. In addition, the new design process, and many of the design considerations, novel interface features, and user experience results may apply in other applications and contexts, eventually leading to increased adoption and standardization of ASL-centric design elements. With this work, we hope to make strides towards a future where designs are not constrained by existing standards and practices based on written languages.

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## A QUESTION LIST USED IN THE SURVEY

The following sections contains the list of questions included in our prototype. Please note that this list contains the translated English version. The questions were constructed, signed and recorded in ASL.

### A.1 Scalar Questions

- (1) What is your cooking skill level?
  - (a) Beginner
  - (b) Learning
  - (c) Average, Can Cook
  - (d) Specialist
  - (e) Expert
- (2) How often do you order takeout?
  - (a) Never
  - (b) Once in a while
  - (c) Monthly
  - (d) Weekly
  - (e) Daily
- (3) How much do you agree/disagree with this statement: "I enjoy playing sports"?
  - (a) Strongly Disagree
  - (b) Disagree
  - (c) Neither agree nor disagree
  - (d) Agree
  - (e) Strongly agree
- (4) How much do you agree/disagree with this statement: "I enjoy going to the beach in the summer"?
  - (a) Strongly Disagree
  - (b) Disagree
  - (c) Neither agree nor disagree
  - (d) Agree

- (e) Strongly agree

### A.2 Multiple Choice Questions

- (1) Which of these colors do you like best?
  - (a) Red
  - (b) Blue
  - (c) Green
  - (d) Purple
- (2) Which of these fruits do you like best?
  - (a) Apple
  - (b) Banana
  - (c) Pineapple
  - (d) Orange
- (3) Which summer activity do you like best?
  - (a) Camping
  - (b) Swimming
  - (c) Boating
  - (d) Hiking
- (4) Which type of game do you like best?
  - (a) Board games
  - (b) Card games
  - (c) Video games
  - (d) None of these

### A.3 Multi-Select Questions

- (1) Which type of game do you like best?
  - (a) Board games
  - (b) Card games
  - (c) Video games
  - (d) VR games
- (2) Which of these activities do you do in the winter?
  - (a) Ice Skating
  - (b) Skiing/Snowboarding
  - (c) Snowmobiling
  - (d) None of these
- (3) Which of these countries would you like to visit?
  - (a) Canada
  - (b) Mexico
  - (c) Japan
  - (d) None
- (4) What methods of transportation do you use?
  - (a) Car
  - (b) Subway
  - (c) Bus
  - (d) Train