



Making Emergency Services Accessible and Equitable

Amanda Kochak, Nailah Hill, Priyanka Dasgupta, V de la Vega

Table of Contents

Table of Contents	1
Abstract	3
Problem Space	4
History and Origin of 911	4
How 911 Works Today	4
Inaccessibility of Emergency Response	5
Inequity of Police Response	6
The Future of Emergency Response	8
Our Scope	9
Final Design of Product	10
Design Research	11
Timeline	11
Semi-Structured Interviews with First Responders	12
911 Calls for Service Data Analysis	15
Card Sort # 1	16
Survey # 1	17
Semi-Structured Interviews with Crisis Intervention Specialists	17
Open and Closed Card Sort Study	19
Design Impact	20
Survey # 2	21
Design Impact	21
Usability Testing	24
Design Impact	26
Limitations and Future Work	32
Acknowledgements	34

Works Cited

34

Appendices

36

Abstract

accessSOS is a non-profit text to 911 service that aims to provide equitable services to millions of Americans in emergency situations through a web based mobile app. This capstone project aimed to guide and inform design decisions in order to make the app easy to use by those reporting the emergency and those receiving the emergency request. In order to provide the most accurate and comprehensive recommendations, our team conducted literature reviews, needfinding interviews, surveys, cardsorts, usability studies, and analysis of existing 911 call data. From our data we were able to provide recommendations regarding the types of emergencies and their icons that are presented in the app, what information is necessary for the user to divulge, and which features to include to make the app a seamless experience.

Problem Space

History and Origin of 911

Until the 1960s, calling emergency services such as police, fire or medical, was a difficult process for everyone. Local jurisdictions had their own local telephone numbers. If someone needed to call the police, they had to figure out the number of their local police center, which was a time consuming process as that information was not readily available [8].

However that changed when President Lyndon Johnson's administration created the centralized 911 system that is currently in place today. While the administration was credited for solving the challenges regarding decentralization and long response time to calls, the actual goals of the 911 system were rooted in white supremacist ideologies - it was primarily created to "surpress the on-going civil disorders of the 1960s, which were mainly the protests led by Black communities against segregation and police brutality" [8]. The centralized 911 call system made it easier for people to report protestors who were fighting for civil rights. This led to increased arrests in Black communities as they were on the forefront of leading the protests against segregation in the 1960s.

How 911 Works Today

In order to understand the problems that exist with 911 today, it is important to understand how the 911 emergency services system works in the United States.

The 911 system was built off of landlines. 911 knows the location of a landline immediately. When cell phones became more common, the 911 system did not update their systems to accommodate this new technology.

Now, one of the most common problems 911 centers face is not being able to locate the emergency. When a person is in an emergency, they don't think to give an address or specific landmarks that help responders locate them. They think, "I need help. I see a bright light," and other descriptions that are not descriptive. 911 dispatchers have learned to ask, "what is the address of your emergency," because asking for their location consistently resulted in descriptions like seeing trees or a stop sign or other vague landmarks.

Another major issue 911 centers face is not having the technology to accept text messages. A 911 dispatcher told us how clunky the technology is to use, if a 911 center even has the technology. It requires a great deal of maintenance and continuing education to operate effectively, which 911 dispatchers don't like because they never have a chance to use it enough to get comfortable with it. It requires a lot of work for only a few people that use the service in a geographic area. The technology needed is also very pricey, which more rural and less affluent areas can't afford, leading to equitable access concerns.

Inaccessibility of Emergency Response

Over 65 million Americans cannot call 911. However, only 30% of 911 call centers can receive texts [2]. It would take at least 10 years to update the technology across all 911 call centers in the US in order to provide texting as an alternative to calling.

We partnered with [accessSOS](#), a nonprofit organization that is developing a progressive web app (PWA) to provide emergency services for those who cannot call 911, particularly in areas that do not have text to 911 available. PWAs are websites that look and feel like an app but are actually just a URL. It is unlikely and unreasonable to expect a person experiencing an emergency to first download an app on their phone. A PWA solves that problem, allowing users to access help that much more quickly.

[accessSOS](#) was founded by Gabriella Wong, who has two deaf parents. Her father texted her to call 911 for him in a medical emergency. She wondered why this was still a problem with all the modern technology solutions available today, and set out to solve the problem.

While this app is focused on addressing emergency access barriers specifically for the deaf and hard of hearing, the organization aims to also serve the needs of others who cannot call - those with speech disabilities, cognitive disabilities such as Autism Spectrum Disorder, or limited English proficiency, as well as abductees and domestic violence survivors. Our focus was on how to make sure that these marginalized communities can receive help for mental health emergencies.

One of the biggest problems with emergency access for people who are deaf or hard of hearing is that they mainly use a video relay service to communicate with hearing people, such as Sorenson, or stenographer services, such as Innocation. However, these services require a strong connection to the internet and significant phone battery. What happens if the person experiencing an emergency is in a rural area,

or has a low battery life? Video relay service works when it is light out and each person communicating can see the other signing, but most emergencies happen at night when it is dark. Some video relay services also require a set up that syncs with the user's home address. Even if someone uses video relay services to contact 911, and even if they mention they are not at their home address, emergency response still shows up at the address registered to the account. Using an interpreter also slows down the process of reporting the emergency. And ASL interpreters are not necessarily trained with the medical or mental health vocabulary that is required for reporting emergencies, leaving them ill equipped to translate for certain types of emergencies.

There are other apps that exist for this type of need, but they require a subscription fee and set up. [accessSOS](#) strives to make emergency help available regardless of how much a person can pay, just as most of us assume we will have access to calling 911 without a fee. [accessSOS](#) also believes that requiring set up to use a service like 911 is not accessible and not equitable, since this is not an expectation or requirement for people who can call 911.

Inequity of Police Response

Even if a deaf person experiences other privileges such as the color of their skin or their gender, police consider deaf people to be noncompliant when they simply cannot hear verbal commands. In one instance, "a Colorado man who is deaf and uses sign language to communicate said two Idaho Springs officers slammed him to the ground during an arrest despite his attempts to tell them that he could not understand their commands" [5].

But what if you have an intersectional identity that has been historically underrepresented, underserved, and overpoliced? What if you have a disability or mental health issue in addition to not hearing? What if police officers consider your skin color a threat? There have been consistent findings that people from marginalized groups experience higher rates of mental health and medical health issues [9].

The problem is not limited to the inaccessibility of calling 911 for people who are deaf or hard of hearing. Problems extend to inadequacies in police response once 911 is successfully contacted and police arrive on the scene, regardless of the characteristics of the people involved in the 911 request for assistance. As evidenced by frequent national news coverage, police response often does not resolve a situation as intended, particularly for marginalized communities. For instance, in 2021 alone, 911

calls requesting assistance for a person in a mental health crisis arguably backfired, as 104 people were ultimately killed in the course of police response to these calls [4].

In fact, in “The Ruderman White Paper on Media Coverage of Law Enforcement Use of Force and Disability”, authors David Perry and Lawrence Carter-Long highlight how “disability is the missing word in media coverage of police violence” [14]. In particular, people with disabilities make up a third to half of all individuals who are killed by law enforcement officers. This number includes people with mental illnesses. A study by the National Center for State Courts has shown that impaired defendants are often handled inappropriately during criminal justice proceedings [10]. Police officers that we interviewed admitted to being embarrassed when encountering a civilian with a disability who they had to write up or arrest. They knew their partner was watching and likely making fun of them. Deaf people complain that the police don’t want to hear their side of the story and don’t take statements from them, looking to a hearing person in the group for all the answers, but that hearing person might not see it the same way or might have their own agenda.



[Fig 1.](#)

The unfortunate reality is that police response is sometimes shaped before they even arrive at a scene. In “911, Is This An Emergency: How 911 Call-takers Extract, Interpret, and Classify Caller Information”, Jessica Gillooly explores reactive or call-driven policing in America’s policing system. There are a range of interactions that take place between 911 callers, 911 call-takers, and dispatchers before the police and other first responders arrive at the scene. These interactions can produce information that shape police responses [6]. In particular, 911 call-takers play an integral role in relaying information from the call to first responders. Emergency services and 911 call-takers are encountered with an “unlimited variety of incidents that require interpretation, decision and coordination” [12]. Studies by O’Reilly show that the amount of information a person receives impacts the quality of decisions that are made [13].

This has implications on the 911 call system where police responses to 911 calls are often shaped by the information passed onto them by the 911 call-takers. Gillooly highlights several instances where 911 call-takers, influenced by their racial biases, have relayed factually incorrect information to first responders, resulting in violent police encounters with civilians which disproportionately impacts marginalized BIPOC communities.

Our interviews with first responders showed that officers are not trained on how to de-escalate or how to handle situations that involve mental health, domestic violence, or substance use, which they also reported were the most common types of emergencies they respond to. When asked why they chose the police force, the trend was liking the adrenaline rush and making a difference. We know that officers can unnecessarily escalate situations when adrenaline is amplified, and unfortunately without the relevant training, that usually ends in making a difference that is negative. They also discussed the lack of support for their own mental health after dealing with a heightened encounter, and that suicide, substance use, and domestic violence are common outlets for officers themselves.

The Future of Emergency Response

There has been a growing need for alternatives to police response, especially for mental health emergencies as most police officers do not receive adequate training for such cases. Crisis intervention plays a significant role in these alternative responses and is usually led by crisis intervention specialists who are counselors that have received training in behavioral and mental health. However, most crisis intervention specialists and social workers are middle class white women. Social work requires a masters degree, but it doesn't adequately prepare their students for the communities they will serve for which they are not a part of. People with lived experience want someone who looks like them, sounds like them, and has experiences like them to respond to their emergency. Similarly, social workers responding to crises in neighborhoods they aren't familiar with or comfortable in want police to back them up, which can further escalate the situations they're responding to by a lack of trust on both sides.

There are several crisis intervention centers across the nation, many of which have developed their own crisis intervention programs. Some of these programs do hire people with lived experience, not always requiring a masters degree level professional to help address an emergency. One such program is Crisis Assistance Helping Out On The Streets (CAHOOTS), developed in Eugene, Oregon. CAHOOTS is a mobile crisis

intervention program that sends a medic and a crisis specialist to respond to emergency calls pertaining to mental and behavioral health [7].

Like CAHOOTS, several other Mobile Crisis Teams (MCT) have emerged across the country in cities such as Seattle, San Francisco, San Diego, Dallas and more. These are mobile services “that provide psychiatric emergency care to individuals experiencing a behavioral health crisis in the community” [1]. The goals of these Mobile Crisis teams are to provide on-site crisis intervention services to the community and divert emergency calls from jail and Psychiatric Emergency Services. Most frequently, MCTs are dispatched by service calls from 911 or emergency crisis lines (NMCAL) as the highest level response for psychiatric emergencies.

Apart from receiving calls from 911, these MCTs will also receive calls from 988. 988 is the National Crisis Hotline which is set to roll out nationwide in July 2022. 988 is a federal response to the rising concerns regarding police response towards individuals with a mental illness or disability [11]. People can contact 988 via call, text or even chat. The call will be forwarded to the caller’s local crisis intervention center where they will be connected to a trained counselor who can provide support and care as needed. [accessSOS](#) will be integrated with the 988 system and will reroute calls regarding mental health to the 988 hotline.

Our Scope

We can’t tackle all the problems with 911. Have to focus on one place and move from there. Our focus is the intersectionality of deaf or hard of hearing with mental health. Our project was focused on how to incorporate alternative emergency responses into the current design. The original design asks users what type of emergency help they need: fire, medical, and/or police. However, we learned from interviews with crisis response specialists and first responders, that giving users a choice of which type of emergency service they want could lead to trust issues because the user doesn’t determine which type of help is ultimately sent - the 911 dispatcher does. In July 2022, 988 a national crisis hotline, will go live nationwide. Our design took into consideration how we might incorporate this new resource into how requests for help can be routed. If a user specifies that an emergency has a weapon involved and/or is life threatening, the request for help will be sent to 911. However, if it is a mental health crisis or something that does not require police, we will route the request for help to 988, the new national crisis hotline. We designed the questions in the app to mitigate call-taker alarmism and unintended escalation of situations.

Final Design of Product

accesSOS is a web-based mobile app that enables anyone in the US with a smartphone to contact 911 without verbally calling or having to use other translation services. This app is also designed with the needs of individuals with mental and behavioral illnesses in mind. The accesSOS app is unique because it automatically translates based on the language you use on your phone, it's free, it protects the sensitivity and privacy of users' data, and it does not require a specific kind of smartphone or operating system to use.

The app mirrors the current 911 process in which a user submits an emergency and that emergency is classified and received by a 911 dispatcher that then determines the type of responder (EMS, Fire, or Police) that is needed for said emergency. Instead of textboxes for short answer descriptions of the emergency, icons were already included in the app to decrease the cognitive load and enhance understanding for individuals of limited English proficiency. In addition, icons were used as a way to speed up the reporting process for users.

Once essential information is provided users are provided the opportunity to immediately contact 911 or continue providing more information. When an emergency is submitted, users receive confirmation that help is on the way and the details of the emergency are sent to the nearest 911 call center, also known as Public Safety Answering Point (PSAP), using text to speech technology. Upon receiving the text to speech call, it is up to the discretion of the dispatcher to determine what type of responders are deployed to the emergency.

Feel free to check out the currently live version on your smartphone, and don't worry, you won't actually contact 911: <https://dev.contact911.org>. This is just to give you a sense of how it works. It is not representative of our work. It is the original design, and the starting point for our design.

Design Research

Timeline

Length of Study	Type of Study	Research Questions
March - April 2021	Survey # 1	What expectations do people have when reporting an emergency? What's most important and least important when reporting an emergency?
March - May 2021	Semi-Structured Interviews with First Responders	What information do first responders need to be most effective?
November 2021 - March 2022	911 Calls for Service Data Analysis	What are the most common emergency categories in cities across the United States?
April - May 2021	Card Sort # 1	How do people categorize different types of emergencies?
October - November 2021	Semi-Structured Interviews with Crisis Intervention Specialists	What information do crisis intervention specialists need to be most effective?
February - March 2022	Open and Closed Card Sort Study	How do people categorize different types (names and icons) of emergencies specifically for mental, medical, and report categories?
February - March 2022	Survey # 2	Are people able to accurately understand what the icons represent in the absence of a text descriptor?
March - April 2022	Usability Testing	Do people know how to use the app from start to finish? Do people know what each of the icons and names mean?

Semi-Structured Interviews with First Responders

Initially, the app only required users to 1) specify their location, 2) specify whether they require police, ambulance, and/or fire services, and 3) whether a weapon is involved. We wanted to know if this information is sufficient for responding to emergencies. We focused on understanding first responders' information needs in order to provide emergency services adequately and appropriately. We were particularly interested in this space because of how intersectionality of some identities (i.e. someone who is black and also deaf) may impact emergency response methods, given the issues surrounding police brutality in marginalized communities. We wanted to understand how to build trust with the app, the communities, and the first responders, and we wanted to understand their perspectives and experiences in order to shape the app in the most effective way.

accesSOS was interested in adding an option for users to request social services (i.e. crisis intervention services) in addition to the standard three options of medical, police, and fire. Our main goal was to incorporate alternatives to 911 into emergency response, such as 988, 311, and 211.

For the purposes of building trust on both sides, it is also important to be transparent with users that although they may choose the type of help that they want, additional forms of help may be sent in response. For example, if someone only requests medical help but discloses that a weapon is involved, police will be sent as well. If accesSOS is not clear that additional services other than the ones requested may be sent, it may be perceived as dishonest.

We conducted eight semi-structured interviews with a variety of first responders from four different states. We recruited a firefighter in North Carolina, a 911 dispatcher in North Carolina, an intelligence officer in Colorado who has lots of crisis intervention experience, two social workers in New York, and three police officers - one in North Carolina, one in California, one in New York. The goal of having such a diverse set of participants was to gain a variety of perspectives from experts who have different cultural contexts, different roles, and different information needs in emergency responses. The 911 dispatcher gave insight into how information is gathered and how callers typically share information. First responders gave insight into first response methods, common emergencies, and useful information in order to handle the situation safely, effectively and respectfully. Social workers and the intelligence officer gave insight into crisis intervention and de-escalation.

Participants were recruited through purposive sampling. Participants were asked about common emergencies that they respond to, community needs (with a special interest in marginalized communities), the different roles of each type of responder, what information responders need to know to de-escalate an emergency, and the types of training that the different types of responders receive. Questions were tailored to each participant’s profession and any expertise that we knew about ahead of time.

Each interview lasted 30-45 minutes. All interviews were recorded after gaining participant consent, and these recordings were transcribed using Descript. All interviews were uploaded to a repository that we created using Airtable. Here, the observations were on sticky notes that were affinity grouped. These small affinity groups had very specific topics, which allowed us to write corresponding insight statements. As can be seen in the image below, the observations are shown in blue, the affinity group titles in black, further affinity groups in gray, and the insights in the pink circles. These insights are ultimately what informed the final results of this study.

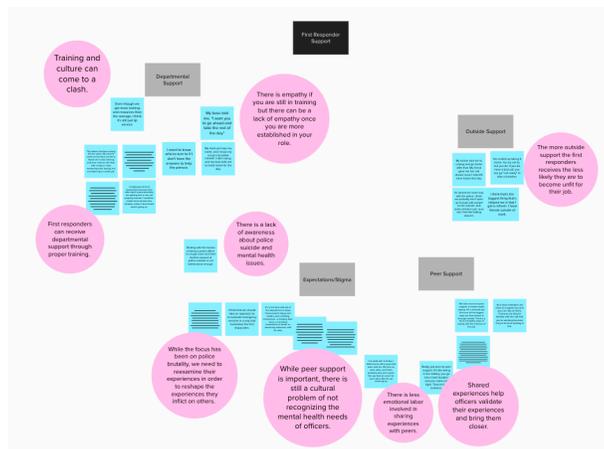


Fig 2.

Affinity groups of observations made within Mural. The topic here is first responder support, with observations in blue, and corresponding insights in pink.

Common Emergencies

We learned that the most common emergencies everywhere involve mental health, substance use, domestic violence, assaults in progress, suicide, and homelessness. Other common emergencies include car wrecks and larceny (which in rural areas usually means stealing something like a tractor, and in urban areas usually means shoplifting).

Most Important/Relevant Information Needed

First responders told us the most useful information to know when going into an emergency situation in order to make sure that the situation does not further escalate unnecessarily includes these details in no specific order: 1) specifying if the person involved in the emergency is suicidal, and if so by what method (if it's a gun, then that's a very different approach than if it's a rope), 2) if the person has a mental health disorder like schizophrenia, 3) if the person has a disability (like autism), 4) if the person uses a different language like ASL or Spanish, 5) if the person is experiencing homelessness, 6) if substance use is involved, and most importantly, 7) if the situation is currently developing.

Some officers have specializations like crisis intervention training, mental health disorders, or autism, but most don't. Providing an option to specify the most common emergencies (that have the most potential for de-escalation by knowing about in advance) could allow first responders to respond with more of a process, and can help establish a baseline of trust between parties involved.

"That's the thing about de-escalation. If you know all the information going in and you know that you have the advantage, you can go in there confidently and follow more of a process. The less you know, the more precautions you have to take to keep yourself safe." - Intelligence Officer, Colorado

Overall, several key insights emerged from our research that will be used in developing the next iteration of [accessSOS](#). The first is that location, type of emergency help needed, and weapon involvement are not the most relevant information first responders need. Instead, they need to know location, then if the emergency being reported is currently developing, and then if it is currently developing, whether there is a weapon involved. Type of emergency help needed is not for the user to decide, so it would be more useful to first responders (and through our previous research it would also be more useful to users) to instead only list options for types of emergency the user is experiencing, so that the dispatcher can determine what type of help to send (not the user). The most common emergencies that arose out of our interviews were mental health, substance use, domestic violence, assaults in progress, suicide, and homelessness. Having the same responders follow up with users helps build trust. The 911 dispatcher said that people will share a lot of irrelevant information while on the phone with 911, so adding suggestions for the most relevant kind of information to share in the open text field could help 911 dispatchers get more useful details, and help users feel more confident about what to share.

This initial study laid the groundwork for our future studies - qualitative interviews with potential users to uncover their expectations, card sorts to understand mental models around emergency categories, and data analysis of actual publicly available 911 call records.

911 Calls for Service Data Analysis

Our initial research with first responders illuminated the need for a more holistic understanding of 911 emergencies across the United States. We thus initiated a search to uncover publicly available data regarding 911 calls for service. We discovered that a few cities provide this data in open data portals, but because every city uses different software to manage these 911 calls, there is no consistency in the data variables captured and data formatting.

We focused our analysis on six cities. We analyzed 911 call data from Seattle [16], San Francisco [15], New Orleans, Charleston, Dallas, and Detroit [17]. In order to analyze the data, we performed exploratory data analysis, data cleaning, and created new variables to standardize call types. Our analysis focused on call types as this information was most relevant for us to determine emergency categories for the app; however, we did additional analysis into call outcomes and specifically crisis call outcomes in Seattle, as this information was uniquely available in this city. Unfortunately, we did not accomplish standardization for San Francisco. For New Orleans, Charleston, Dallas, and Detroit, we were able to leverage a starter standardization pipeline to build upon provided by the Vera Institute of Justice [17], and therefore analyzed these together.

Top 8 Call Types for Cities Analyzed

New Orleans, Charleston, Dallas, and Detroit (Standardized)	Seattle (Standardized)	San Francisco (Not Standardized)
Other	Traffic Related	Passing Call
Statuses	Disturbance	Traf Violation Cite
Accidents/Traffic Safety	Crisis Complaint	Traffic Stop
Complaints/Environmental Conditions	Public Assistance	Suspicious Person
Property Crime	Trespassing	Homeless Complaint

Alarms	Alarm	Fight No Weapon
Other Crimes	Theft	Well Being Check
Violent Crime	Hazards	Trespasser

Based on our data analysis, we were able to ensure that the top 911 call categories in the cities analyzed were reflected in the app. We were also able to see that the call types are highly dependent on the location. For instance, in San Francisco, it was disheartening to find out that homeless complaints were in the top five types of complaints to 911, whereas in other cities, this type of complaint was lower among the 911 calls for service, if there was even a specific category for it at all.

Card Sort # 1

In Spring 2021, the team conducted an unmoderated card sorting task that aimed to answer two questions; which emergency service would you request for each emergency and how would you label each emergency into overarching categories. The first question required participants to put 44 cards with different emergencies into 4 predefined categories (Crisis Intervention, Police, Ambulance, and Fire). Participants were also given the option to create custom categories that they believed would better classify the emergencies on the cards.

Key findings from the first card sorting task were that participants were mostly able to assign the emergencies to one first responder. However, comments and interviews suggest that some emergencies could require more than one first responder to show up. In addition, a few participants suggested an option for Social Services or an “intervening body of power that can take action, while mitigating an issue without the use of harm/violence/weapons.”

The second task required participants to classify the same 44 emergencies into 8 predefined categories that included overarching themes for emergencies. These 8 categories were trouble breathing, domestic violence, accident, crisis intervention, bleeding, robbery, unconscious, and assault. Participants were also given the opportunity to create custom categories that they believed to better classify the cards.

The key findings from the second card sorting task were that many participants mentioned being confused by some of the 8 predetermined categories. Some felt as though the categories provided were insufficient and did not align with some of the

emergencies. For example, there was no predetermined category for fires. Additionally, some categories were too broad and needed to be more detailed. For example, the category Accidents could refer to a car accident or someone tripping and falling.

It's important to note that for both card sorting tasks, participants were not shown any icons that would match up with the cards or categories.

Survey # 1

The team also conducted a 30 minute survey through Qualtrics and mTurk with 200 participants of ages ranging from 23-40 years old. In order to receive a range of feedback, we aimed to include participants with a relevant disability such as cognitive processing disorder, stroke, speech, ASD, or hearing. We also aimed to include a mix of individuals with various housing arrangements. The key questions that we were aiming to answer are:

- Are people aware of text to 911 services, and do they know if it exists in their area?
- Which URL would people think to try for emergency services?
- What expectations do people have when reporting an emergency?
- What's most important and least important when reporting an emergency?
- Can people identify what type of emergency they are having accurately?

The results from the survey showed that participants felt as if the features and the questions within the app were appropriate and aligned well with their needs in reporting an emergency. Additionally, even though participants provided positive feedback for the app, the majority were not familiar with text to 911 services in their area. Also, we were able to determine that 911.us is the preferred URL for emergency services.

Semi-Structured Interviews with Crisis Intervention Specialists

Previous user research informed us that those reporting emergencies would like to request alternative emergency services to respond to their emergency other than the Police, Ambulance and Fire department. Our goal was to confirm if this addition aligned with the needs of Emergency Service Professionals.

In addition, we needed to understand what the needs and pain points of those responding to the emergencies were and what features would be most helpful in order for them to receive emergency reports and respond appropriately.

Finally, our last goal was to understand the requirements needed in the app to correctly redirect calls to crisis hotlines such as 988, the national crisis hotline, and 311, non-emergency services line.

We recruited 9 participants, 8 Crisis Intervention Specialists and Social Workers, and 1 Academic. Each interview was 45 minutes long and conducted over Zoom. Because this was such a niche sample, we used personal outreach emails and referrals to connect with all participants.

There were four Key Insights from our interviews. The first was that Crisis Intervention Specialists aim to avoid calling the police as much as possible. This is for a few reasons, the police have a negative stigma surrounding them and that police departments are already short staffed when it comes to responding to emergency calls. Having a separate intervention team that can respond to non violent emergencies allows the police to focus more on situations that are violent or have the presence of a weapon.

The second insight was that in order to understand the caller and the emergency better, dispatchers or crisis response phone operators will ask the caller questions in order to receive information regarding their current and past mental health status, any relevant medical information, and their current emotional state. These questions are necessary to ensure that the caller receives the most appropriate care and ensures the safety of those responding to the emergency.

The third insight was that almost all of the participants highlighted the importance of creating a relationship with the caller. The majority of calls that participants received were those regarding domestic abuse, depression, mental breakdowns, suicide ideation, and anxiety as a result of COVID's stay at home orders. Being that these are all sensitive topics, callers may be reluctant to divulge information unprompted. Building trust and a safe environment allows the caller to feel comfortable speaking about their situations and thought processes. Some ways that crisis intervention specialists build trust with the caller is by listening to their stories and offering them emotional support, reassuring the caller that the police will not be involved (unless there are weapons involved) and by having the same responder follow-up with the individual later on.

The last insight was that it's important for Crisis teams to have strong relationships with Emergency Service Response teams. Emergencies can be pretty volatile and can escalate very quickly. Crisis Intervention Specialists are trained to

de-escalate situations very quickly and to appropriately deal with mental health crises. However, they are not equipped to deal with violent situations and in the event that a situation escalates to violence, they must be able to quickly contact the police, ambulance, or fire departments to keep themselves and the caller safe.

Open and Closed Card Sort Study

We conducted two card sort studies - one open card sort and a closed card sort. Our goal with these card sort studies was to understand people's mental models and how they categorize different icons into groups. In the closed card sort, we provided users with three categories, "Report, Mental and Medical" as it currently exists in our app and wanted to see whether most user's categorize the icons the same we did on our app. For our open card sort, we did not give the users any categories and let them choose their own categories. We mainly did this because we were curious to see if there was another label people most commonly used instead of "Report".

Some of the research questions we aimed to answer:

- What emergencies do people expect to be categorized under Medical, Mental, and Report?
- Is there another label people frequently use instead of "Report"?
- Are the emergencies clear, distinct, and comprehensive?
- Do users feel as though their emergency was effectively communicated through the app?

For this study, we recruited around 100 participants. We wanted to recruit people from diverse backgrounds so we could get an understanding of how the general population perceives the icons and categories. We posted the links to the card sort and various platforms such as LinkedIn, Facebook, Reddit, Instagram and Twitter. We also directly reached out to friends and family.

Out of the 25 icons that we had, there were 5 that a majority of our users incorrectly categorized (Extreme Weather, Housing, Unknown Problem, Welfare Check and Disability). Other than those 5, the remaining icons were correctly categorized by most of our participants. This was a really great signal because it indicated that our categorization of the icons aligned with the majority of participants.

From our open card sort, we observed that there was not a popular alternative for the "Report" category. Other options people utilized instead of "Report" were "Crime", "Emergency", "Police", "Violence", "Physical Health" and "Other". None of these other

options are an appropriate replacement for “Report” since it did not encompass all the different icons that are categorized under “Report.” However, since we also did a closed card sort, we know that users are generally able to categorize the correct icons into the Report category if the category is already provided for them.

Design Impact

Icon	Our Categorization	Participant's Categorization	Ideas & Insights	Design Changes
 Extreme weather	 Medical	 Report 96%	Change icon - include hot and cold extreme weather.	 Extreme weather
 Housing	 Mental	 Report 72%	Change the icon from a house to a tent	 Housing
 Unknown problem	 Mental	 Report 67%		 None of the above
 Welfare check	 Mental	 Report 48%  Mental 42%		Kept the same

 Disability	 Mental	 Medical 74%	Have two icons - one in Mental and the other in Medical	 Disability  Disability
---	---	---	--	--

Table: Results from Closed Card Sort

Survey # 2

We conducted a qualtrics survey where we showed our participants pictures of the icons on our app and asked them to label them with just one word. We wanted to see whether people are able to accurately understand what the icons represent in the absence of a text descriptor. Our team used similar methods of recruiting from our card sort study. This qualtrics study was done simultaneously as our card sort and we used the same participants from the card sort.

Out of the 19 icons we tested in this survey, 7 of our icons were clearly understood by most of our participants as they were able to appropriately label them. Their labels clearly matched the way we labeled these icons. These were the icons for House, Drugs, Breathing, Seizure, Disability, Allergic Reaction and Theft.

8 of our icons were slightly confusing for our participants as there was no clear match between how we labeled them vs how the majority of our participants labeled the icons. These were the icons for "Report", "Extreme Weather", "Chest Pain", "Unpredictable Behavior", "Welfare Check", "Trespassing" and "Kill/Homicide".

Lastly, 5 icons had a clear mismatch between what we labeled them vs how our participants labeled them. These were the icons for "Unconscious", "Mental Health", "Suicide", "Sexual Assault" and "Unknown Problem".

Design Impact

Icon Before Changes	Participant's Labels	Ideas & Insights	Design Changes
 <p>Extreme weather</p>	<p>Overheat 88 participants</p> <p>Sunburn 13 participants</p> <p>Exhausted 7 participants</p>	<p>Not representative of all extreme weathers.</p> <p>Change icon to include both hot and cold extreme weather</p>	 <p>Extreme weather</p>
 <p>Chest pain</p>	<p>Healthcare 30 participants</p> <p>Heart Issue 27 participants</p> <p>Additional Support 25 participants</p>	<p>Need to make it more clear that this is explicitly for chest pain/heart issues and not an umbrella term for all healthcare related issues.</p>	 <p>Chest pain</p>
 <p>Unpredictable behavior</p>	<p>Confused 76 participants</p> <p>Question 16 participants</p> <p>Uncertain 12 participants</p>	<p>Unclear whether people would choose to select this option when reporting unpredictable behavior of a person.</p>	<p>Kept the same</p>
 <p>Welfare check</p>	<p>Care 45 participants</p> <p>Love 28 participants</p> <p>Donate 11 participants</p> <p>Heart 10 participants</p>	<p>Term "care" is general and not specific to welfare checks.</p> <p>Unclear whether participants would choose this option when requesting for a welfare check.</p>	<p>Kept the same</p>

 <p>Trespassing</p>	<p>Break in 24 participants</p> <p>Burglary 22 participants</p> <p>Surveillance 17 participants</p> <p>Theft 17 participants</p>	<p>Remove the camera in the icon.</p> <p>Add a "Do Not Enter" sign to the icon.</p>	 <p>Trespassing</p>
 <p>Homicide</p>	<p>Gun violence 31 participants</p> <p>Shooting 27 participants</p> <p>Robbery 11 participants</p> <p>Assault 10 participants</p>	<p>Replace gun with a knife.</p>	 <p>Homicide</p>
 <p>Unconscious</p>	<p>Fall 72 participants</p> <p>Faint 18 participants</p> <p>Unconscious 3 participants</p>	<p>We already have an icon specifically for fall.</p> <p>Just have a person lying on the ground. Remove the person standing and the arrow.</p>	 <p>Unconscious</p>
 <p>Mental</p>	<p>Love 52 participants</p> <p>Emotional Support 24 participants</p> <p>Mental Health 16 participants</p>	<p>Mental health is a very complex topic and hard to represent with just an icon.</p>	<p>Kept the same</p>

 <p>Suicide</p>	<p>Poison 32 participants</p> <p>Death 22 participants</p> <p>Danger 11 participants</p>	<p>Suicide is hard to represent with just an icon without it becoming quite graphic and triggering.</p>	 <p>Suicidal thoughts</p>
 <p>Sexual assault</p>	<p>Help 35 participants</p> <p>Pat 17 participants</p> <p>Groping 16 participants</p> <p>Assault 8 participants</p>	<p>Have the hand touch another part of the body to make it more obvious.</p>	<p>Kept the same</p>

Table: Results from Icons Qualtrics Survey

Usability Testing

We designed a new prototype that instead of asking users what type of help they want, asks users what type of emergency they are experiencing: medical, mental, or report. We conducted eight 30-45 minute usability interviews with deaf and hard of hearing participants from a deaf conference in Albuquerque and from The New Mexico School for the Deaf in Santa Fe March 14 - 18, 2022. V conducted the interviews, and Gabriella, the founder of [accessSOS](#) who is a CODA (Child of Deaf Adults) and whose first language was ASL interpreted the interviews. We paid participants \$20 for their time and feedback.

Before and after flow

<p>Original design (red = required) One long scroll</p>	<p>Design incorporating feedback from previous research (red = required, blue = new suggestion from participants) Each question is a new page</p>
<p>What is your location?</p>	<p>What is your location?</p>

What type of emergency are you experiencing?

- Medical
- Fire
- Police

Are there weapons involved?

- Yes
- No
- Not Sure

Can you describe your emergency?

- Physically unstable
- Breathing problem
- Traffic accident
- Chest pain
- Social services
- Bleeding
- Assault
- Crime active
- None of the above

What type of emergency are you experiencing?

- Medical
- Mental
- Report

Are there weapons involved?

- Yes
- No
- Not Sure

Is the emergency currently life threatening?

- Yes
- No
- Not Sure

Do you need an interpreter?

- Yes
- No
- Not sure

Do you have time to share more details?

- No, contact help now
- Share more info (1 min)

If they chose medical:

Can you describe your emergency?

- Allergic reaction
- Animal bite
- Bleeding
- Breathing
- Chest pain
- Disability
- Extreme weather
- Fall
- Physical injury
- Poison
- Pregnant
- Seizure
- Unconscious
- None of the above

If they chose mental:

<p>Can you describe your location? Select one</p> <ul style="list-style-type: none"> ● Indoors ● Outdoors ● Moving <p>Who is in need of help?</p> <ul style="list-style-type: none"> ● You ● Someone else ● Both <p>Anything important to know?</p> <ul style="list-style-type: none"> ● Open text box 	<p>Can you describe your emergency?</p> <ul style="list-style-type: none"> ● Disability ● Housing ● Mental health ● Substance use ● Suicidal thoughts ● Unpredictable behavior ● Welfare check ● None of the above <p>If they chose report: Can you describe your emergency?</p> <ul style="list-style-type: none"> ● Fight ● Fire ● Gun shots ● Homicide ● Sexual assault ● Theft ● Traffic accident ● Trespassing ● None of the above <p>Can you describe your location? Select all that apply</p> <ul style="list-style-type: none"> ● Inside ● Outside ● Moving <p>Who needs help?</p> <ul style="list-style-type: none"> ● You ● Someone else ● Both <p>Anything important to know?</p> <ul style="list-style-type: none"> ● Open text box
---	--

Design Impact

It's really simple and easy to use

Participants thought it was straightforward and not confusing overall to use. They had a good experience using the app from start to finish. The questions asked

made sense to participants, and the order in which the questions were asked made sense to participants.

Make icons bigger

Although we originally didn't consider those with vision impairments as this app is focused on catering to the needs of disabilities that might limit ability to speak and listen, deaf participants pointed out that their eyes become fatigued by the end of the day from relying on them all the more without having hearing. Half of the participants mentioned how small the icons were, and another participant didn't say anything about it but squinted and couldn't accurately assess what some of the icons were because of their size.

Too word heavy and too difficult for people who don't use English primarily

One participant said: The language is really advanced for a normal person. I feel like it's really formal.

More clicks for more control

For required pages that users can only select one option, we had an automatic transition to the next page after they selected an option, instead of having to click "Next" to progress.

Participants felt rushed when screens automatically continued to the next page after they selected an option. They didn't feel confident in their choice, and wanted to be able to go back to be sure they chose the right option.

While we originally were focused on less clicks since we know that more clicks could mean less users make it through the whole process, we learned that the right balance will involve a back button.

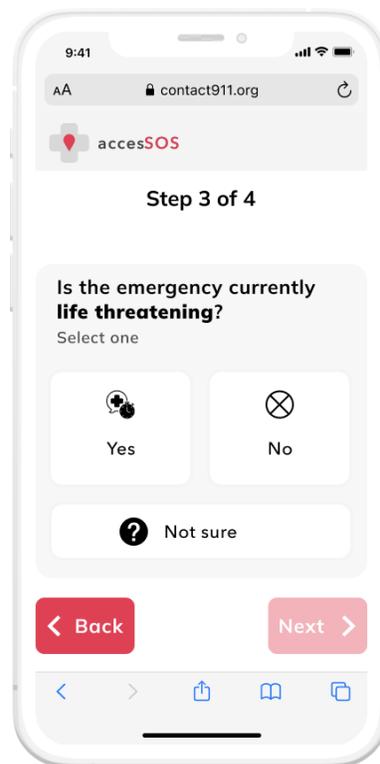


Fig 3.

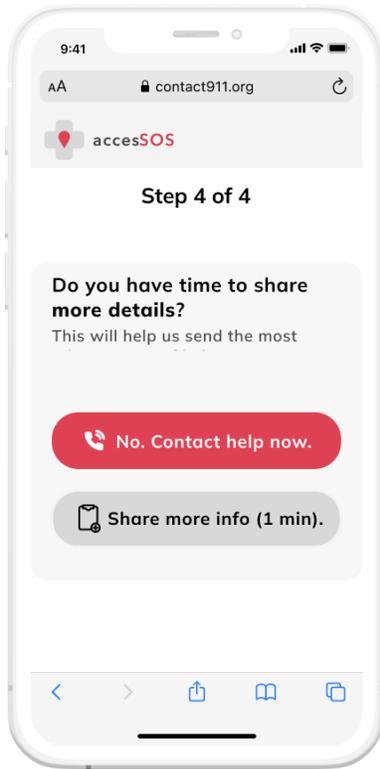


Fig 4.

Progress bar is important

Participants really appreciated the progress bar.

One participant said:

I love step one out of four. I know how many are left. That's letting me know: "Okay. I'm almost there. I'm almost done."

Add a required page for whether a user needs an interpreter

Participants asked why there wasn't a question about their language needs if this is supposed to be for deaf users.

We thought that the app automatically converting to the language your phone uses answered this need, but we hadn't considered the need for having an interpreter present when emergency services arrive on scene.

Unfortunately, the police don't know who to contact for an interpreter, and interpreters aren't typically available late at night when most emergencies happen.

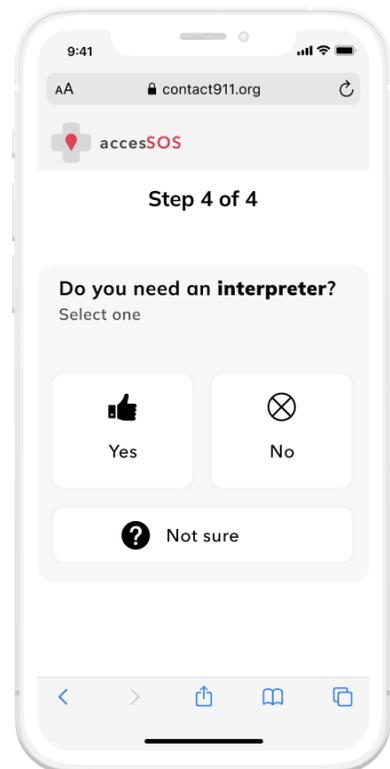


Fig 5.

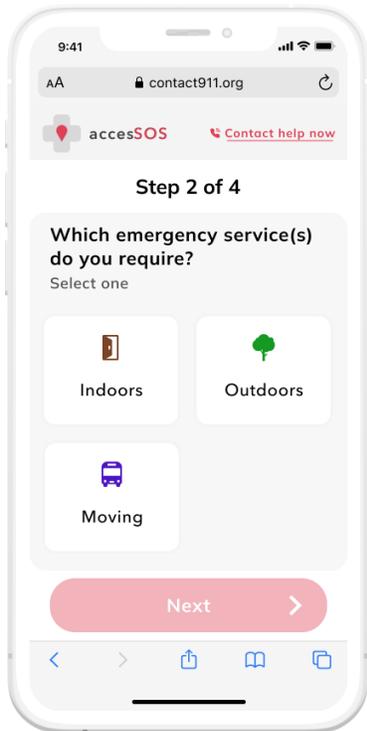


Fig 6.

Allow users to select more than one option for whether their location is indoors, outdoors, or moving

Participants wanted to choose outdoors *and* moving.

While we originally thought moving would indicate being on a highway or in public transit, participants thought of scenarios we hadn't considered, like walking outside.

Change outdoors to outside

Participants thought outdoors meant being in nature.

They also suggested changing the icon to include a sun instead of just a tree, or adding a building and people walking.

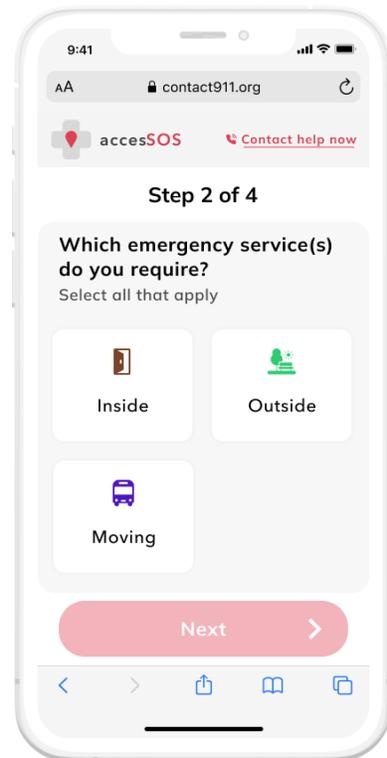


Fig 7.

Suggested Improvements for Icons

Icon + Name	Category	Pain Point	Explanation
 Bleeding	 Medical	Icon	Two participants suggested something more severe for the bleeding icon, explaining that the blood drips from a finger wouldn't warrant calling an ambulance.
 Chest pain	 Medical	Icon + Name	Participants didn't consistently understand the umbrella of situations that would be relevant for chest pain .
 Extreme weather	 Medical	Icon + Name	In the desert it is possible to have a life threatening emergency from both extreme cold and extreme hot within the same day. Participants from the desert understood the purpose and value of the extreme weather option, while those from other areas of the country did not.
 Pregnant	 Medical	Icon	Two participants thought the pregnant icon looked like a man.
 Disability	 Mental	Name	Most did not like the icon for mental disability , suggesting a wheelchair instead (even when it wasn't a physical disability).

 <p>Housing</p>	 <p>Mental</p>	<p>Name</p>	<p>Participants did not live in areas where there is a large homeless population. They did not understand what the word housing represented, but the tent in the city was clear.</p>
 <p>Welfare check</p>	 <p>Mental</p>	<p>Icon</p>	<p>Some didn't know what the welfare check icon represented, though we weren't concerned about this because if users don't know what it is then it likely isn't relevant to them.</p>
 <p>Sexual assault</p>	 <p>Report</p>	<p>Icon</p>	<p>Participants didn't always understand the icon for sexual assault, suggesting that it looked like a pat on the shoulder, and something more graphic would be more clear. However, those who had more of a framework for sexual assault liked the icon.</p>

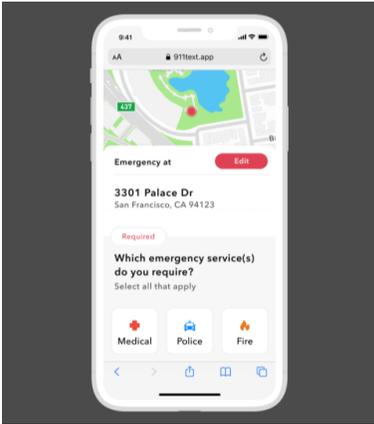


Fig 8.

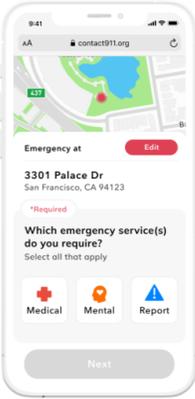
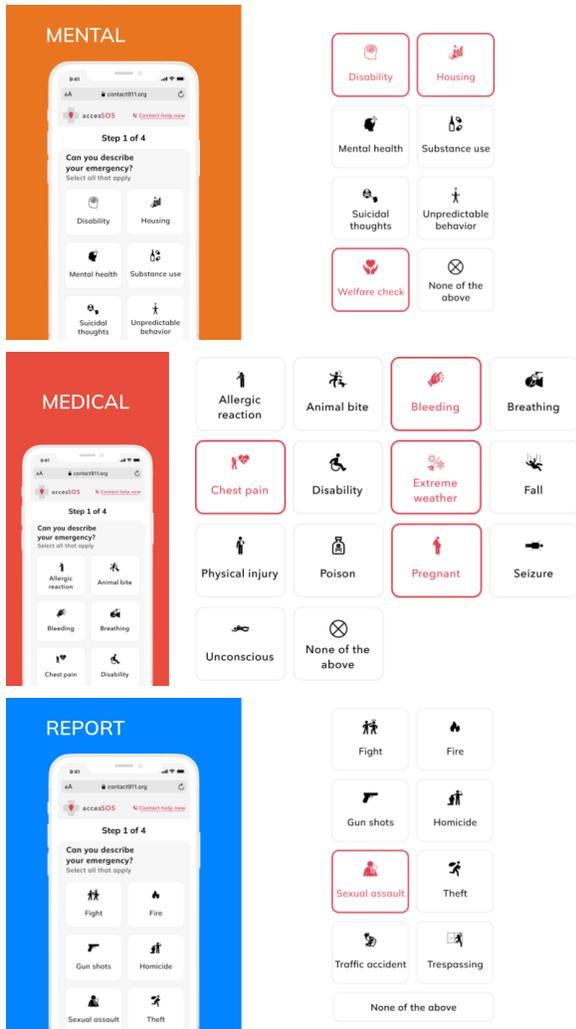


Fig 9.

Our research findings directly informed design changes that we made. We incorporated 988 into **accesSOS** design by changing the app from asking if the user wants medical, fire, or police to asking the user if their emergency is medical, mental or a report.



We added new icons and categories approved by social workers and crisis intervention specialists to be appropriate and relevant without being triggering.

Fig 10.

Limitations and Future Work

Our product facilitates contact with 911 and 988, but it does not influence changes to the existing 911 system or the soon to be realized 988 system. Therefore, as previously discussed, we sought to accurately depict the categorization scheme that 911 call takers use when they receive an emergency call. We did not approach this problem the same way for 988 because there is no official categorization scheme to be considered yet.

Our research revealed that not only are 911 categorizations extremely diverse across the country, but also that our in-app emergency categorizations would need to be limited based on necessity to not overwhelm the users. After reviewing publicly

available 911 calls for service data from dozens of cities, and performing more thorough exploratory data analysis on six cities, we found that cities used thousands of categories to classify emergencies, and the data was limited to call type (there were no extra notes about calls to analyze). Standardizing these categories for cities across the country without significantly more domain expertise was unrealistic and would require more time than we had available to us. Not only this, but providing such a diverse set of categories to our users would result in overwhelming cognitive load and would warrant the app ineffective during a time of crisis. Therefore, we primarily leveraged the 911 call data analysis as a mechanism to validate what we were uncovering through our qualitative research, as opposed to a blueprint for our own app's emergency categorization scheme.

Furthermore, we sought to gain insight into the needs of a wider range of marginalized communities than we accomplished. We sought to interview people with limited English proficiency, people historically mistreated by the police such as lower socio-economic status BIPOC communities, and people experiencing homelessness. However, we found difficulty in recruiting participants with lived experience from these populations for our studies. We believe future research should prioritize investigating these populations' particular needs, and how to incorporate further community resources into the app for non-emergency situations.

This brings us to a discussion on future product directions. Several of the crisis intervention specialists we spoke to mentioned that they take the caller's demographics into account when deciding which crisis intervention specialist to send to the scene. Sending someone who is similar in demographics to the caller has the potential to build trust between the caller and crisis intervention specialist and eases the tension. Especially in cases of domestic violence, crisis intervention teams try to send other women to provide care for the caller, as it is less triggering for the caller. We believe the number one priority for future iterations of the product should include a more robust setup prior to an actual emergency event that enables the user to optionally specify their demographics and further personal characteristics (such as gender, race, medical conditions, etc). This information will help emergency services professionals decide who to dispatch to the scene and how to address the crisis.

Lastly, a salient point brought up during our interviews is the importance of two way conversation when an individual might be experiencing a mental health crisis. As the [accesSOS](#) app only enables one way communication, facilitated by text to speech technology, we encourage further investigation into the viability of the opposite technology, speech to text, as a solution to enable two way communication.

Acknowledgements

We could not have accomplished this project without the mountain of support we received. We would like to express our deepest gratitude to accesSOS' founder, Gabriella Wong, and our faculty advisor, Dr. Coye Cheshire, for serving as our guiding forces throughout this project.

We would also like to extend a special thank you to our research assistants Cynthia Salazar, Maneet Bhatia, and Peggy Maleki, all of whom played a crucial role in helping bring this project to completion. Thank you to our funders, MIT Solve Stand Together Ventures Unbundle Policing, Sozosei Foundation, Melissa Beck, Betsy Fader, CTSP. Lastly, thank you to the numerous other faculty, students, friends, and family that supported our work throughout the life of this project.

Works Cited

- [1] Alei, A., Pierotti, C. (2016) Crisis Services (Mobile Crisis Teams)
- [2] Anderson, M. (2018) *Only a quarter of emergency call centers accept text messages to 911*
<https://www.csmonitor.com/Technology/2018/1031/Only-a-quarter-of-emergency-call-centers-accept-text-messages-to-911>
- [3] Blackwell DL, Lucas JW, Clarke TC. Summary health statistics for U.S. adults: National Health Interview Survey, 2012. National Center for Health Statistics. Vital Health Stat 10(260). 2014.
- [4] Burghart, B. (2022). Fatal Encounters. <https://fatalencounters.org/>
- [5] Burke, M. (2021, September) *Deaf Colorado Man Arrested for not complying with police commands he could not understand, lawsuit says*. NBC News
- [6] Gillooly, J. (2020) 911, Is This an Emergency?": How 911 Call-Takers Extract, Interpret, and Classify Caller Information
- [7] Griggs, T. (2021, April) *This city uses crisis workers to answer 911 calls. Now, others want the blueprint*. What's Next Magazine
<https://whatsnextmagazine.com/stories/this-city-uses-crisis-workers-to-answer-911-calls-now-others-want-the-blueprint>
- [8] Feldkamp, K., Neusteter, R. (2021, January). *The Little Known, Racist History of the 911*

Emergency Call System. In *These Times Magazine*
<https://inthesetimes.com/article/911-emergency-service-racist-history-civil-rights>

- [9] Kushalnagar, P., Reeseman, R., Holcomb, T., & Ryan, C. (2019) Prevalence of Anxiety or Depression Diagnosis in Deaf Adults. *The Journal of Deaf Studies and Education*
- [10] Law Enforcement, Justice, and People With Disabilities. US Department of Justice Office of Justice Programs
<https://www.ojp.gov/ncjrs/virtual-library/abstracts/law-enforcement-justice-and-people-disabilities>
- [11] National Suicide Prevention Lifeline
<https://suicidepreventionlifeline.org/current-events/the-lifeline-and-988/>
- [12] Normark, M., & Randall, D. (2005). Local expertise at an emergency call centre. In *ECSCW 2005* (pp. 347-366). Springer, Dordrecht.
- [13] O'Reilly III, C. A. (1980). Individuals and information overload in organizations: is more necessarily better?. *Academy of management journal*, 23(4), 684-696.
- [14] Perry, D., & Carter-Long, L. (2016) *The Ruderman White Paper on Media Coverage of Law ...* Mar. 2016
- [15] San Francisco. (2022). *Police Department Incident Reports*. [Data set].
<https://data.sfgov.org/Public-Safety/Police-Department-Incident-Reports-2018-to-Present/wg3w-h783>
- [16] Seattle Police Department. (2022). *Call Data*. [Data set].
<https://data.seattle.gov/Public-Safety/Call-Data/33kz-ixgy>
- [17] Vera Institute of Justice. (2022). *Making 911 Accessible - A Guide to 911 Open-Datasets*. [Data set & Publication].
Publication: <https://www.vera.org/publications/making-911-accessible/>
Data set: <https://github.com/tsdataclinic/Vera>

Appendices

[Figma Prototype](#)

[Study Details](#)

[Interview Questions & Discussion Guide](#) for Interviews with Crisis Intervention Specialists

[Detailed Results](#) from Interviews with Crisis Intervention Specialists

[Research Plan](#) for Card Sort Study (March 2022)

[Detailed Results for Card Sort Study](#) (March 2022)

[Website Github Repository](#)