# U.S. Deaf Community Perspectives on Automatic Sign Language Translation

Nina Tran*
University of Washington
Seattle, WA, USA
ninatktran@gmail.com

Richard E. Ladner
University of Washington
Seattle, WA, USA
ladner@cs.washington.edu

Danielle Bragg
Microsoft Research
Cambridge, MA, USA

## ABSTRACT

Millions of Deaf and hard-of-hearing (DHH) people primarily use a sign language for communication, but there is a lack of adequate sign language interpreting to fill these communication needs. Development of automatic sign language translation (ASLT) systems could help translate between a sign language and spoken language in situations where human interpreters are unavailable, and recent advances in large multi-lingual language models may soon enable ASLT to become a reality. Despite the potential for ASLT, Deaf community perspectives on and requirements for such technologies are poorly understood. In this work, we conduct a survey of Deaf community perspectives in the U.S. on ASLT in order to inform the development of ASLT systems that meet user needs and minimize harms. Our results shed light on scenarios where DHH users in the U.S. might want to use ASLT, their performance expectations for ASLT in these scenarios, design preferences for ASLT interfaces, and the benefits and harms they see in the development of ASLT.

## CCS CONCEPTS

• **Human-centered computing → Human computer interaction (HCI)**; **Accessibility technologies**.

## KEYWORDS

American Sign Language (ASL), Deaf community, sign language translation, machine translation, design criteria, survey

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## 1 INTRODUCTION

More than 70 million Deaf and hard of hearing (DHH) people primarily communicate in sign language [22]. Sign languages are natural languages completely distinct from spoken languages. To facilitate bidirectional communication between DHH sign language users and hearing people who do not know a sign language, sign language interpreters may be employed. Even in countries with legal protections for interpreting services, there are severe shortages of interpreters, which excludes DHH signers from full and equal participation in society.

It is possible that the development of automatic sign language translation (ASLT) could help bridge accessibility barriers when human interpreters are unavailable. For example, ASLT could enable DHH patients and hearing doctors to better communicate in rural communities where interpreters are difficult to find, or in emergency or last-minute situations that do not allow for interpreter scheduling and travel time. No viable ASLT systems currently exist, but recent advances in multi-modal language models (e.g. DALL-E 2 [24]) and large text-based language models (e.g. ChatGPT [23], GPT-4 [25], and Bard [9]) make the emergence of ASLT increasingly imminent.

Despite such potential, DHH user perspectives on such systems are poorly understood. In this work, we explore U.S. DHH community perspectives on ASLT to help facilitate the development of ASLT systems that provide benefits while mediating harms. Through a survey with 32 DHH participants, we focus on: (i) potential use cases, (ii) performance requirements for ASLT across use cases, (iii) design preferences for ASLT interfaces, and (iv) concerns. Our results suggest that DHH community members would be willing to use ASLT in some scenarios, shed light on expectations for performance and interface design, and highlight concerns for people developing these sensitive technologies.

## 2 BACKGROUND AND RELATED WORK

Communities that primarily communicate in a signed language form distinct [32] but also diverse [26] cultures. Within these communities, Deafness – with a capital 'D' – is a proud cultural identity [27]. American Sign Language (ASL) is the main sign language used in the U.S., and the primary language of about 500,000 DHH people [19]. Just like spoken languages, each sign language is a complete natural language with a unique structure, vocabulary, and syntax.

"Audism" refers to discrimination and prejudice on the basis of audiological status [13]. Cultural appropriation, the "use of a culture's symbols, artifacts, genres, rituals, or technologies by members of another culture" [28] can also occur with Deaf cultures. For example, a number of sign language AI projects have been developed by hearing people without Deaf community input, and prior works have noted such concerns about cultural appropriation in such cases [2, 7, 10]. This work attempts to prevent such harms in the development of ASLT by highlighting DHH perspectives on ASLT.

*Author also affiliated with Microsoft Research during the project.


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While professional ASL interpreting can expand communication access, there are still challenges in attaining equitable access [17]. Contributing factors include insufficient numbers of sign language interpreters to meet community needs [15], lack of legal recognition or requirement of provision [21], and logistical challenges like scheduling [5]. DHH perspectives are also under-considered in understanding and providing professional interpreting [11]. It is possible that the development of ASLT with community input could help address some of these shortcomings.

Automatic Sign Language Translation (ASLT) refers to computer systems that translate bidirectionally between a signed language and another language. Though no viable general sign language translation systems currently exist, several startups are pursuing ASLT (e.g. OmniBridge [14] and SignAll [31]). In addition, large language models are currently emerging that handle both text (e.g. ChatGPT [23], GPT-4 [25], and Bard [9]) and multi-modal setups (e.g. DALL-E 2 [24]), that introduce new, unexplored possibilities for sign language modeling and translation.

Though ASLT is in active development, there is little prior work on Deaf community perspectives on ASLT. Prior work includes an interdisciplinary overview of sign language AI [3], and exploration of the DHH user experience with other types of AI technologies, e.g. digital personal assistants [8], and community preferences in avatar design [1, 4, 18, 20] and generation performance [12]. However, the community has been largely critical of avatar systems and their inadequate performance [34]. We complement this prior work by exploring Deaf community perspectives on ASLT more holistically (including use cases, performance criteria, design of multimodal input and output, and concerns).

## 3 PROCEDURE

The study was run as a public online survey, with IRB approval. The survey consisted of multiple-choice, Likert-scale, and free response questions, all provided in both English text and ASL video. The survey took about 45 minutes, and participants could enroll in a gift-card raffle. To help verify that participants were members of signing communities, we added questions that required ASL knowledge – transcribing ASL handshapes, and identifying ASL signs. All participants had high accuracy ($\geq$ 70% fingerspelling accuracy, and 100% quiz accuracy except one close mistake).

### 3.1 Survey Structure

The study consisted of five main sections, after consent and before basic demographics:

**(1) Experience with ASL interpreting:** Participants were asked how often they have wanted to use an ASL interpreter in various scenarios (taken from [33]), and the importance of the interpreter's cadence, accuracy and delay. **(2) ASLT Background:** We provided an explanation of ASLT, and asked if they were familiar with the idea of ASLT.

**(3) ASLT performance:** Participants rated the importance of ASLT cadence, accuracy in various scenarios.

**(4) ASLT system design:** Participants selected from various ASLT interface designs (grounded in prior work [4, 18]).

**(5) ASLT concerns and benefits:** We asked participants to select concerns and benefits they see in the development of ASLT (lists based on prior work [2, 6, 16, 29], with write-in option).

Please see the Appendix for exact questions.

### 3.2 Participants

We recruited 32 participants (excluding two who did not self-identify as DHH) through email lists and social media. All 32 participants included in our analysis identified as DHH and were proficient in ASL. ASL was a primary language for 26 (81%) participants. General demographics were – Gender: Female (19, 59%), Male (12, 38%), Other (1, 3%); Age: 19-60 ($\mu = 35$, $\sigma = 11$); Audiological status: Deaf (30, 94%), Hard of hearing (1, 3%), Deaf with cochlear implant (1, 3%); ASL level: 1 (0, 0%), 2 (0, 0%), 3 (2, 6%), 4 (4, 13%), 5 (26, 81%); Prior familiarity with ASLT: Yes (18, 56%), No (10, 31%), Unsure (4, 13%).

To help verify that participants were members of signing communities, we added several questions that required knowledge of ASL to answer. The first question after consent requested transcription of 10 ASL handshapes displayed in an image, and a concluding question required watching an ASL video and answering the signed question, which was a vocabulary quiz of three basic signs.

All participants answered the questions with high accuracy. For the fingerspelling transcription, all participants got at least 7 of 10 handshapes correct, and many of the mistakes still demonstrated ASL knowledge. For example, multiple participants entered "k" instead of a correct answer of "2" or "v"; the "k" handshape involves the same two fingers extended the same way, but with the hand at a different angle. All participants identified all three signs correctly in the vocabulary quiz, except one person entered "shave" instead of "ice cream", though these are also visually similar signs, both using similar motions near the mouth.

## 4 RESULTS AND DISCUSSION

### 4.1 Opportunities for ASLT

To better understand unfulfilled need for communication in ASL – and thus potential opportunities for ASLT – we asked participants how frequently they have wanted an ASL interpreter but been unable to get one (results in Figure 1). Interestingly, medical settings is at the top of the list in Figure 1, followed by professional and education settings. These are all scenarios where interpreting is mandated. However, our results suggest there are still unmet needs.

Figure 2 shows participants' willingness to use ASLT in various scenarios. Most participants ($n = 25, 78\%$) indicated high willingness (rating of 5) in at least one scenario, and all participants indicated some willingness (rating $\geq 2$) in at least four scenarios. Going into a business received the highest average rating, with all participants indicating some willingness, followed by self-service kiosks and informal educational activities. At the bottom of the list was mental healthcare, education settings, and formal personal events. The scenarios with the highest variance were medical ($\sigma = 1.75$) and mental healthcare ($\sigma = 1.73$), which show a bimodal distribution in Figure 2 (most selecting 1 or 5).

We also asked about which scenarios ASLT developers should focus on (Likert 1-5 for each scenario). Going into a business was the top-rated scenario ($\sigma = 3.94$), followed by professional settings and

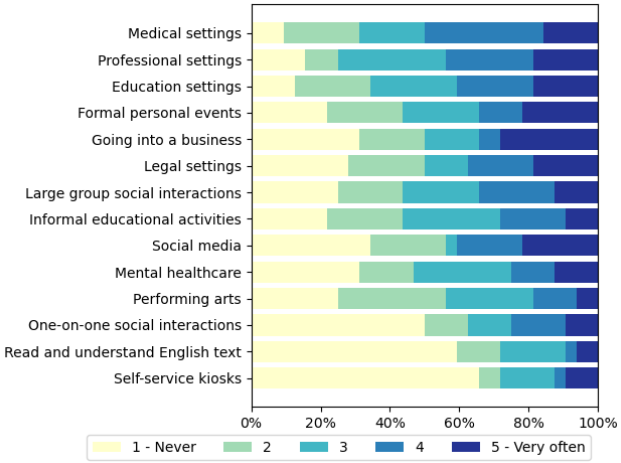


**Figure 1: Frequency of wanting but being unable to attain interpreting.**

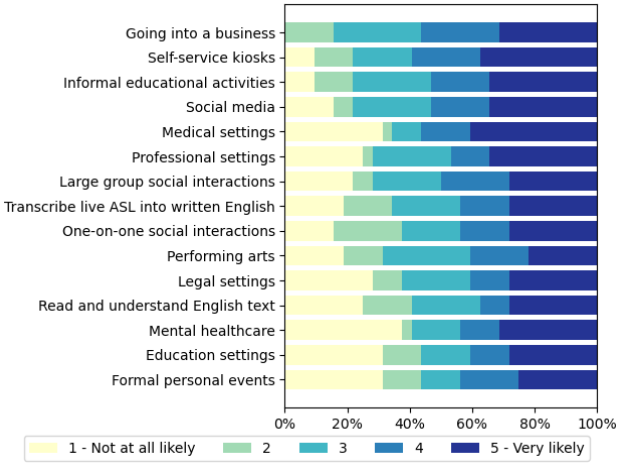


**Figure 2: willingness to use ASLT in various settings.**

social media. Lowest priorities were performing arts and reading and understanding English text. However, there was not a large difference across scenarios, with the lowest rating for "read and understand English text" ($\sigma = 3.31$).

## 4.2 Performance Expectations of ASLT

To help establish ASLT performance expectations, participants rated the importance of accuracy, cadence, and delay for a variety of settings (Likert 1-5). We asked the same question about human interpretation for comparison.

The scenarios with the lowest and highest expectations were for accuracy: self-service kiosks (ASLT 3.6, human 3.6) to medical settings (ASLT 4.9, human 5.0); for cadence: read and understand English text (ASLT 3.9, human 3.3) to medical settings (ASLT 4.8, human 4.6); for speed: read and understand English text (ASLT 3.7, human 3.7) to medical settings (ASLT 4.8, human 4.9). Across the criteria, participants had the highest performance expectations for ASLT in medical settings, and consistently high expectations for ASLT in education, professional, legal, and mental healthcare scenarios. On the other end of the spectrum, ASLT used for self-service kiosks and to read and understand English text had the lowest performance expectations, taking the bottom two spots for all three criteria. Social media also had consistently low performance expectations, coming in third-to-last across criteria.

To explore whether participants had different standards for ASLT compared to human ASL interpreters, we ran Wilcoxon signed ranks tests to compare standards for accuracy, cadence, and speed. The difference was not statistically significant for accuracy or speed, but was for cadence ($Z = 3902.5, p < .001$), with higher importance for ASLT performance ($\mu = 4.1, \sigma = 1.3$) compared to interpreters ($\mu = 4.5, \sigma = 1.0$). This concern with ASLT naturalness aligns with prior work and statements by the Deaf community on the shortcomings of signing avatars (e.g. [34]).

## 4.3 ASLT Interface Preferences

For avatar designs, we asked participants about the type of characters they would want, and which aspects they would want to customize. For characters, a realistic human appearance was most popular for both signing and speaking avatars ($n = 25, 78\%$). Cartoon characters and create-your-own-avatar tied for second-place for both signing ($n = 16, 50\%$) and speaking ($n = 15, 47\%$) avatars. Animalistic, robotic, stick figures, and block-like designs were less popular ($n \leq 6, 19\%$). For customization, most (>50%) participants reported wanting the ability to customize each option given (speed, gender, facial expressions, race/ethnicity, dialects/accents, custom backgrounds, personal style). Rather than stating preferences, several indicated that they do not want signing ($n = 3, 9\%$) or speaking ($n = 4, 13\%$) avatars.

For ASLT hardware, the most popular were mobile phone applications (n=29, 91%), followed by stand-alone systems (n=22, 69%), wearables (n=12, 38%) and implantables (n=2, 6%). One participant (n=1, 3%) opted for "N/A - I am not comfortable using ASLT." We also asked participants interested in wearables what type(s) of wearables they would be comfortable using. Half of all participants reported interest in wristbands/smartwatches ($n = 16, 50\%$), followed by headsets and glasses/goggles (each $n = 9, 28\%$), and signing gloves ($n = 6, 19\%$). The variety of preferences suggest that hardware customization may also be valuable, and introduces future work directions.

## 4.4 ASLT Concerns

To help shed light on ASLT concerns, we curated a list of 41 potential concerns, organized into eight topics. The topics, sorted by the percent of participants who identified with concerns for that topic, were: System design - 32 (100%), Social - 31 (97%), Policy/government - 31 (97%), Cultural appropriation - 30 (94%), System performance - 30 (94%), Data privacy - 29 (91%), Employment - 26

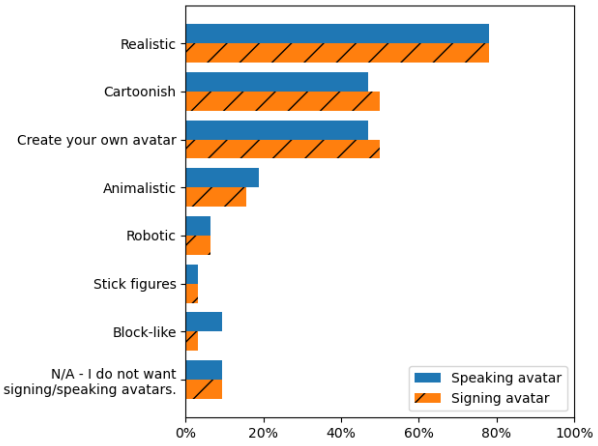


**Figure 3: Participant preferences for ASLT avatar character design.**

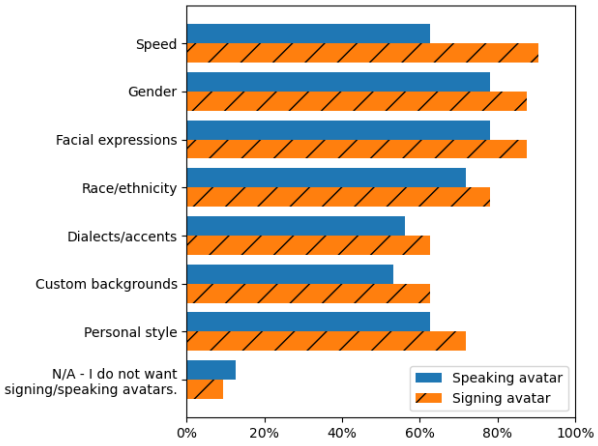


**Figure 4: Participant preferences for customizing ASLT avatars.**

| Concern topic | Concern | # (%) Participants |
|---|---|---|
| Appropriation | Hearing people profiting from ASL | 29 (90.63%) |
| System performance | Missing ASL grammatical features | 29 (90.63%) |
| System design | Accessibility of the system | 28 (87.50%) |
| Policy | ASLT might weaken legal protections of the right to other accommodations | 28 (87.50%) |
| Appropriation | Ignoring the values and needs of the Deaf community | 27 (84.38%) |
| System design | Content quality issues | 27 (84.38%) |
| System performance | Poorer performance for some users than others | 26 (81.25%) |
| System performance | Lack of recognizing environmental references while describing spatial info | 26 (81.25%) |
| System design | Limited involvement of Deaf people in leadership or as contributors | 26 (81.25%) |

**Table 1: Most common concerns with ASLT development (>80% participants reporting the concern).**

(81%), Ownership - 24 (75%). For each topic, most participants identified with at least one concern. This suggests that a variety of concerns may be broadly relevant to the community.

Table 1 shows the most common concerns with ASLT development. Top concerns include two about cultural appropriation – hearing people profiting from ASL (91% participants, tied for top concern), and ignoring the community's values and needs (85%) – underscoring the importance of meaningful community engagement. In particular, ensuring that Deaf people are the primary beneficiaries of ASLT will be essential to addressing the top reported concern.

We also explored how knowledge of ASLT might relate to concerns. To do this, we ran a t-test comparing the number of concerns identified by participants who were vs. were not familiar with the idea of ASLT prior to the survey. The test revealed statistical significance between groups ($t = 2.201, p = .0356$), with those with prior knowledge of ASLT ($n = 18, \mu = 32.67, \sigma = 8.44$) having fewer concerns than those without prior knowledge ($n = 14, \mu = 26.64, \sigma = 6.55$). This result suggests that education about ASLT may help reduce concerns, and opens up avenues for future work.

To explore benefits that community members see in ASLT, we also developed a list of 13 potential benefits for participants to select from. All participants identified some benefits. The most common was availability of services in more locations or at the last minute (n=29, 91%). This potential benefit aligns with prior work showing that there are fewer human ASL interpreters in many regions including rural areas, making it challenging to get access [30]. The second-most commonly identified benefit (n=25, 78%) was expanded access to technology for ASL users. This benefit also aligns with the design of current technologies, which primarily focuses on written or spoken language users and can exclude DHH ASL users [6].

## 5 CONCLUSION

In this work, we explore U.S. DHH perspectives on ASLT. As deep learning, multi-modal models, and large language models evolve and ASLT becomes increasingly viable, understanding Deaf community perspectives on ASLT becomes increasingly important. To this end, we ran a survey with 32 U.S. DHH participants, and present findings on performance expectations, design preferences, and concerns and benefits. Key findings include interest in using ASLT in businesses, importance of ASLT cadence, interest in customizability, and the importance of preventing cultural appropriation in

ASLT. Future work is required to deepen findings, in particular to understand DHH perspectives outside of the U.S.

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# A APPENDIX

## A.1 Survey Questions

(1) Enter the ASL letters and numbers below. [Image of 10 fingerspelling handshapes.]
[free-form text response]

**Experience with ASL Interpreting**

(2) In which of the following scenarios would you like to use American Sign Language (ASL)? (Select all that apply.)
[answer choices listed in Figure **??**]

(3) Have you ever used a professional ASL interpreter?
[Yes / No]

(4) In which of the following scenarios have you used a professional interpreter? (Select all that apply.)
[answer choices listed in Figure **??**]

(5) In each of the following scenarios, how often have you wanted to use a professional interpreter, but have been unable to get one?
[scenarios listed in Figure **??**; Likert scale answer choices from "1 - Never" to "5 - Very often"]

(6) In each of the following scenarios, how important is it that the professional interpretation captures the original meaning?
[scenarios listed in Figure **??**; Likert scale answer choices from "1 - Very unimportant" to "5 - Very important"]

(7) In each of the following scenarios, how important is the cadence of signing (e.g. choppy vs. smooth signing) of professional interpretation?
[scenarios listed in Figure **??**; Likert scale answer choices from "1 - Very unimportant" to "5 - Very important"]
(8) In each of the following scenarios, how important is it that the professional interpretation does not have much delay?
[scenarios listed in Figure **??**; Likert scale answer choices from "1 - Very unimportant" to "5 - Very important"]

**Automatic Sign Language Translation (ASLT) Background**

(9) People are working on making it possible for ASL users to communicate in ASL in more situations. For example, a restaurant might be able take your food order in ASL, personal assistants like Alexa might respond to signed commands, or a computer or phone might be able to translate a conversation between an ASL user and an English speaker. We call this technology automatic sign language translation (ASLT). Today, ASLT does not work well enough for real-world use. In the future, it is possible that ASLT will improve and become available.
Before this survey, were you familiar with the idea of automatic sign language translation (ASLT), described above?
[Yes / No / Unsure]

**ASLT Performance**

(10) In each of the following scenarios, how important is it that future automatic sign language translation (ASLT) captures the original meaning?
[scenarios listed in Figure 2; Likert scale answer choices from "1 - Very unimportant" to "5 - Very important"]
(11) In each of the following scenarios, how important is the cadence of signing (e.g. choppy vs. smooth signing) of future automatic sign language translation (ASLT)?
[scenarios listed in Figure 2; Likert scale answer choices from "1 - Very unimportant" to "5 - Very important"]
(12) In each of the following scenarios, how important is it that future automatic sign language translation (ASLT) does not have much delay?
[scenarios listed in Figure 2; Likert scale answer choices from "1 - Very unimportant" to "5 - Very important"]

**ASLT System Design**

(13) Which scenarios should technologists focus on, when developing automatic sign language translation (ASLT)? [scenarios listed in Figure 2; Likert scale answer choices from "1 - Very low priority" to "5 - Very high priority"]
(14) A signing avatar is a human-like character that signs, and can be used to provide translations of English into ASL (e.g. to make English text on a website available in ASL, or to translate a hearing person's voice into ASL). If a signing avatar were built into an automatic sign language translation (ASLT) system, what would you want the avatar to look like? (Select all that apply.)
[Realistic (e.g. looks like you) / Robotic / Block-like (e.g. Minecraft character) / Cartoonish (e.g. AR Emoji, Apple Memoji, Bitmoji, etc.) / Animalistic (e.g. tiger face, dog/cat face, etc.) / Stick figures / Create your own avatar (total face customization) / N/A - I do not want signing avatars.]
(15) If a signing avatar were built into an automatic sign language translation (ASLT) system, which parts of the avatar's appearance would you want to be able to change or customize? (Optional)
[Gender (e.g. feminine, masculine, gender neutral) / Race/ethnicity / Dialects/accents / Personal style (e.g. clothing, hair style) / Custom backgrounds / Speed (e.g. slow or fast signing) / N/A - I do not want signing avatars. / Other write-in option]
(16) A speaking avatar is a human-like character that speaks, and can be used to provide translations of ASL into English (e.g. to translate an ASL video into English, or to translate a Deaf person signing into English). If a speaking avatar were built into a automatic sign language translation (ASLT) system, what would you want the avatar to look like? (Select all that apply.)
[Realistic (e.g. looks like you) / Robotic / Block-like (e.g. Minecraft character) / Cartoonish (e.g. AR Emoji, APple Memoji, Bitmoji, etc.) / Animalistic (e.g. tiger face, dog/cat face, etc.) / Stick figures / Create your own avatar (total face customization) / N/A - I do not want signing avatars.]
(17) If a speaking avatar were to be built in an automatic sign language translation (ASLT) system, which parts of the avatar's appearance would you want to be able to change or customize? (Optional) [Gender (e.g. feminine, masculine, gender neutral) / Race/ethnicity / Dialects/accents / Personal style (e.g. clothing, hair style) / Custom backgrounds / Speed (e.g. slow or fast signing) / N/A - I do not want signing avatars. / Other write-in option]
(18) What type(s) of sign language translation technologies would you be comfortable using? (Select all that apply.)
[Mobile phone applications / Stand-alone systems (e.g. a computer on a counter in a coffee shop) / Wearables (e.g. signing gloves, wristbands, etc.) / Implantables (objects that can be inserted directly into a human body) / N/A - I am not comfortable using sign language translation technology. / Other write-in option]
(19) If you selected wearables in the previous question, which type(s) of wearables would you be comfortable using? Otherwise skip the question. (Select all that apply.)
[Signing gloves / Wristbands/smartwatches / Headsets / Glasses/sunglasses/goggles / Other write-in option]
(20) In which of the following scenarios would you be willing to use automatic sign language translation (ASLT)?
[scenarios listed in Figure 2; Likert scale answer choices from "1 - Not at all likely" to "5 - Very likely"]

**ASLT Concerns and Benefits**

(21) Do you have any data privacy concerns with the development of automatic sign language translation (ASLT)? (Select all that apply.)
[options listed in Table **??**, plus other write-in option]
(22) Do you have any ownership concerns with the development of automatic sign language translation (ASLT)? (Select all that apply.)

[options listed in Table **??**, plus other write-in option]

(23) Do you have any employment concerns with the development of automatic sign language translation (ASLT)? (Select all that apply.)
[options listed in Table **??**, plus other write-in option]

(24) Do you have any social concerns with the development of automatic sign language translation (ASLT)? (Select all that apply.)
[options listed in Table **??**, plus other write-in option]

(25) Do you have any policy/government concerns with the development of automatic sign language translation (ASLT)? (Select all that apply.)
[options listed in Table **??**, plus other write-in option]

(26) Do you have any cultural appropriation/exploitation concerns with the development of automatic sign language translation (ASLT)? (Select all that apply.)
[options listed in Table **??**, plus other write-in option]

(27) Do you have any system performance concerns with the development of automatic sign language translation (ASLT)? (Select all that apply.)
[options listed in Table **??**, plus other write-in option]

(28) Do you have any system design concerns with the development of automatic sign language translation (ASLT)? (Select all that apply.)
[options listed in Table **??**, plus other write-in option]

(29) What benefits do you see in the development of automatic sign language translation (ASLT)? (Select all that apply.)
[options listed in Table **??**, plus other write-in option]

(30) Do you have any other thoughts or feedback about automatic sign language translation (ASLT)? (Optional)
[free-form text response]

**Demographics**

(31) How would you classify your audiological status?
[Deaf / Hard of hearing / Hearing / other write-in option]

(32) Do you have Deaf parent(s)?
[Yes / No /Prefer not to say]

(33) What is your gender?
[Male / Female / A different gender from the options listed above / Prefer not to say]

(34) What is your primary language? (Select all that apply)
[American Sign Language (ASL) / English / other write-in option]

(35) How frequently do you use ASL in your day-to-day life for communication?
[Likert scale from "1 - Never" to "5 - Very frequently"]

(36) Rate your fluency in the following uses of language and communication. (Select all that apply)
[American Sign Language (ASL) / Reading and writing English / Lipreading / Speaking; Likert scale from "1 - I do not use" to "5 - I am fluent"]

(37) What is your age (years)?
[integer write-in]

(38) What is your race/ethnicity? (Select all that apply)
[White/Caucasion / Asian - Eastern / Asian - Indian / Hisplanic / Black/African-American / Native-American / Mixed race / Prefer not to say / other write-in option]

(39) Which region of the U.S. are you from? If outside the U.S., please specify in "Other". [diagram of regions]
[West / Midwest / Southwest / Northeast / Southeast / other write-in option]

(40) Watch the video and then type your answer in the text box below. [Video asking participants to type the English version of three demonstrated signs: night, toilet, ice cream]
[free-form text response]