Covid Connect: Chat-Driven Anonymous Story-Sharing for Peer Support

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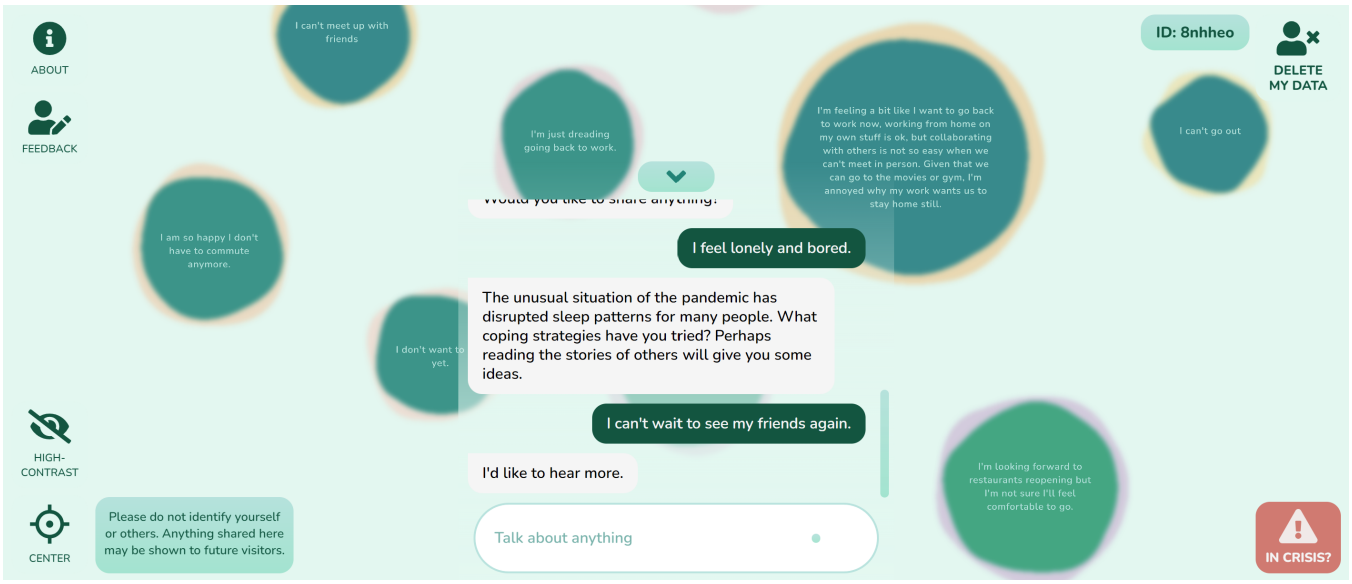

Figure 1: The Covid Connect interface showing the central chat area, several bubbles of statements by previous visitors, and icons for help, feedback, and emergency support.

ABSTRACT

The mental-health impact of the Covid-19 pandemic and the related restrictions and isolation have been immense. In this paper, we present a system designed to break down loneliness and isolation, and to allow people to share their stories, complaints, emotions, and gratitude anonymously with one another. Using a chatbot interface to collect visitor stories, and a custom visualization to reveal related past comments from others, Covid Connect links people together through shared pandemic experiences. The collected data also serves to reflect the experiences of the community of participants during the third through fifth waves of the pandemic in the local region. We describe the Covid Connect system, and analyze the collected data for themes and patterns arising from stories shared with the chatbot. Finally, we reflect on the experience through an autobiographical lens, as users of our own system, and posit ideas for the application of similar approaches in other mental health domains.

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CCS CONCEPTS

• **Human-centered computing** → *Collaborative and social computing systems and tools*; **Natural language interfaces**; *Information visualization*; • **Applied computing** → **Psychology**.

KEYWORDS

chatbot, Covid-19, mental health, visualization

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1 INTRODUCTION

The past two years of the Covid-19 pandemic have brought restrictions, fear, disease, anger, anxiety, and inequity around the world. Workplaces, retail stores, gyms, entertainment venues, personal care services and restaurants have closed repeatedly as new waves of the virus circumnavigate the world. Travel has been severely curtailed. Perhaps most devastatingly from a mental health perspective, social gatherings of all types have been constrained. There have been months when indoor gathering were prohibited. Visiting elderly family in care homes or sick friend in the hospital was not permitted. The impacts of the pandemic are myriad — health, including loss of life, economic and employment challenges, and, importantly, the mental health consequences of restrictions, fear, grief, and isolation.

This project was born out of a recognized need for support for people forced to work from home early in the pandemic, and expanded to broader pandemic-related challenges. In some ways, it was a project for which the research team ourselves were part of the intended audience, and it was motivated by our own mental health needs. Starting in March 2020, our local region began a series of lockdowns and restrictions, some of which continue to this day (restaurants and gyms are closed again in January 2022).

This paper is about Covid Connect, a support application which collects and shares *personal stories*. Following this theme, we will intersperse our own autobiographical experiences [19] as they relate to the design of Covid Connect, as sidebar comments noted in boxes, and marked with the initials of the author, like this:

> On March 17, 2020, I wrote my group: *"Does anyone need anything from the lab? If you need something in the coming month, probably best to go get it now, or DM me and I will get it for you. I'm heading in to get my plants."* Clearly I underestimated the timeline we were facing. Already by two weeks later, I was feeling the effects, posting, *"So lonely now in the morning drop-in Zoom. I even brought my silly mug today but no one joined to see it." (CC)*

That feeling of isolation and loneliness, coupled with the lack of capacity for mental health services, inspired the idea of a system to help make connections in an anonymous, safe way, which could be casually accessed. While inspired by personal experiences, the need was broad: contemporary machine learning analyses of social media posts revealed that discussions of anxiety and suicidal thoughts were already increasing between January and April 2020 [17].

This project draws on the expertise of an interdisciplinary team including computer scientists, a therapist, and a clinical psychologist. Professionals in human resources were consulted for advice on the types of challenges employees were reporting early in the pandemic. The design of Covid Connect centres around three goals:

(1) A simple chatbot to encourage story-sharing and expressing feelings during the pandemic.
(2) Language processing and a visual interface to display the statements and stories of others in real-time during the chat session, to help visitors feel less alone.
(3) Collecting and archiving the submitted statements as a record of the impacts of the pandemic to be shared as an open dataset.

While the stigma around accessing mental health support has lessened in recent years, economic, social, and availability barriers still make it challenging for many people to seek out support [27]. Chatbots are commonly used in museums as guides, as customer service agents, and personal assistant [13]. In recent years, as the need for mental health help increased, especially during the Covid-19 pandemic, there has been higher demand for an accessible solution. Building on the impacts of simple chatbots such as ELIZA [34], we envisioned Covid Connect as a free, anonymous, low-barrier way for anyone with a phone or computer to share their feelings and experiences. Of course, no chatbot, no matter how sophisticated, can replace the nuanced responses and guidance of a qualified therapist. That is not our goal here. Covid Connect does not advise or provide feedback, but rather emulates a Rogerian style, using questions to help visitors to open up and share their experiences and feelings. It is always positive and encouraging to the visitor. Despite this emulation, of course, just as ELIZA was a simulation [2], Covid Connect is not actually Rogerian therapy, which requires, among other things, active listening and empathy, neither of which are possible with a simple chatbot. Thus, we position Covid Connect as a facilitated form of story-sharing, which may also provide opportunities for reflection and journaling.

In the remainder of the paper, we will explore related approaches to using automated chat and visualization for mental health support, review the design of the Covid Connect system, analyze the stories and comments collected through a nine-month deployment, and reflect on our own experiences through an autobiographical design lens to motivate future work.

2 BACKGROUND

In this section we will break down the related work to discuss mental health chatbots and peer-to-peer systems. Covid Connect is a hybrid of these approaches, using a chatbot to create peer-to-peer connections. Finally, we will review the most relevant approaches in visualizing collections of short texts.

2.1 Mental Health Chat Systems

The policy response to Covid-19 has inadvertently exacerbated the already limited access to mental health services, while simultaneously increasing the number of people who need to access support. Much of the current mental health help system relies on in-person interaction, which has proved to be difficult due to regulations put in place to limit the spread of the virus. In the face of these issues, there has been a push towards the inclusion of digital tools for mental health. Even with virtual (e.g., video call) therapy, there are still capacity and cost barriers. Chatbots could aid our current situation, as they engage with users by mimicking human-like behaviour and carry out conversations with users. They have been employed for

a variety of reasons, including enhanced productivity, assistance, entertainment, socialization, and mental health [3]. Conversational agents, or chatbots, have been introduced to aid in suicide prevention [4, 18] and cognitive behavioural therapy (CBT) [12]. In a study conducted by Sweeney et al., professionals who work in mental health view chatbots' importance in supporting mental health and wellbeing to be relatively high (74%, $p < .01$) [29]. However, it is important to note that chatbots are not a substitute for the care provided by a licensed professional [31]. Chatbots do not understand the nuances of human language and in some situations provide unclear or nonsensical responses. However, despite the disadvantages, chatbots have been found to have positive effects on individuals with varying severity of depression in randomized controlled trials [11] which is the reason why we chose to include a simple chatbot within Covid Connect.

One of the first chatbots built to mimic therapists was ELIZA, created in 1964 by Weizenbaum. It made to use Rogerian therapy techniques, where the system would "reflect" questions to the patient using parts of the patients' original response [34]. ELIZA used pattern matching and pronoun substitution to mimic human understanding and could converse with the user despite having no built-in knowledge. Our web application draws inspiration from the Rogerian therapy techniques used by ELIZA as we felt that it would be a useful method of eliciting responses from users and allow them to reflect of their experiences during Covid-19.

Since then, various other chatbots have been developed with mental health counselling in mind. Some take advantage of artificial intelligence to detect the emotion of the speaker to better relate to them. Lee et al. built a chatbot that uses emotion recognition, where the main purpose of their system is to detect emotion through continuous observation of the chatbot's conversation with the user in order to change the drinking habits of the users [15]. They showed that emotion detection-based chatbots were useful for personalized response generation. Another mental health chatbot focusing on emotions is Wysa, developed by Touchkin, which focuses on delivering empathy-driven conversations with its users [11]. A study was conducted to determine the effectiveness of delivering positive psychology and mental well-being techniques using Wysa on users with self-reported symptoms of depression. Users were given questionnaires at various points during a conversation, and the app asked for voluntary feedback. They found that individuals who interacted with the application more showed significantly higher average improvement compared to the low usage individuals [11]. Overall, their study showed that using chatbots, like Wysa, can be effective for people with depression if used frequently.

Commercially, mental health chatbots mainly target individuals with depression and anxiety. As previously mentioned, chatbots can be seen to relieve certain barriers, such as stigma against mental health services [29], and provide round-the-clock help for those in need. One method mental health chatbot creators have adopted to make chatbots more accessible is to incorporate them into social media apps like Facebook Messenger [6, 10]. A randomized controlled feasibility trial was conducted to test whether chatbots could be used to deliver positive psychology skills and promote well-being amongst young people after cancer treatment using Vivibot, built atop Facebook Messenger [10]. The study participants included young adults who had completed cancer treatment within the past five years, and results showed that the experimental group who used the chatbot had, on average, reduced anxiety [10]. Another chatbot launched via Facebook Messenger, Woebot, delivers CBT using short daily conversations which include mood-monitoring exercises and personalized content based on the user's mood states [6]. In a study conducted over the course of ten months, data from adult users was collected and showed that within five days of initial app use, people felt that they bonded with the chatbot [6].

With the people's mental state being affected by Covid-19, research like that conducted by Yarrington et al. can give us an insight into how chatbots are currently being used for mental wellbeing [37]. They collected data from February through July 2020 using a mental health app named Youper. They examined the effects of Covid-19 on the mental health of over 100,000 individuals located in the United States. Youper allows users to submit mood ratings, guides them through meditations, and engages in conversations.Through their study with Youper data, they found that negative emotions, anxiety, tiredness, stress, and sadness increased significantly compared to pre-Covid-19 [37]. On the other hand, some users reported feeling more calm, happy, and optimistic during the pandemic. This study demonstrates that emotional responses to the pandemic are complex and people are willing to share their emotions through applications that aid their mental well-being.

2.2 Peer support

Much of the focus in mental health recovery of mental health self-help relies on formal services. These services might not be readily available to many people, for instance, those working irregular hours or having financial difficulties. Although chatbot systems can remedy some disadvantages of the current infrastructure for mental health, there are other methods for support. A commonly used method for helping those struggling with mental health is offering peer support. Peer support allows for people who have gone through similar experiences to bond and find role models. Participants of peer support groups report that they see pieces of themselves within the mentors that lead the meetings [21]. Traditional health systems often lack the space that allows people to create empathetic connections and a sense of validation from their peers. Therefore, peer support is often preferred over formal therapy by some, as it is perceived as more relatable and less stigmatizing [21]. However, with the Covid-19 situation and lack of funding towards peer support programs, help that can be provided by such resources has been made inaccessible or difficult to access. To make peer support groups for mental health more accessible, online based support systems can be used to create spaces where people can share their thoughts freely and interact with others experiencing similar situations as them.

An example of a system that allows users to interact with peers experiencing similar situations is Togetherall[1]. Togetherall is an online mental health support network for individuals above 16 years old that claims to help people manage stress and anxiety. Its online service is monitored by professionals at all times and is supported by clinical analytics. It aims to provide immediate access and support for mild to moderate mood and anxiety symptoms. Although it does offer trained counsellors to chat with, its main

[1] https://togetherall.com/

Table 1: The chat system was trained to recognize greetings, generally positive and negative emotions, exceptional situations (e.g. self-harm statements), and the ten intents (topics) listed here. One or more responses were written for each intent. Responses were generated randomly based on the detected intent. All possible bot statements are in the supplemental material.

Detected Intent	Example Bot Response
School	Studying from home has been a challenge for many people. What coping strategies have your tried and are effective?
Work	What advice can you share about making the best of working from home?
Alcohol	It is normal to experience difficult feelings during the pandemic You aren't alone. What are some other coping strategies you can try?
Food	Changes and losses experienced during the pandemic can influence our eating patterns. You aren't alone. What have you tried to cope with this?
Childcare	Many people have struggled with childcare during this past year. You aren't alone. What coping strategies have your tried? Are they effective?
Finances	The past year has brought financial insecurity to many people. What have you tried to cope? Perhaps reading the stories of others will give you some ideas.
Job	This has been a difficult time for many people who have lost work. Can you tell me more about your experience?
Relationship	That sounds difficult. Isolation and the abnormal situation of the pandemic have strained relationships for many people. What coping strategies have you tried? Perhaps reading the stories of others will give you some ideas.
Sleep	The unusual situation of the pandemic has disrupted sleep patterns for many people. What coping strategies have you tried? Perhaps reading the stories of others will give you some ideas.
Loneliness	Experiencing loneliness is difficult. What advice would you give someone who is feeling lonely?

function is as a posting wall. Users add emotion 'bricks' to a large white wall as a way to share their mood or feelings at the moment. Users can also view other bricks in the wall and comment on them. Our system took inspiration from the format Togetherall, and we employed a similar metaphor based approach when designing.

This project is also inspired by the PostSecret community art initiative [32]. PostSecret invites participants to mail a physical postcard to the curator of the site. Postcards are annotated with a personal secret, often moving, emotional, or shocking, and are completely anonymous. Selected postcards are displayed on the blog, as a way to connect the audience with the author through a mediated channel. Similarly, our work seeks to use the chatbot agent as a form of anonymous computer-mediated communication between visitors.

Another outlet where people find comfort by sharing their personal experiences with others and seeking out peer support is through forum-type websites like Reddit. Reddit has multiple mental health subreddits like *r/covid19_support*, *r/Depression*, and *r/Anxiety* that offer help for individuals with varying mental health concerns. Like many of the previously mentioned online-based peer-to-peer support systems, Reddit allows users to remain anonymous and various forums encourage the use of throwaway accounts to seek help with more privacy. In an article published by MIT News, a group of researchers used machine learning to track Covid-19's impact on mental health using 800,000 Reddit posts. They focused on analyzing the data from the first wave of Covid-19, spanning from January 2019 to April 2020. They found that over 15 different subreddit groups devoted to mental illnesses, most increased significantly in size [30]. Additionally, the subreddit created dedicated to Covid-19, *r/Coronavirus*, grew from 2000 subscribers to around 2 million[9], showing that Reddit has been a source of information and help for many struggling during the pandemic.

2.3 Visualizing Text Collections

While Covid Connect builds on previous research in visualizing collections of documents, the visualization component is intentionally unsophisticated in terms of supporting analysis and investigation. Instead, our aim is to *honour the individual* in the data, building on ideals of feminist approaches to data visualization [7]. Thus, we do not create word clouds or summaries of the contents of the text collection, but rather reveal the most relevant texts in their entirety, to encourage reading and reflection. There is a long history of visualizing text, best covered in broad surveys [14, 16]. Specifically for this project, we use text similarity measures to layout short texts using a simple similarity-based rank layout, inspired by early approaches to document collection visualization by Wise [35].

3 CONTEXT AND GROUNDING STUDY

To gain a better sense of the topics on which the system should focus, we conducted an online survey with a group of four human resources professionals and one department manager from our local municipal government. This was followed by an online focus group with the same individuals. The goal of these investigations was to gather the most common issues being raised by employees who were forced to work from home, which was the original target audience for our work. We quickly realized in this discussion that many challenges were also arising for essential workers who could not work from home but instead had to continue in public-facing

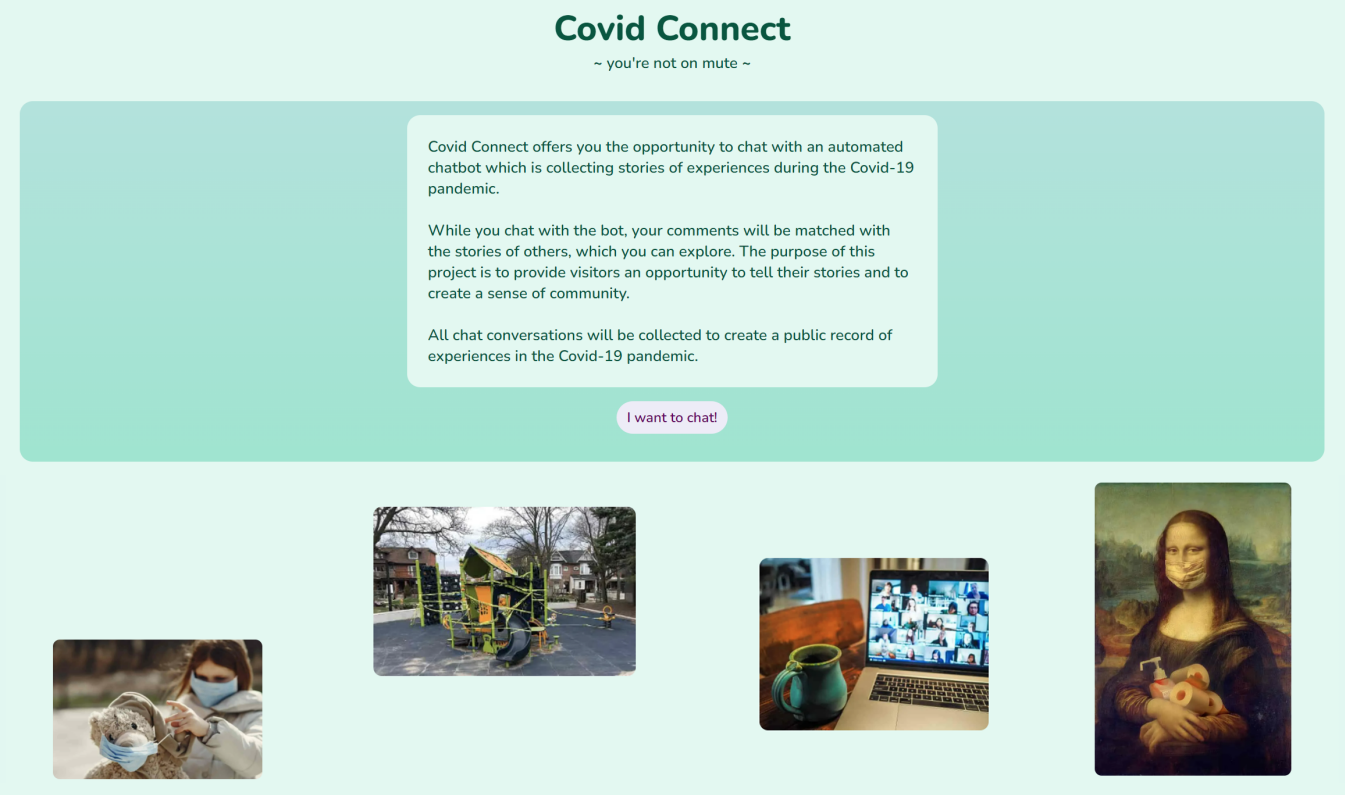


Figure 2: The welcome page of Covid Connect. Each time the page loads, a random selection of pandemic-related images is shown, as a form of a priming for the experience ahead.

positions. We subsequently decided to broaden the intended audience to include any adult who wanted to share pandemic-related stories and feelings.

> In the focus group meeting, while I was one of the facilitators, it struck me during the discussion that while I didn't have strong health concerns, I was harbouring a lot of fear for my parents' health, and it was affecting my productivity at work. Just hearing someone else share concern for elderly parents helped me put a name to the general dread I was feeling. (CC)

We conducted the survey in November 2020, with questions focusing on personal experiences, coping strategies, challenges faced by other employees, and support structures provided by the employer. Respondents reflected on their own experiences, citing increased workload and more time spent at work due to blurred boundaries between work and home life. The uncertainty of the future, "no promise of when things will get back to normal", and the lack of an established workplace culture of using video for remote work lead to difficulties. With respect to challenges faced by employees in their organization, participants mentioned the lack of a "work from home culture" as a source of stress due to incumbent uncertainties with work schedules and breaks. Also, staff were "feeling out-of-the-loop" and experiencing a lack of connection. Other themes of concern were: fatigue, everything taking longer to complete, isolation, competing demands, and balancing work and home life.

We followed the survey with a 90 minute focus group consisting of the same five professionals from the municipal government and the entire project team. The discussion was guided by the initial responses received in the survey. Three broad areas of impact emerged:

Individual Concerns include isolation, lack of hope, monotony, health anxiety, unhealthy coping strategies, etc.

Work-related Concerns include quality of work, suffering, connectivity, technology not working, increased workload, struggles with collaboration, feeling like they can't step away from the computer, disconnect between on sight and from home employees, etc.

Interactions Balancing individual and work-related challenges, setting boundaries on work time, child care while working at home, etc.

The participants were shown sketches of the initial interface design for Covid Connect. From their feedback, the idea of upvotes (for helpful messages) and flags (for potentially harmful messages) was added. The idea of a direct reply function to allow future participants to reply to past statements was discussed, but rejected in favour of consistent interaction with the chatbot itself, to avoid

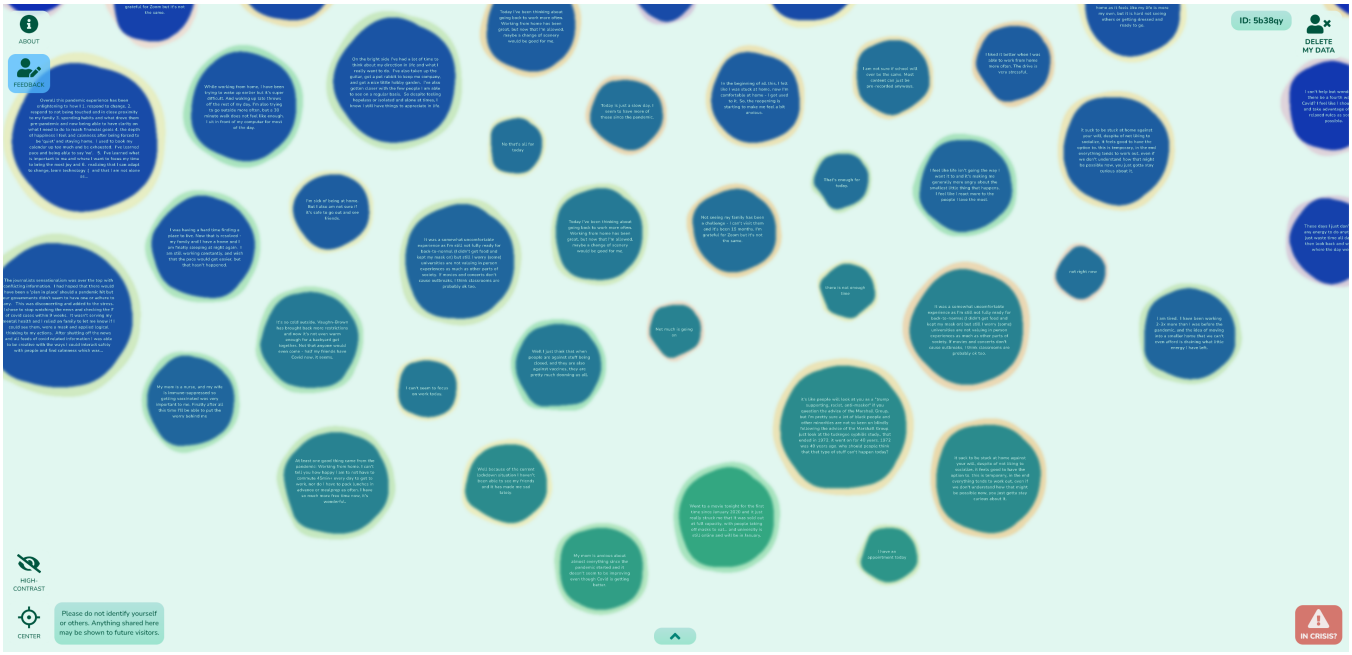


Figure 3: An example array of bubbles (zoomed out) showing the gradation of background colours representing recency. Here, the chat window is minimized.

people providing direct advice or feedback to others, which may be unwelcome.

From these discussions, we decided to focus the chat script on common pandemic-related challenges related to personal life, working-from-home, and the intersection of personal and work life.

4 COVID CONNECT

In this section, we will describe the design of Covid Connect (http://covidconnect.me)and the rationales behind key design decisions. We have separated this into the chat system, the visual display, the special considerations for privacy and safety, and finally details of the implementation approach.

4.1 Design of Chat Scripts

The chatbot driving the Covid Connect experience is designed to first-and-foremost elicit stories and comments from visitors. So, the chat system takes a questioning approach, commonly inviting visitors to share more on a topic. Because of the rapid-deployment timeline of the system in an emergency situation such as the early days of Covid-19, we decided to launch early, with a basic script and some software bugs, using daily iterative refinement of the underlying chat scripts and interface software post-deployment. The final chat script and interface were established in the second month of deployment; these are what is described here. Following the advice highlighted by Klopfenstein et al., we did not want our chatbot to pretend to be human neither did we want to perfect the intent or meaning extraction using natural language processing techniques [13]. Additionally, they recommended avoiding using excessive artificial intelligence when similar performance could be achieved using simpler models. Our chat system (described later in this section) was implemented with a pre-trained model that could recognize some high-level categories of comments, called *intentions*. For example, greetings, goodbye messages, requests for support, or mentions of keywords such as school or work. Model re-training, to improve intent recognition, was periodically conducted as more data was collected. The system also recognized *template* statements, such as phrasing containing feelings. Words recognized in a template are slotted into the chatbot response, to make the interaction more direct and personal. For example, a detected {feeling} word would be inserted into the response "Why are you feeling {feeling}?" Based on the recognized intent of a user statement, the chatbot replies with a random selection from pre-programmed responses. As we were limited in the sophistication and detail of intent recognition, we also embedded a series of topic-agnostic *fallback* statements, such as "Would you like to share more?" and *redirect* statements, such as "What advice do you have for others for dealing with the effects of the pandemic?" Redirects are issued after fallbacks, to move the discussion forward and prevent monotonous responses.

We aimed at a general population, with moderate (e.g., some high school) literacy levels. This meant avoiding jargon and complex phrasing in the scripts. The conversation experience follows a looping structure of continuous validation, based on existing practice in dialectic therapy [23]. The system asks the participant to share, provides general *validation* (specific, if the *intent* was detected) and *normalization*, then invites more sharing. When the participant is finished, a *closure* routine activates, to end on a positive note.

Validation is provided through chatbot responses, e.g., "Feeling {feeling} is okay, it's good that you recognize your feelings. Please,

tell me more about it." *Normalization* comes through responses to specific scenarios, e.g., "Studying from home has been a challenge for many people. What coping strategies have your tried and are effective?" Normalization is also provided through the display of similar comments by others, as described in the next section. Finally, *closure* is achieved through ending on a positive reflection and an invitation to return: "Let's end on a positive note. What is the best thing that happened to you over the pandemic?" followed by "Thank you for participating - feel free to explore the visualization more. If you want to continue to talk, just write here and we can pick up the conversation."

Building on the results of initial conversations with HR and management professionals from our partner organization, as well as pilot testing with lab members, friends, and family, and studies done on social media such as Reddit [17] , we created a list of 10 common specific themes of concern for recognition by the bot. These are shown in Table 1 along with example responses. All chat responses were reviewed and approved by the mental health professionals on our project team, as well as our institutional Research Ethics Board. The entire collection of chat responses is provided in the supplemental material.

> While testing the prompts of the chat, I remembered how uncertain the pandemic felt at first. Like it was wrong to go into work. I remember staying away at my family's urging because I worked in a hospital. But I had to go in once to participate as a panellist in a job interview. My extended family saw this as very troubling and did not want to see me until I had isolated for two weeks. I remember feeling so conflicted. I was trying to do my job, but it felt almost dangerous for those around me. (SA)

4.2 Visual and Interaction Design

We began our design process by reflecting on our previous work with *Tied In Knots*, a visualization which expressly honours the individual stories by presenting them in full on a visual canvas [8]. Shared goals with that project were (1) honour individual stories without abstracting, (2) usability without any training. Additionaly, we aimed for (3) a look and feel which was not overly dramatic or depressing, given the stress participants were already facing. Our team generated a series of seven design alternatives, each consisting of the chat box and a set of related responses from prior participants, arranged in different ways. Alternatives considered included split-screen with a scrolling list of related chat comments, radar chart glyphs representing characteristics of the comments, bubble sets [5] enclosing related comments, or chat comments arrayed on an infinite canvas in circles. These sketches were shared with research team and broader research group for feedback, and discussed in a group meeting. Glyphs were considered too complex and abstract, and a scrolling list too conventional to be enticing. Lab members suggested to stick with the circles but apply a metaphor of 'bubbles'. This metaphor was guided by the idea of something shimmering and ephemeral in appearance. We decided to work with this as our design inspiration, and to blend the chat box and bubble area with similar colours to visually reinforce their connectedness.

Upon arriving at the Covid Connect site, visitors are greeted by a landing page designed to set the tone of casual conversation around the pandemic, with a playful tagline, *'you're not on mute'*, and images of pandemic experiences that evoke the difficulties (playgrounds covered in caution tape, empty classrooms), the coping strategies (board games, humorous graffiti), and the realities of life under restrictions (masked people, birthday parties on zoom). We intentionally avoided overly dramatic or triggering images (renderings of the virus, images of temporary hospital wards, etc.). Thematic images are selected at random from a curated collection of royalty-free images, including our own photos (see Figure 2). After the landing page, participants are presented with the consent form, which then leads to the main interface (see Figure 1).

All pages of the interface contain three utility buttons:

High Contrast This button changes the colour scheme and styling of the site to a high contrast mode for increased accessibility. (see supplement for an example)

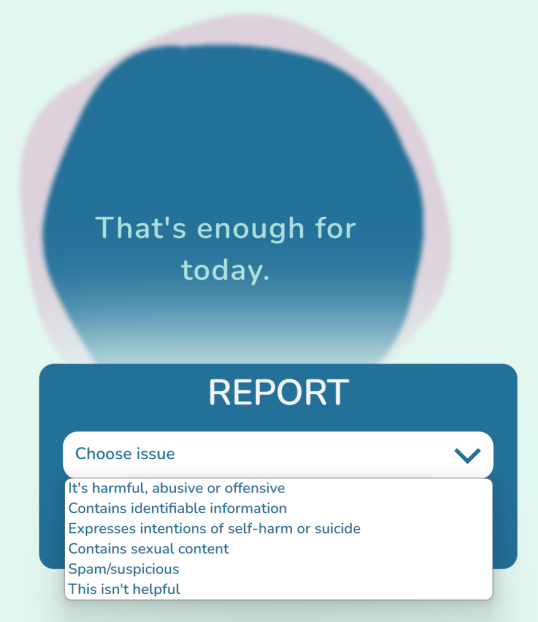
In Crisis? This button opens a dialog which contains advice to call emergency services and links to government-curated support resources.

Delete My Data This button provides an easy mechanism for participants to delete their data from the system by providing their randomly assigned ID.

The Covid Connect interface is centred around a chat window anchored in the bottom centre of the screen, with the remainder of the window background available for the presentation of prior statements from the dataset in the visualization. The background of the chat window is semi-transparent to give the impression of connection and contiguity with the statements shown in the background. The chatbox can be minimized, and the visualization can be panned and zoomed manually using mouse or touch, or automatically while clicking a statement. Statements are displayed in animated containers we called *bubbles*. Bubble interaction is available when the chat box is opened, allowing for quick interleaving of exploration and chat. Each bubble has an animated two-layer border, and each bubble independently slowly changes shape. The background colours rotate through a set of colours sampled from photographs of soap bubbles in the sun. This 'airy' design was intentional to balance the sometimes heavy emotional weight of the content of the texts.

Bubbles are laid out roughly in a semicircle anchored at the chatbox (the specific layout is governed by a stochastic force-directed layout discussed later). The bubbles which are closer to the chat window represent similarity to recent statements made by the participant, while those further out are related to past statements. A gradation of the background colour from green to purple double encodes this recency factor, as shown in Figure 3.

Drawing inspiration from Togetherall and PostSecret, Covid Connect displays bubbles filled with messages from previous chats so that users can interact with them. Additionally, the interaction design is aimed at a 'walk-up-and-use' scenario, with minimal technical expertise or instruction required. Upon opening the chat interface, a transient instruction "Pan & zoom to explore bubbles" appears on the background, and fades out after five seconds. The chat agent immediately starts the conversation with a random greeting, some contextualizing instructions, and a reminder of the



(a) The reporting tool for flagging comments for moderation.

(b) The upvote button boosts the probability of a comment being shown again.

Figure 4: Interactions for providing feedback on comments displayed on screen.

unique user ID, before asking an opening question (e.g. "What would you like to talk about?"). Chat agent messages are broken into short blocks of text and timed to simulate a person typing. The system is responsive to screen sizes, including mobile, in which utility buttons are placed in a menu and the user can toggle between chat and exploration.

4.3 Privacy and Safety Considerations

Safety and privacy considerations were integrated into both the chatbot script and the visual design of Covid Connect. We were acutely aware that the chatbot could not replicate professional mental health support. Indeed, we positioned Covid Connect as a story-sharing system, not a support service. It was not designed to provide links to community resources or additional support mechanisms, which were available through many other services. We felt that curating and maintaining these rapidly changing links was beyond the scope of the project, and there was a risk of misrecognizing a request and providing incorrect references. However, this could be an interesting avenue for future work. Though we did not design for providing support, we did anticipate that participants may request help. The chat system recognizes these requests for support and explains that it cannot offer support, but provides a hyperlink to the local government's list of Covid-19 mental health support resources, which was regularly maintained: "I cannot provide direct support, however, you can find support through this government Covid-19 support page (link). There are various health, mental health, financial, and family supports listed there." The chatbot also attempts to recognize intents of self-harm, suicide, and violence. When detected, it redirects the participant to emergency resources, followed by the aforementioned support statement: "If you are experiencing severe distress or danger, please call 911 or go to your nearest emergency room. If you are not in danger but need support, please visit ... " Support links and emergency information are also always available on the interface screen, with a prominent "In crisis?" button on-screen at all times.

Another risk of Covid Connect as an anonymous chat system is the inadvertent (or intentional) disclosure of personally identifiable information. This would include the names of other people (e.g. one's supervisor) or employers. To mitigate this risk, a proper noun recognition system was created to processed submitted statements before they were stored in the database. This system replaced detected proper nouns with randomly generated substitutions of the same category (e.g. names, organizations). This substitution occurred before storing the statement in our database to prevent any inadvertent release of personal data. As any such system will miss some items, an on-screen warning is always visible: "Please do not identify yourself or others. Anything you say here may be shown to future visitors."

An open system to collect stories from the public runs the inherent risk of abuse through the injection of hate speech. There is also the possibility of participants sharing stories that may be triggering or upsetting to future visitors. To counter these risks, we embedded a 'toxic speech' filter to flag potentially harmful comments. These comments are shifted into a queue for moderation approval before being released to the visualization. We also provide a flag capability to allow visitors to flag displayed comments for a number of reasons, including harmful speech (see Figure 4(a)). We also provide

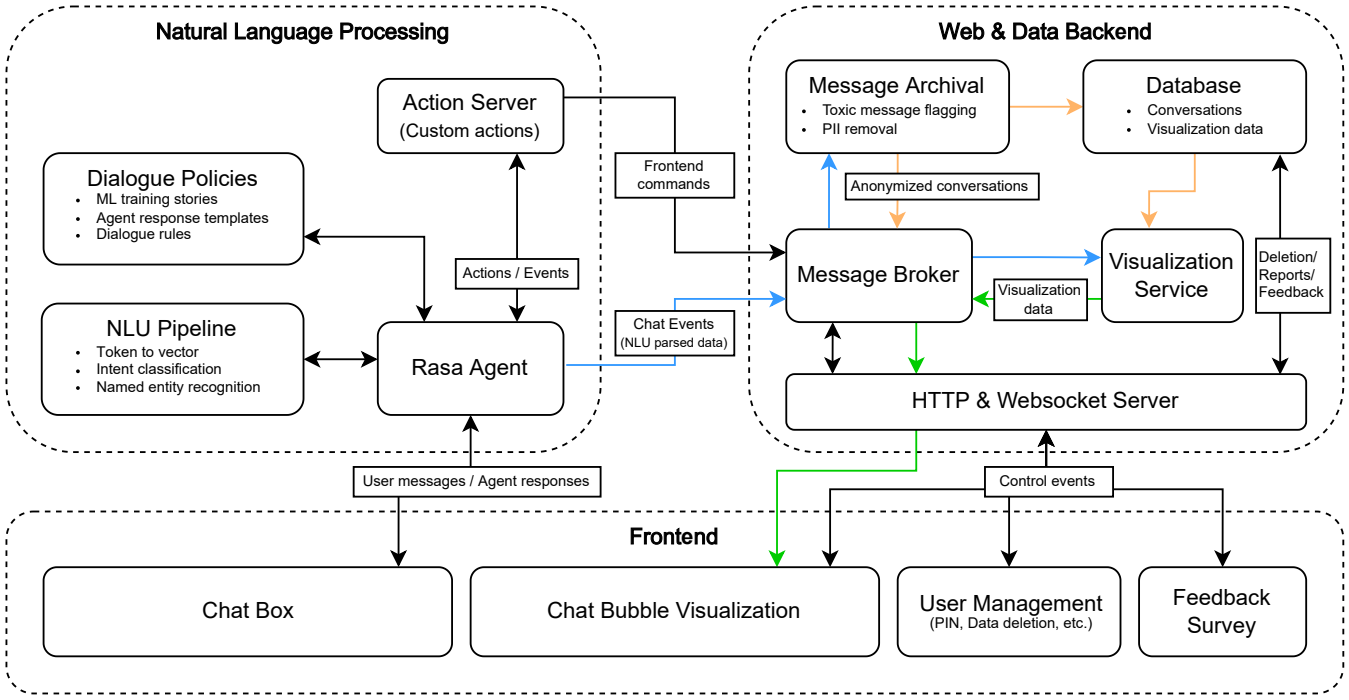


Figure 5: System architecture of Covid Connect, including the major components of the chat system (top left), data store and message broker (top right) and the front end visual interface (bottom).

the converse, an upvote system that boosts the probability of a story being shown to future visitors (see Figure 4(b)).

Rifat et al. developed an application for adolescents to ask questions concerning sexual and reproductive health in a culture where the topic is treated as a taboo. One problem they encountered during their system evaluation was that participants felt uneasy sharing their issues individually when they could be identified by the research staff [22]. Therefore, to ensure that users felt comfortable sharing their information, we ensured they were anonymized and built in the right to withdraw user data into the system. Every participant is assigned a unique, random alphanumeric ID. This ID is introduced to the participant through the initial welcome script of the chatbot, and also remains on screen at all times. It is also repeated by the chatbot at the end of the conversation, to remind participants to record it in case they later wish to delete their data. Conversations entered into the dataset are held for three days before being drawn to populate the visualization. In this way, visitors are offered a three-day 'cooling off' period in which to reconsider participation before their data is shown to others.

4.4 Implementation

There are two major components of the Covid Connect interface: the back-end chat and data management system and the front-end visual interface. These modules communicate through chat messages and control events, selecting related comments from the data and sending them to the visual interface after every participant chat turn (see Figure 5). Our goal was to integrate these components as a holistic experience, partially achieved through the chat system triggering some on-screen events, such as highlighting the feedback button when the chatbot invites the participant to provide feedback. In addition, the chatbot periodically references the bubbles in the background, inviting visitors to explore. Visitors can use the chat and visualization in any order, interleaving each.

4.4.1 Back-end Chat and Data System. The back-end is composed of numerous microservices that all communicate using a Message Broker server (RabbitMQ[2]). The chat system is built on the open-source Rasa framework in Python.[3] We selected Rasa over cloud-hosted services as we wanted to retain all data on local servers, to protect participant privacy. Rasa allows for flexibility when choosing how much of the Rasa stack one wants to use. The discrete components of the back-end system are described below.

First, the *Rasa Agent* is responsible for ingesting user input, classifying the intent and labelling it, and then choosing the appropriate response from a set of *stories* that form a directed graph. The detected intents (user inputs) and stories (chatbot responses) are provided in full in the supplemental material. The *Action Server* is a customizable component of the Rasa stack, used for adding custom event handlers for conversation intents.

In addition to providing interactive chat with visitors, the chat system is responsible for processing and archiving received messages. The *Message Archival Module* is a custom component that receives the same data as the chat agent, through the message broker. Messages are processed using the *spaCy NLP* component to parse the data, and the *spaCy Named Entity Recognition* component

[2]https://www.rabbitmq.com/
[3]https://rasa.com/

of Rasa to detect proper nouns of type `person` and `organization`. Recognized entities are replaced with random entries of the same type using the *faker*[4] library. The final text is stored in the database for future analysis and to show to future visitors. The archival module also analyzes comments for potentially harmful content, using the pre-trained *Detoxify* library.[5] Messages classified as potentially harmful are queued for curation. Otherwise, the text is forwarded to the visualization broker for the next step.

The *Visualization Service* receives user input from the Archival Module, embeds the message document as a vector using *spaCy's* pre-trained medium-sized English language model[6] embedding, and stores that embedding in a database table. It then searches for similar messages using the cosine distance as the measure of similarity between vectors. Scores are boosted by any previous upvotes on the message and by the message length (longer messages are preferred over short). Finally, it forwards any matching messages with similarity above a threshold to the web server, using the message broker.

The final back-end component is the *Web Server* which is responsible for WebSocket communication between the frontend browser and the backend visualization broker. When a user connects and creates a new session, a temporary message queue is created just for that conversation instance. The Visualization Broker routes data to the correct user-specific message queues, the web server listens to these and converts them to WebSocket messages to be sent to the browser. Selected similar messages are sent to the frontend for use in the visualization layer. The webserver also implements the various report, data deletion and user validation methods as REST listeners on the server.

4.4.2 Visualization. The visualization system is implemented with D3.js[7] and Pixi.js[8]. D3.js is solely used to assign the positioning of the bubbles. Positions are computed using a force-directed simulation called forcePolar. This enables the bubbles to be spread through a top-filled semicircle that attracts bubble positions toward the bottom center (where the chat box is located, by default). Random angles between 30-150 degrees and an initial depth factor for the bubbles are provided to the simulation. As new bubbles are added, the depth factor increases for the old ones, so they spread further and provide space for new ones. When bubble positions are too close to each other, they will repel using their individual charge and collision forces. After the force simulation completes, the position coordinates are converted to be compatible with Pixi.js' viewport. Pixi.js renders the bubbles and text as raster graphics in those positions. This provides greater performance compared to using SVG vector graphics with D3. Pan and zoom operations are provided on the visualization canvas, while the chat widget remains centred and anchored at the bottom of the screen.

For responsive mobile interaction, users can switch between the chatbot and the visualization screens by tapping the chatbot's dropdown button to hide it. When a bubble is chosen, the auto-zoom is adjusted so that the bubble fits the width of the mobile device's screen. Surrounding menu options from the desktop version will appear if the burger icon on the top left is chosen. In order to maintain a stable framerate for the system, the wave animation for the bubbles is capped to 40fps. If the overall system runs at below 20fps, animation frames for the bubbles are skipped to maintain interactive performance. Furthermore, bubble graphics are removed when they reach out of the Pixi viewport's bounds.

[4]https://faker.readthedocs.io/
[5]https://github.com/unitaryai/detoxify
[6]https://spacy.io/models
[7]https://d3js.org/
[8]https://pixijs.com/

4.5 Deployment and Recruitment

Covid Connect was deployed in the spring of 2021, and promoted through direct emails to staff and students at the three participating organizations, as well as a large regional employer which had agreed to send a message to employees. We invited participation through social media, including Facebook, Reddit, and Twitter and invited people to forward the message widely. A feature story was hosted on the university website homepage. We sent direct emails to area employers to request they forward to their employees. Printed posters were placed on campus later in the pandemic, when the campus reopened. We repeated social media postings every three months. System performance was monitored daily, and for the first three months of deployment, chat script quality and participant feedback was monitored, enabling active iterative refinement to the chat logic and interaction design.

5 RESULTS

In this section, we explore the impacts of Covid Connect through three lenses. First, we analyze the collected statements using an open-coding approach. Secondly, we grouped and analyzed statements based on whether the user was sharing a stressor or exhibiting a coping strategy. Thirdly, we provide some reflections on the impacts on members of the research team, through an autobiographical lens.

5.1 Analysis of Collected Data

We conducted a qualitative analysis of the messages logged by Covid Connect using a variety of approaches, including open coding and pattern analysis using the word tree visualization approach [33].

5.1.1 Analysis Methodology. Similar to chatbot data analysis conducted by Sviknushina et al. and Rifat et al. we used open coding to obtain overarching themes present in the collected data [22, 28]. Data was collected from 423 unique sender IDs over February 2021 to January 2022, almost one full year of the pandemic. 14 participants withdrew their data, leaving 409 sessions which make up this analysis. We chose to use an open coding approach to qualitatively evaluate the data collected, as open coding allows us to examine each entry comparatively and specify its relation to entries in the data through the use of categories. The first step we took was to take each message sent to the chatbot and separate them out by length. As many short entries were simple greetings, and we had a large volume of data, we performed coding on entries with more than five words. One researcher (the *coder*) conducted an initial pass over all entries with more than five words, each message was grouped into one or more categories. These categories were emergent from the data. The coder then met with another member of the project team to review and confirm the categories. Then, using axial coding, the coder further grouped original categories into larger categories. Using an iterative process, each category was fine-tuned

Table 2: The main 11 categories for coding participant messages, with examples. Counts are for the primacy coded category of the 564 messages of five words or longer.

Category	Example Participant Message	Count
Hopeful	Online meetings are better if I am able to sit outdoors - that's one benefit of the pandemic!	28
Sad	I am depressed and dont know what to do	34
Angry	I feel like life isn't going the way I want it to and it's making me generally more angry about the smallest little thing that happens.	14
Bad	I'm feeling overwhelmed, to be honest.	28
Personal finance	I can't pay my rent anymore.	17
Health	I think my dad has covid	32
Active lifestyle	I don't get as much exercise as I used to	27
Working from home	Managing work time while at home is difficult	60
Relationships	OK. Well another thing that is difficult right now is that my partner is working too much. So I can't really see friends, but I hardly see him either.	74
Restrictions	People seem to think that Step 1 in the reopening means everything goes	92
Meaningful exchanges	I am going to share lots, believe me! Im the best sharer	138

and messages were reorganized to better reflect the categories they belonged to. A final review with a mental health professional member of the project team revealed an alternative framing of *challenges* and *coping strategies*. Both the open coding and challenges/coping analysis are discussed below. The messages used for evaluation and the accompanying category list with descriptions are available in the supplemental materials.

5.1.2 Data Overview. A total of 1769 valid entries were collected from users and the median value for the number of messages sent to the chatbot by all 409 unique sender IDs is 2. The longest conversation with a user consisted of 36 user sent messages. Messages sent by users ranged in length, with the longest being over 150 words and the shortest being one word. Due to the nature of chatbot conversations, around 38% of the messages sent by the user had a length of one. Most of these messages consisted of greetings and simple "Yes/No" responses. The second most common message length was three words, these were mainly populated by phrases such as "how are you", "I am sad", and "I feel isolated". Shorter messages tended to be messages of personal feelings, while longer messages tended to be reflective narratives recalling feelings or memories of events that happened during the pandemic.

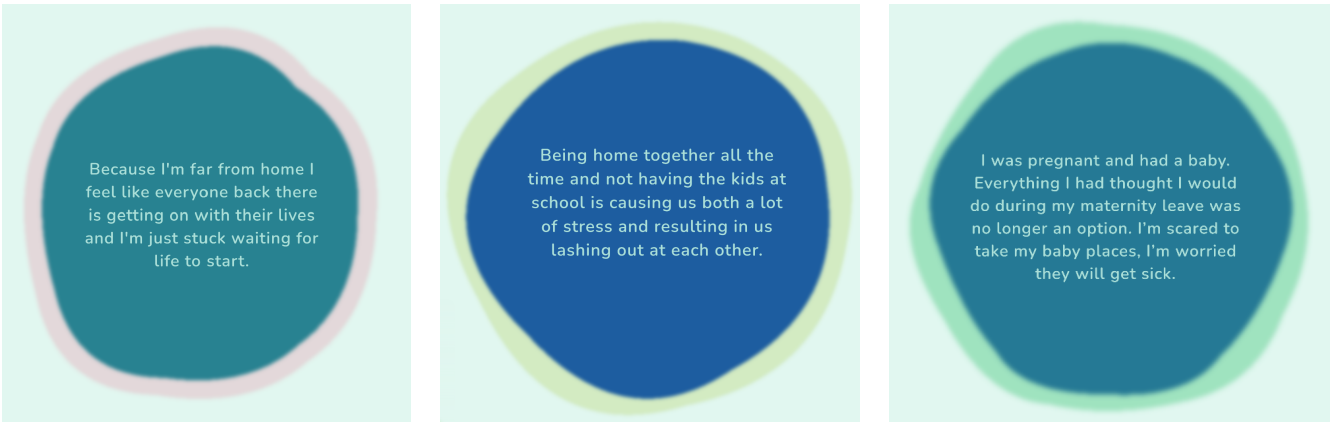
As mentioned in the previous section, our evaluation of the collected data focuses on messages with a word count higher than five words. This made up 34% of the total messages, or 604 entries. After filtering out hard to categorize entries (i.e. gibberish, copy/paste texts, or evidence of participants testing the system), the final dataset of categorized and labelled data summed to 564 entries.

We also had a participant feedback form on the site, consisting of Likert-scale response factors on features, and opportunities for free-form comments. The chatbot encouraged participants to complete it during the conversation finalization. Despite this, only three people completed the form, all of them early in the deployment. So, we only discuss this aspect briefly, as follows. Only two of the feedback responses we received were complete. In those responses, they brought forth issues related to the lack of other user entries displayed on screen (an artifact of not yet having collected sufficient data) and user interface issues with the bubbles themselves (which we rectified in response). On the questions "I enjoyed sharing my thoughts with the chat system" and "I felt comfortable engaging with the chat system", all both respondents rated "agree" or "strongly agree". Both respondents were neutral on the statement, "I would rather talk to a real person." One respondent said:

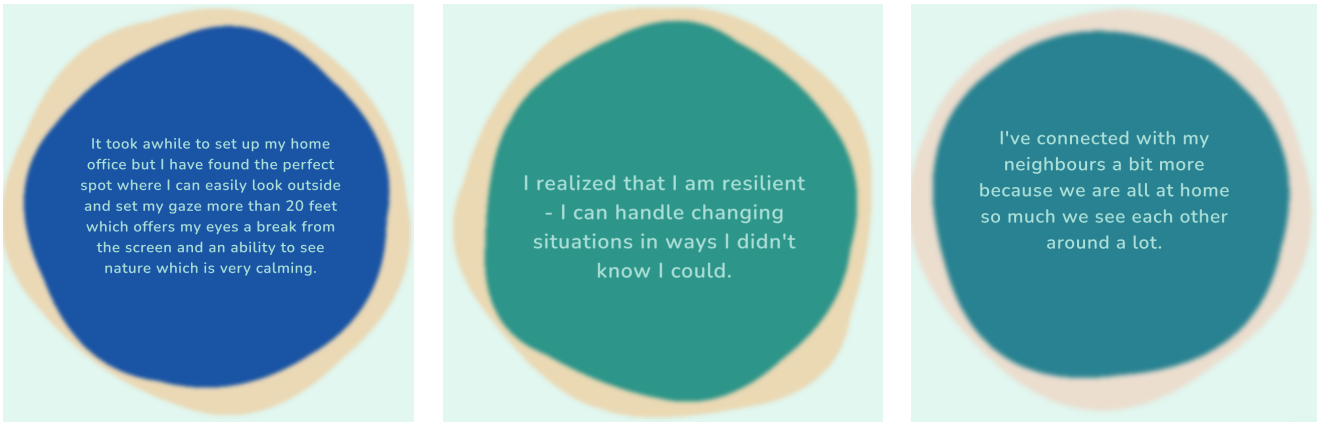
"This is great and a wonderful opportunity to reflect on the whole experience to date, all in one spot. Remembering what it was like in the beginning did trigger some anxiety. However, the reflection teaches that I can overcome the next obstacle and hopefully won't be so anxious in the beginning know I can overcome. Even though it was a bot - it didn't matter. This was on-line journaling. Therapeutic."

The final feedback response was received a few days apart from the initial two and also focused on technical difficulties the user faced while using the system. We addressed this bug as well.

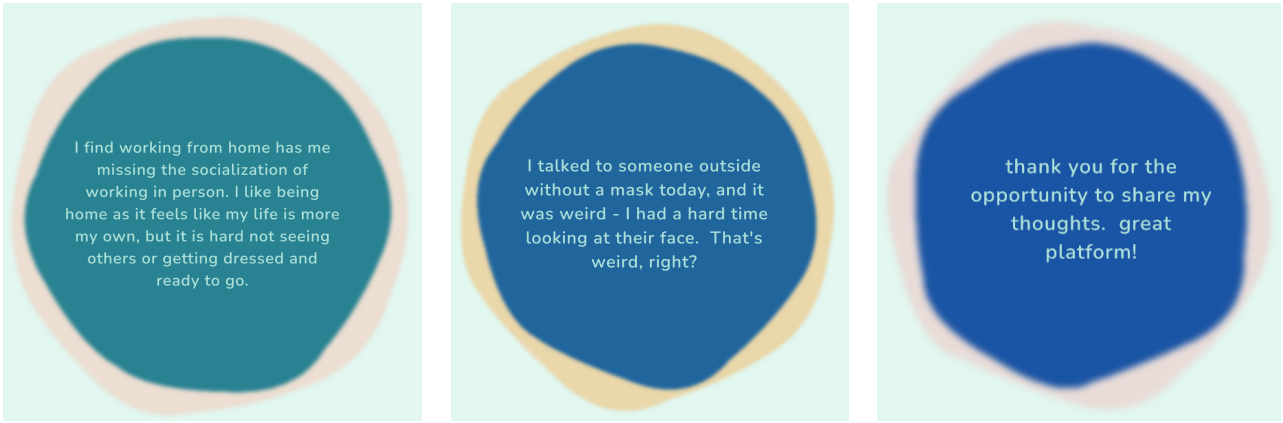
5.1.3 Discovered Categories. We separated the 564 entries into 11 high level categories of varying topics, with some entries belonging to two categories. The categories include **emotion-based categories**: *hopeful*, *sad*, *angry*, and *bad*. Other categories focused more on **experiences or topics** users experienced during the pandemic related to *personal finance*, *health*, *active lifestyle*, *governmental control*, *working from home*, and *relationships*. The final category that we separated were entries where the user seemed to **bond with the chatbot** and hold *meaningful, human-like conversations*. The final category will be covered in more detail in the subsequent section. Examples of messages which belong in each category can be seen in Table 2. Within each larger category, there are sub categories which



(a) Examples of challenges shared with the system.



(b) Examples of coping strategies shared with the system.



(c) Examples of miscellaneous topics shared with the system, including mixed feelings, humour, and direct feedback.

Figure 6: A curated selection of example chat bubbles including challenges, coping strategies, and other topics.

describe specific themes that occurred. There are 56 subcategories overall, 48 relating to the emotion-based and experiences topics, and 8 relating to bonding with the chatbot. Overall, 37 entries were tagged with two high-level categories, with the most commonly cross categorized categories being *relationships* or *working from home* paired with an emotion-based category.

For the emotion-based categories, entries tagged as *hopeful* contain messages that are focused on positive and beneficial aspects that resulted due to the pandemic. These entries generally showed

that people gained a positive outlook on originally negative events, such as initially finding working from home frustrating, but slowly changing their attitude towards it. People felt that they were presented with new opportunities to start new projects or move to a new city because they now had a more flexible schedule. On the contrary, people also felt overall *bad* emotions like feeling bored by the mundanity of their lives, feeling held back or left behind, and overwhelmed by stress. Similarly, with entries categorized under *sad*, people felt down, lonely, and lost. Due to the uncertainty of Covid-19, people wrote messages expressing their *anger* by complaining to the chatbot about their life, frustration with work, and sharing that they became more irritable during the pandemic.

The overlap of an emotion-based category with an experience- or topic-focused category made up most of the entries which belonged to more than one category. Entries tagged with *personal finance* related to the housing crisis that many felt during the pandemic where people were evicted from where they were living or struggled to find a place to live. Another aspect of the *personal finance* category relates to employment, for example, some people were unable to find jobs and service-based businesses, like hair salons, suffered due to restrictions set on them.

People also felt that their *health* declined through the pandemic, for instance, some people became insomniac due to stress and others were concerned about getting Covid-19 from an unknown source. People brought up catching a cold or coughing, and alluded to having Covid due to their symptoms. Along those lines, there were people who adopted more *active lifestyles* during Covid-19 to achieve better *health*.

As people *worked from home*, they were able to spend more time exploring their neighbourhood and enjoying the outdoors. Additionally, within the *active lifestyle* category, there are entries related to exercising more and weight fluctuations. Moreover, due to *governmental control* forcing many to stay home and felt that they became isolated and were tired of staying home all the time. Due to the uncertainty of the Covid-19 situation, many restrictions were put in place in a short amount of time, making people wary of changes that might follow and become uncomfortable with pushing boundaries. People mentioned that despite the lessening of restrictions, they still felt wary and on guard. Furthermore, due to restrictions placed on travel and physical distancing, people felt that commonplace events that were normal before the pandemic became more exciting and would be *hopeful* about being allowed to dine in at restaurants or travel once again.

The local *work from home* mandate also generated quite many related messages. This category contains entries about a lack of work-life balance and being forced to face a screen all day. Some disliked working from home because they found it inefficient and hard to focus. However, despite the downsides of working from home, people were grateful that they did not have to make long commutes to work and that they could wear comfortable clothes at home. The final topic focus category is *relationships* with family, friends, and partners. Having to stay physically distanced from others and working remotely has made people lose their connection with their friends. They found it hard to keep in touch with their friends and felt that they were losing friends. Additionally, the lack of interaction with others led people to question whether their social skills had deteriorated. There was also a split of opinions, where people became closer with those around them because they bonded over a shared experience, versus people who became cross with those they lived with. Thus, as shown by the responses from collected data, people had varying relationship experiences.

The types of information people shared with Covid Connect were surprisingly poignant, emotional, and relatable to our own experiences. People shared stories of hardship, from the anxiety of having a suicidal grandparent to the stress of having a baby during the peak of the pandemic. People shared their successes, from reorganizing and decluttering their homes to getting to know the neighbours. The changes in society that were experienced by the participants are captured in often moving, simple comments made to the bot. Some of these are reflected in Figure 6.

5.1.4 Types of Interactions with Chatbot. There were several ways people generally interacted with the chatbot in meaningful ways. The main types of interaction that we saw were users asking for help, expressing personal emotion, sharing facts about themselves, conversing in small talk, complaining, using the chatbot as a form of posting board, and questioning the chatbot's words.

> When attempting to initially categorize the data, I thought about creating main categories of what I thought would be main topics mentioned by different people in the dataset. However, as I went through entry by entry, I noticed that my assumption about the "common" experience did not fit with the messages in the system. I believed that most people would feel hopeful about the reopening, but, there were not as many mentions as I thought there would be. (ZZ)

As chatbots have become popular in recent years, people have become more familiar with the functionality of chatbots as information-providing sources. Therefore, many users would ask the chatbot for resources and ask for advice. Users also shared how they were feeling with the chatbot, as if they were talking to a friend. They shared intimate details, for example, sharing details about their day and events happening in their life unrelated to Covid-19. This type of behaviour aligns with the results obtained in the study of other mental health chatbots like Wysa and Youper [11, 37]. There were also pleasantries, greetings, and polite exchanges made between the participant and the chatbot, making it seem as if people were treating the chatbot as another human being. Some participants even tried to explain slang to the chatbot in hopes of increasing its knowledge.

However, when the chatbot's script veered off track, people treated responded with a more serious or sarcastic tone and questioned its functionalities. Participant asked the chatbot to switch to a different topic or told the chatbot exactly what it is doing incorrectly. For example, "I think my response triggered the chatbot to end the session. I said I'm tired of the pandemic, which it seemed to mean I was done talking." People also used the chatbot as a place to complain about matters bothering them. This could be complaints about the weather, people, or other events happening around them. Similar to complaining, people also used the chatbot similar to how one uses social media posts to share small random details about

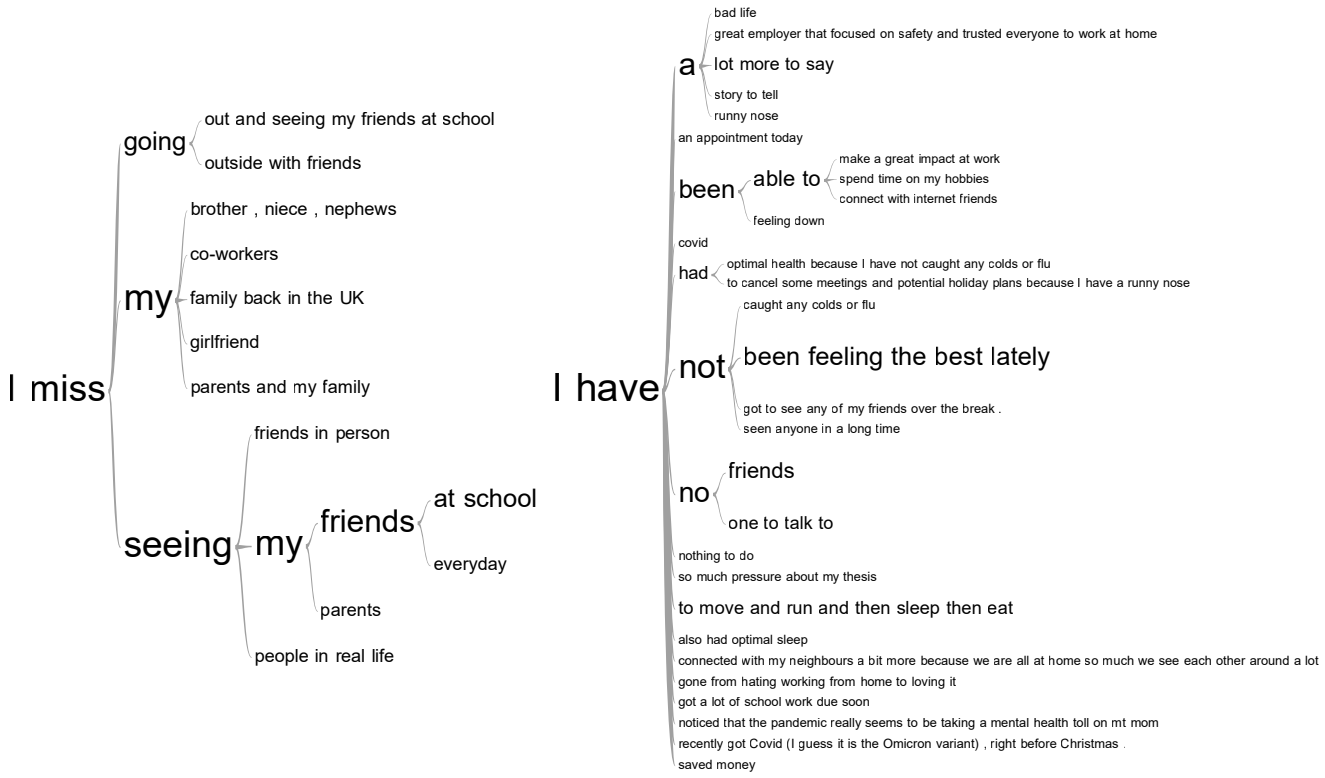


Figure 7: Word trees of collected statements starting with "I miss" (left) and "I have" (right). Word trees size the terms according to their frequency of occurrence.

their lives. For instance, there was a participant who said, "I want to eat salsa."

In addition to sharing details about their lives, some participants talked about their hobbies and interests with the bot. One problem we ran into was named entity replacement. Some famous names, such as a participant's favourite music artist or a politician, were caught by our named entity replacement system and replaced by fake random names. Similarly, in the first few months of data collection, "Covid" was recognized as a name and replaced. We have attempted to repair these data entries where the context is obvious, and also added an ignore rule for Covid-related terms to reduce future occurrences.

Overall, we found that the roles that our chatbot fulfilled aligns with the social roles identified by Svikhnushina et al. in their analysis of commercially available chatbots [28]. They highlighted that chatbots generally fill one of four social roles: bot, person, confidant, and other. We believe that due to the slightly unconventional structure of our application, involving both peer support and chatting functionalities, the lines between the social roles were slightly blurred. In most cases, the Covid Connect chatbot acted as a confidant – taking on the role of a friend and diary – as well as a bot which can provide, albeit limited, information to the user.

5.1.5 Coping Mechanisms. An alternative analysis of the themes presented through the categories mentioned in the previous section reveals information about the participants' stressors. This is not overly surprising given that the pandemic is a disruptive life stressor. Generally, the stress caused by an external event is correlated with the amount of change an individual had to make due to the external event [1]. As the Covid-19 situation is acting as a disruptive life stressor for people, participants shared a variety of life stressors associated with the pandemic, such as financial, relationship, and uncertainty.

To deal with the stressors presented by the pandemic situation, many participants also shared aspects of their coping strategies. The collected data revealed a variety of problem- and emotion-focused coping strategies. Problem-focused coping strategies are those targeting the stressful situation or gaining resources to deal with it. Seeking formal treatment for mental health problems or developing better work-life balance skills would be examples of this type of coping strategy, for example, "Bought a pullup bar so been doing a bit of working out." By sharing these strategies, participants reading their peer's messages could feel a sense of support and feel encouraged. They also likely felt validated in knowing others are experiencing challenges as well.

In our collected data, we found that there were people who struggled financially and shared stories of their experience with that. They shared that they had found employment and moved their family to a new house. People also revealed that they had changed their opinions on working from home after making some changes to their at home work environment, for instance, a user wrote:

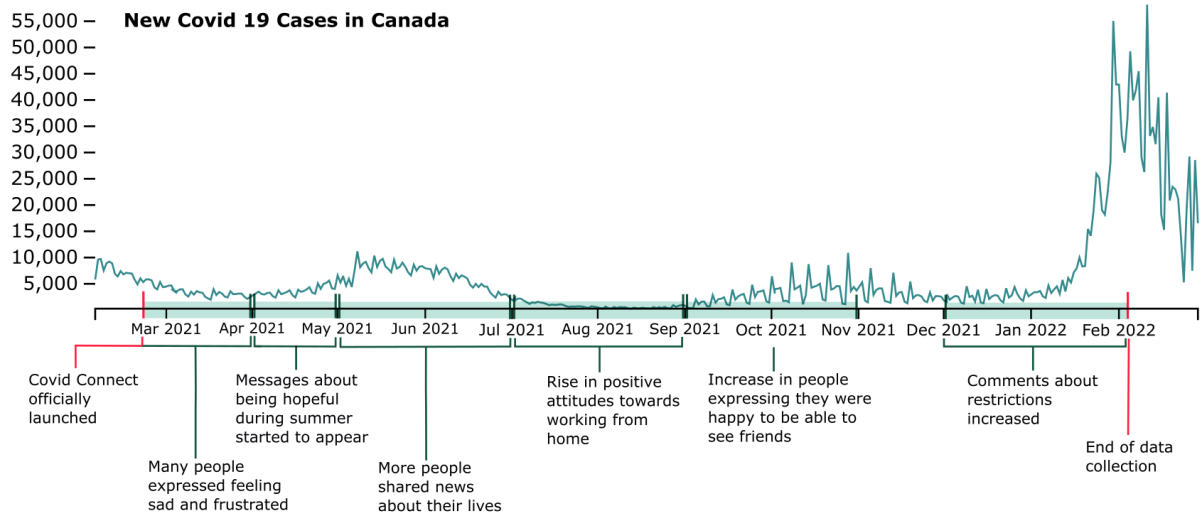


Figure 8: Timeline of trends in messages sent to the system, against local region Covid statistics, from the launch until the termination of data collection in February 2022.

"It took awhile to set up my home office but I have found the perfect spot where I can easily look outside and set my gaze more than 20 feet which offers my eyes a break from the screen and an ability to see nature which is very calming."

Emotion-focused coping strategies involve changing one's emotional response to a stressor [26]. This can include seeking support from others, cognitive reframing, or engaging in distracting activities. This type of coping mechanism is used when a stressor is felt to be outside the individual's control. Some examples of emotion-focused coping strategies users used include rationalizing, accepting, and changing to a more hopeful outlook on the stay-at-home order. We saw a number of emotion-focused coping statements, for example "Today I'm grateful that I have resources to help me deal with my irritability." and "By stopping, I've been able to reevaluate my work & life situations and try to steer things in a direction that makes me happy."

Others spent more time outdoors and sought out the company of others around them to try to form connections. Not all emotion-focused coping strategies mentioned by the participants were positive emotions: some complained to the chatbot about their frustration. Additionally, we saw examples of distraction strategies, including three participants mentioning turning towards alcohol, and one mentioning shopping and overspending to feel better. Within the collected data, most of the coping strategies were emotion-focused. This could suggest that people perceived the Covid-19 situation as something out of their control and felt that they were living under uncertainty.

5.1.6 Entries that Starts with "I". The chatbot was created with the intention of acting as a catharsis, as sharing personal experiences and anecdotes placed the writer at the central focus. So, it is not surprising that the chatbot received many responses which start with the first-person pronoun "I". To process all the entries and analyze them for patterns of "I" statements, we carried out some transformations. The text was changed to lowercase and contractions were expanded (e.g. "I'm" and "im" became "I am"). After text processing, we found the top three most common phrases to be *"I am sad"* with 78 entries, *"I am lonely"* with 26 entries, and *"I am bored"* with 12 entries. In general, most of the entries that started with "I" involved the verb *to be* showing that the users were reflecting on themselves. We found that the topics of these entries often related to what we perceived to be the main emotions portrayed in media during the Covid-19 pandemic.

To display patterns found within the text, we created *word trees*, a type of visualization of repeated sequential patterns in a collection of texts [33]. We used the Google Charts Word Tree API to generate initial word trees, then modified the resulting code to open all branches. Example word trees for statements that start with "I miss" and "I have" are shown in Figure 7. Several larger word trees, including one encoding all 592 "I" entries are available in the supplemental material.

5.1.7 Effect of Time. We collected data for almost a year and during that time (2021) there were various changes in both governmental policies and outlook on the Covid-19 situation. A timeline of the trend in messages can be seen in Figure 8. Messages sent to the chatbot during the initial launch revealed that people were feeling sad and feeling frustrated about having to work from home. People mentioned how it was hard to follow restrictions and felt that restrictions did not make sense at times. Then slowly there were messages mentioning going to hair salons and going to see friends, this parallels with the lessening of restrictions that happened during the summer in our local region.[9] A large portion of entries received during May and June were made up of a mixture of people having conversations with the chatbot about their personal lives

[9]While the system was open to anyone online, it was primarily advertised locally.

unrelated to Covid-19, coinciding with a period between waves. Though, people also continued sharing that people around them had caught Covid-19. The overall more positive attitude continued through July and August when comments about enjoying, rather than disliking working from home started to become more common. In September and October, users mentioned being able to see friends again and remarked enjoying not having to commute to work. Comments about childcare reduced as children were back in school. However, as the Omicron variant cases rose through November to January 2022, stricter restrictions were once again put in place, more messages under the category of restrictions increased.

Simply by looking at the categories of the messages sent over time, we can see that people's attitudes towards the pandemic shifted depending on their situation. At the beginning of 2021 people were feeling frustrated and sad about the overall situation, but with the change of seasons and lowering cases, people became hopeful once again. Then, as cases rose again and restrictions were set, people started to once again become stressed about the situation which was beyond their control. However, this is not to say that all the entries received from segments in time fall within that trend, there were messages categorized under hopeful from the early stages of this project, for example, one respondent said *"Yes. I actually like working from home."* in February of 2021. Therefore, although there is a general trend of how people felt during the Covid-19 pandemic in 2021, there are varying experiences and opinions that are unique to each individual.

5.2 Autobiographical Design Reflections

Part of the experience of designing Covid Connect was to realize that all members of the team were also part of the target audience of people who were living through the pandemic and the related restrictions. This gave us the advantage of testing with real experiences and stories we were going through, and allowed us to leave this data in the dataset. Of course, we also had test phrases and sentences to challenge the chatbot capabilities, but these were removed. From an autobiographical design [19] perspective, our own use of the system resulted in several key changes. First, the look and feel started as something darker and sombre. In using the system ourselves, as well as demonstrating it to lab members in pilot testing, it became apparent that the situation everyone was facing was grim enough without bringing in a prototype support tool set in dark purple tones. So, we regrouped to focus on the *bubble* metaphor and inject some levity (including the 'You're not on mute' tagline). After deployment, it became a routine for the team to periodically test if things were up and running. To do that, it made sense to run a session with the system. These sessions were not just tests, but also opportunities to safely share our own pandemic experiences with 'someone'. We found these sessions to be cathartic, and in particular, the quick nature of a 'check in' with the system acted as a low-cost, low-commitment way to say things we may not otherwise share. Another change that we made shortly after deployment, based on our own experience, was to bias the selection of 'related messages' by the visualization broker module to prefer longer statements (which were more interesting to read) and to remove duplicates (some people said identical things which could be shown twice).

> There were days when I felt like no one wanted to hear any more complaining about Covid. Or, my concerns were not as bad as others, and I didn't want to 'one up' my friends or partner. But, in sharing my thoughts with the chatbot, I felt like I was telling *someone*. The messages from others stuck with me. I remember one about a person unable to visit their grandfather in long-term care. When I saw that I realized what we were doing with this project was meaningful and people were really opening up in this safe space. (CC)

We were sometimes dissatisfied with the generic nature of the responses. This improved over the deployment period as we collected more data and retrained Rasa to better recognize the various intents. However, frustrations occasionally arose at the mistakes the bot would make (in particular, misrecognizing attempts to say goodbye and end the conversation, responding with requests to 'tell me more'). The fact that the system remained helpful in the light of obvious chat logic failures points to the power of tools like this as a form of facilitated journaling [36]. The robustness of the impact of chat-facilitated support approaches has previously been demonstrated, most notably by Weizenbaum's ELIZA [34], but we also must be cautious that systems like ELIZA or Covid Connect are *not* replacements for human-human interaction and a professional therapy approach.

Weizenbaum famously grew distasteful of his own creation, calling the idea of computational therapy 'perverse' [2]. We take a cautiously more optimistic view, from experience, of the possibilities of such systems as facilitators or mediators of human-human connections, or as tools to support reflection and journaling. The simplicity of the Covid Connect approach and script may contribute to the safety and comfort of its use. In the light of recognized risks when power is handed to AI systems [20], in particular when their decision-making becomes more sophisticated, and inherently less explainable and more opaque, systems such as Covid Connect must also be viewed with a critical lens. What if the system says something upsetting or triggering to a vulnerable person? A more sophisticated system may build a personality model of visitors to improve responses. Could such a model draw on inappropriate data such as race, or draw inappropriate or privacy-invading conclusions about the user? Thus, despite our occasional frustration with the simplicity of the underlying chat model, the way forward may not be to aim for increasingly more human responses. That could lead to excessive trust and reliance, privacy concerns, and further embed the very feelings of isolation and disconnection the system was designed to break down. In conclusion, we found our use of Covid Connect to be helpful, especially in the context of a global emergency where personal connections were literally forbidden by government orders, but indeed it should be seen as a computer-mediated communication system and not a substitute for a human psychotherapist.

6 DISCUSSION

The pandemic is an equalizer of sorts — putting the globe on the same side in managing and coping with all the uncertainty involved

in a public health crisis. Previous works with mental health chatbots are focused more with providing help for users receiving or are in the process of seeking professional help, in comparison our project aims to include the public, even those who feel like they do not need mental health support. Additionally, compared to mental health focused experience sharing websites like PostSecret and Togetherall, we utilized the pandemic as the trigger point for people to share not only problems they faced during this period of time but also other smaller events that might be occurring within their lives, unrelated to Covid-19. Our interface did not provide traditional peer support, instead the chatbot did afford some similar aspects that possibly led to comparable benefits. In sharing aspects of working from home, participants were able to reflect on and process their experiences, both good and bad. In sharing, participants were able to provide others with social support. Giving support is as important a process as receiving support [26]. Seeking out the opportunity to share one's experience, emote and process some of the stressors experienced can be beneficial and provide a sense of community. In addition, the fact that the participants were able to share in a non-judgemental forum can minimize the feeling of inadequacy or discomfort that some may experience in expressing challenges [26]. This notion of inclusivity is a principle component of peer support [24] and was emulated through the chat prompts. An additional tenet of peer support reflected in the interface was the notion of reciprocity [24]. Peer support involves both sharing and receiving. Within the interface, participants can not only reflect on and share their own experiences, but they were also given the opportunity to read the experiences of others. This feature likely created the perception that participants were not alone in their experiences and may have gained some strength and support from that insight. Previous work regarding peer support has demonstrated this value not only in mental health, but in other aspects including, but not limited to physical health [25]. Results from the current project also suggest that informal non-professional support is of value, as over 400 chat sessions were initiated, including sessions where the participant specifically referred to past conversations with the bot, indicating repeat use.

From an implementation point of view, we learned some things about launching a project like Covid Connect. First, when under time pressure in an emergency, some typical processes were not ideal. For example, the intention recognition training and chat script were launched too early. The errors encountered in early days may have caused people not to return or to bounce after one response. Even at this point, some of the specific intents (see Table 1) have never been issued. As the topics were infrequently arising, we did not have enough training data to reliably recognize the variety of ways these topics could be expressed. Through continuous tagging of incoming data and retraining of the model, or seeding with external data sources, this could be improved. Continuous monitoring, tagging, and retraining is resource intensive, but would be important to consider in future projects building on Covid Connect. It may have been preferable to soft launch a bit longer, gathering data to improve the scripts and avoid the cold start problem of not having interesting data to show to visitors. This may have helped the project gain more traction. It was a trade-off, as the longer we worked, it seemed the less urgent the pandemic became. While grateful for that, we did not want to miss the opportunity. We were slow in the development because the whole research team was also working under the same strains of the pandemic as our target participants. However, of course, there were several more severe waves of the virus after Covid Connect went live, but we could not predict that, thus launched publicly before refining the systems.

Another learning from our experience with Covid Connect is that voluntary feedback forms, especially after the end of the chat session, do not work. People are most interested in the novelty of interacting with the bot itself, not filling out a form. Also, we noticed that the vast majority of participants did not continue to the intended finalization of the chat. They simply closed the window without notice, or directly after saying 'goodbye' or a similar greeting. Only 34 sessions were completely finalized. Without the opportunity to issue the finalization script, the reminder prompt to fill the feedback form was not stated. It may be preferable for the chatbot directly to solicit feedback periodically during the conversation. Even without explicit prompting, people told the chatbot what they thought about their experiences and its responses. Mining the logs for these types of exchanges could also be a source of data to guide iterative improvement.

7 CONCLUSIONS AND FUTURE WORK

To conclude, Covid Connect provided an opportunity for people to share their feelings and experiences in the pandemic, and read the stories of others. Motivated by our own pandemic challenges and coping strategies, and knowledge shared through consultation with human resources professionals, we created a system which not only provided a form a peer support but also allowed for the collection of a dataset of thoughts and experiences over a year of the pandemic. The chat dialogue followed a pattern of validation, normalization, and closure designed by the mental health professionals on the project team.

Through analyzing the data, we have identified themes of experience but also opportunities for improvement of the system. In particular, better recognition of chat turn intents could likely be achieved training the model with more data. One avenue to achieve this could be to tag data gathered from external resources, such as Reddit, and use it as part of the training set. We found that the formal feedback mechanism we provided was not used, but that people provided feedback directly to the chat system. Designers of future of chat-based support tools should consider embedding feedback mechanisms directly into the chat system. If a larger amount of data is collected in the future, we could investigate supplementing the open coding data analysis using categorizing using topic modeling methods such as latent Dirichlet allocation (LDA), similar to Svikhnushina et al.[28].

While Covid Connect is still available to use, gratefully the pandemic situation is easing in our local region. The need for the system may not be as urgent as when it was launched, but this is something to celebrate. However, the technique and technology created in this work may be useful for other scenarios where mental health support is difficult to access due to demand, preferences to remain anonymous, or hesitancy to talk to a human due to privacy concerns, such as addiction recovery. In the future we hope to investigate extensions of these ideas to other domains of application.

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REFERENCES

[1] Elliot Aronson, Timothy D. Wilson, Robin M. Akert, and Beverley Fehr. 2004. *Social Psychology.* Prentice Hall.

[2] Caroline Bassett. 2019. The computational therapeutic: Exploring Weizenbaum's ELIZA as a history of the present. *AI & SOCIETY* 34, 4 (2019), 803–812.

[3] Petter Bae Brandtzaeg and Asbjørn Følstad. 2017. Why people use chatbots. In *International Conf. on Internet Science.* Springer, 377–392.

[4] Karen Brown. 2021. Something bothering you? Tell it to Woebot. *New York Times* (June 2021). https://www.nytimes.com/2021/06/01/health/artificial-intelligence-therapy-woebot.html

[5] Christopher Collins, Gerald Penn, and Sheelagh Carpendale. 2009. Bubble sets: Revealing set relations with isocontours over existing visualizations. *IEEE Trans. on Visualization and Computer Graphics* 15, 6 (2009), 1009–1016.

[6] Alison Darcy, Jade Daniels, David Salinger, Paul Wicks, and Athena Robinson. 2021. Evidence of human-level bonds established with a digital conversational agent: Cross-sectional, retrospective observational study. *JMIR Form Res* 5 (5 2021), e27868. Issue 5. https://doi.org/10.2196/27868

[7] Catherine d'Ignazio and Lauren F Klein. 2016. Feminist data visualization. In *Proc. Workshop on Visualization for the Digital Humanities (VIS4DH).*

[8] Tommaso Elli, Adam Bradley, Christopher Collins, Uta Hinrichs, Zachary Hills, and Karen Kelsky. 2020. Tied in Knots: A case study on anthropographic data visualization about sexual harassment in the academy. In *Proc. IEEE VIS Arts Program (VISAP).* IEEE, 29–44.

[9] Manas Gaur, Kaushik Roy, Aditya Sharma, Biplav Srivastava, and Amit Sheth. 2021. "Who can help me?": Knowledge Iinfused matching of support seekers and support providers during COVID-19 on Reddit. In *IEEE Int. Conf. on Healthcare Informatics (ICHI).* IEEE, 265–269.

[10] Stephanie Greer, Danielle Ramo, Yin-Juei Chang, Michael Fu, Judith Moskowitz, Jana Haritatos, et al. 2019. Use of the chatbot "Vivibot" to deliver positive psychology skills and promote well-being among young people after cancer treatment: Randomized controlled feasibility trial. *JMIR mHealth and uHealth* 7, 10 (2019), e15018.

[11] Becky Inkster, Shubhankar Sarda, and Vinod Subramanian. 2018. An empathy-Driven, conversational artificial intelligence agent (Wysa) for digital mental well-being: Real-world data evaluation mixed-methods study. *JMIR mHealth and uHealth* 6 (11 2018). Issue 11. https://doi.org/10.2196/12106

[12] Sooah Jang, Jae Jin Kim, Soo Jeong Kim, Jieun Hong, Suji Kim, and Eunjoo Kim. 2021. Mobile app-based chatbot to deliver cognitive behavioral therapy and psychoeducation for adults with attention deficit: A development and feasibility/usability study. *International Journal of Medical Informatics* 150 (June 2021), 104440. https://doi.org/10.1016/J.IJMEDINF.2021.104440

[13] Lorenz Cuno Klopfenstein, Saverio Delpriori, Silvia Malatini, and Alessandro Bogliolo. 2017. The Rise of Bots: A Survey of Conversational Interfaces, Patterns, and Paradigms. In *Proceedings of the 2017 Conference on Designing Interactive Systems* (Edinburgh, United Kingdom) *(DIS '17).* Association for Computing Machinery, New York, NY, USA, 555–565. https://doi.org/10.1145/3064663.3064672

[14] Kostiantyn Kucher and Andreas Kerren. 2015. Text visualization techniques: Taxonomy, visual survey, and community insights. In *Proc. of the IEEE Pacific Visualization Symposium (PacificVis).* IEEE, 117–121.

[15] Dongkeon Lee, Kyo Joong Oh, and Ho Jin Choi. 2017. The chatbot feels you - A counseling service using emotional response generation. *2017 IEEE International Conference on Big Data and Smart Computing, BigComp 2017* (3 2017), 437–440. https://doi.org/10.1109/BIGCOMP.2017.7881752

[16] Shixia Liu, Xiting Wang, Christopher Collins, Wenwen Dou, Fangxin Ouyang, Mennatallah El-Assady, Liu Jiang, and Daniel A Keim. 2018. Bridging text visualization and mining: A task-driven survey. *IEEE Trans. on Visualization and Computer Graphics* 25, 7 (2018), 2482–2504.

[17] Daniel M Low, Laurie Rumker, Tanya Talkar, John Torous, Guillermo Cecchi, and Satrajit S Ghosh. 2020. Natural language processing reveals vulnerable mental health support groups and heightened health anxiety on Reddit during Covid-19: Observational study. *Journal of Medical Internet Research* 22, 10 (2020), e22635.

[18] Megan Molteni. 2017. The chatbot therapist will see you now. *WIRED* (June 2017). https://www.wired.com/2017/06/facebook-messenger-woebot-chatbot-therapist/

[19] Carman Neustaedter and Phoebe Sengers. 2012. Autobiographical design in HCI research: Designing and learning through use-it-yourself. In *Proceedings of the Designing Interactive Systems Conference.* 514–523.

[20] Cathy O'Neil. 2016. *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy.* Broadway Books.

[21] S.J. Onken and J.M. Dumont. 2002. Mental health recovery: What helps and what hinders? A national research project for the development of recovery facilitating system performance indicators. *Health Program* (2002).

[22] Rifat Rahman, Md. Rishadur Rahman, Nafis Irtiza Tripto, Mohammed Eunus Ali, Sajid Hasan Apon, and Rifat Shahriyar. 2021. AdolescentBot: Understanding opportunities for chatbots in combating adolescent sexual and reproductive health problems in Bangladesh. In *Proc. of the SIGCHI Conf. on Human Factors in Computing Systems* (Yokohama, Japan) *(CHI '21).* Association for Computing Machinery, New York, NY, USA, Article 710, 15 pages. https://doi.org/10.1145/3411764.3445694

[23] Jill H Rathus and Alec L Miller. 2014. *DBT Skills Manual for Adolescents.* Guilford Publications.

[24] Julie Repper, Becky Aldridge, Sharon Gilfoyle, Steve Gillard, Rachel Perkins, and Jane Rennison. 2013. *Peer support workers: Theory and practice.* Technical Report ImROC Briefing Paper 7. Centre for Mental Health, London.

[25] Julie Repper and Liz Walker. 2021. *Peer support for people with physical health conditions.* Technical Report ImROC Briefing Paper 14. Nottinghamshire Healthcare NHS Foundation Trust, London.

[26] Edward P. Sarafino and Timothy W. Smith. 2016. *Health Psychology: Biopsychosocial Interactions.* John Wiley & Sons Inc.

[27] Loren Soeiro. 2017. 10 reasons why people refuse talk therapists. *Psychology Today* (Oct. 2017). https://www.psychologytoday.com/ca/blog/i-hear-you/201710/10-reasons-why-people-refuse-talk-therapists

[28] Ekaterina Svikhnushina, Alexandru Placinta, and Pearl Pu. 2021. User expectations of conversational chatbots based on online reviews. In *Proc. ACM Conf. on Designing Interactive Systems* (Virtual Event, USA) *(DIS '21).* Association for Computing Machinery, New York, NY, USA, 1481–1491. https://doi.org/10.1145/3461778.3462125

[29] Colm Sweeney, Courtney Potts, Edel Ennis, Raymond Bond, Maurice D Mulvenna, Siobhan O'Neill, Martin Malcolm, Lauri Kuosmanen, Catrine Kostenius, Alex Vakaloudis, et al. 2021. Can Chatbots help support a person's mental health? Perceptions and views from mental healthcare professionals and experts. *ACM Transactions on Computing for Healthcare* 2, 3 (2021), 1–15.

[30] Anne Trafton. 2020. Using machine learning to track the pandemic's impact on mental health. *MIT News Office* (Nov. 2020). https://news.mit.edu/2020/covid-19-impact-mental-health-1105

[31] Aditya Nrusimha Vaidyam, Hannah Wisniewski, John David Halamka, Matcheri S Kashavan, and John Blake Torous. 2019. Chatbots and conversational agents in mental health: A review of the psychiatric landscape. *The Canadian Journal of Psychiatry* 64, 7 (2019), 456–464.

[32] Frank Warren. 2005. PostSecret. https://postsecret.com/

[33] Martin Wattenberg and Fernanda B Viégas. 2008. The word tree, an interactive visual concordance. *IEEE Trans. on Visualization and Computer Graphics* 14, 6 (2008), 1221–1228.

[34] Joseph Weizenbaum. 1966. ELIZA: A computer program for the study of natural language communication between man and machine. *Commun. ACM* 9, 1 (Jan. 1966), 36–45. https://doi.org/10.1145/365153.365168

[35] James A Wise. 1999. The ecological approach to text visualization. *Journal of the American Society for Information Science* 50, 13 (1999), 1224–1233.

[36] Andrew D Wong. 2021. *Facilitating Giving and Receiving Support in Existing Social Groups with a Journaling Chatbot.* Master's thesis. Massachusetts Institute of Technology.

[37] Julia S. Yarrington, Jana Lasser, David Garcia, Jose Hamilton Vargas, Diego Dotta Couto, Thiago Marafon, Michelle G. Craske, and Andrea N. Niles. 2021. Impact of the COVID-19 pandemic on mental health among 157,213 Americans. *Journal of Affective Disorders* 286 (5 2021), 64–70. https://doi.org/10.1016/J.JAD.2021.02.056