Developing An Automated COVID Risk Counselor:
Situation Type and Perceived Risk

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The COVID-19 pandemic has required individuals to understand and respond to evolving threats during their daily lives. Our goal is to develop an interactive risk counselor to help people evaluate risk-related implications of participating in daily situations and consider behaviors to mitigate risk. Automated tools have already been developed to help determine whether users may have COVID and should seek care, or to help users evaluate daily risk and provide advice and guidelines. Our tool will use a conversational interface to educate users about risk in a wider range of scenarios and provide recommendations that simplify risk perception. As an initial step, we conducted a survey to elicit people’s concerns about COVID risk in daily situations. Participants were asked to identify situations and for each situation, they were asked about dimensions relevant to risk, similar to the questions we envision the agent asking. Participants responded to our survey in a variety of ways. Some unexpectedly responded with comments, expressing opinions or observations about the pandemic circumstances. Others responded as we expected, describing a variety of objectively risky situations (e.g., indoor activities with little social distancing), and many reported moderate/extreme levels of concern about these situations. The descriptions, whether comments or situations, seemed to cluster into categories. We report several analyses of the survey data that help characterize differences between these two general kinds of responses. We next plan to confirm our initial observations that the data set enables reliable classification of user comments and situation descriptions. The classifiers would enable the agent to respond to a diverse user goals, including recognizing types of situations with known risk attributes related to the pandemic, so the agent can ask questions to help users evaluate situational risk. User responses will in turn allow the agent to educate the users about sources of risk mitigating behaviors.

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The COVID-19 (C-19) pandemic has upended our society, requiring rapid and dramatic responses from government and non-government institutions. Perhaps most important, adapting to this ongoing, dynamic threat has required each of us to understand and respond to these threats as they play out in our daily lives. This has been a daunting educational challenge exacerbated by uncertain and rapidly evolving scientific understanding of the virus, how it is transmitted, and how it affects individuals and communities. There is a need for tools that help us make sense of risks associated with C-19 and to learn what behaviors may mitigate these risks, based on current scientific evidence.

Our ultimate goal is to develop and evaluate an interactive risk mitigation counselor to help people evaluate risk-related implications of participating in daily situations and consider behaviors that may mitigate this risk. Understanding threat in a way that motivates and warrants action requires creating a mental model of the relevant concepts and their relationships (e.g., pathways of virus infection and its consequences; Downs & Fischoff, 2011). People tend to explain threats by creating mental models, and unsafe decisions and behaviors are often rooted in faulty or incomplete models. An effective tool will help people develop and update a mental model that guides planning for safe behaviors during myriad daily uncertain situations.

We are developing an interactive tool guided by the social and computational sciences to support risk assessments. The envisioned system would allow users with concerns about the risk of a particular activity (real or hypothetical) to interact in natural language with our system in order to describe their situation, with

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the goal of assessing the risks. A knowledge base and set of resources representing the most current science about risks and risk mitigation strategies would be the primary source of information for the tool. It would then identify the user’s concerns from their initial description, link the concerns to information that seems likely to be relevant, and then present it in the form of a set of follow-up questions that attempt to drill down deeper (e.g., asking for more details about the doctor’s office, if the “doctor’s office” frame has been identified). The result would be a set of recommendations for mitigating and managing the risk involved with the activity.

Not surprisingly, several automated C-19 risk assessment tools have been deployed. Many of these tools helped users determine whether they may have COVID and should seek care (e.g., Apple and WHO apps). More recent apps (e.g., https://mycovidrisk.app) help users evaluate daily risk and provide direct advice and easy access to relevant data (e.g., positivity rates in the user’s county). Especially relevant to our project, the Texas Medical Association published a resource that identifies daily situations ordered by risk of COVID infection (Doolittle, 2020). Unlike these resources, our tool will use a natural conversational interface to educate users about risk in a wider range of scenarios and provide recommendations that simplify risk perception for the public. Adopting an educational approach may have longer-lasting impact on society by supporting a deeper understanding of both virology and health.

Survey Study
As a first step in developing the tool, we sought to better understand how people describe their everyday activities and how they feel about their pandemic-related risk. We were unable to find existing data sets that matched our needs, and so we designed and conducted a survey to elicit people’s situation descriptions and associated concerns about risk of COVID in daily life. Our intent was to collect data that could eventually support the classification of situation descriptions for the envisioned risk-assessment agent.

Method
Introduction. The survey was conducted on Amazon’s Mechanical Turk during February and March, 2021. Only participants with a task approval rating of at least 90% and over 100 approved tasks were included. In addition, participants were excluded if they failed to correctly answer either of our two attention-check questions.

Participants. Participants were 156 adults (18-74 years old; 46% female; 20% non-white; 31% less than a bachelor’s degree, 54% Bachelor’s degree, 15% advanced degree).

Procedure and measures. Participants were asked to identify a recently experienced and an upcoming situation that elicited concerns related to COVID infection. For each situation, they were then asked about specific dimensions relevant to risk, similar to the questions we envision the agent asking to better understand a participant’s risk-related concerns related to the situation (e.g., was the situation inside or outside, how many people were involved, how closely spaced were they). After the situation tasks, demographic, COVID risk perception, and experience with COVID were measured.

Results
Participants were similar to the type of people we envision using our risk counselor tool: They were concerned about COVID risk to themselves (scale from 0=no threat, to 100=enormous threat; mean score=54.0) and to their community (mean=63.3), with 58% reporting knowing someone with COVID and 14% having COVID or not sure. Consistent with risk perception theories in general, and results during the pandemic in particular (Dryhurst et al., 2020), reported personal risk was higher for those who knew someone with COVID (57.4 vs 47.5, t= 2.22, p < .05). A similar but nonsignificant trend occurred for those who did versus did not experience COVID (63.8 vs 53.5, t= 1.56, p > .10).

Interestingly, a nontrivial percentage of participants responded to the situation prompts in an unexpected way: When asked to describe a recently experienced situation, 29% actually chose to comment on the pandemic instead. Similarly, when asked to describe an upcoming situation that they needed to assess, 28% again chose to share comments and/or opinions. Given this surprise, we decided to distinguish and characterize these two types of responses because they were fairly revealing about the differences with respect to goals and motivations of potential users of our envisioned system. Specifically, we felt that our agent would be more effective if it could intelligently respond to such comments rather than merely complain that they were not valid situations. By recognizing and responding to diverse user goals, including a pressing desire on the part of some users to share their opinions on mask-wearing or social distancing, an agent could engage in more robust dialogs and potentially do a better job in achieving the goal of supporting risk mitigation.
We next explored characteristics of the comments and situations. 1. While comments and situations varied in length, comments (experienced: mean=21.0, std=34.7 words; upcoming: mean=15.9, std=14.7 words) tended to be shorter than situations (experienced: mean=24.3 std=17.8; upcoming: mean=18.9, std=11.5). 2. Comments and situations appeared to have different functions/goals. Comments tended to express opinions or general observations about the COVID-19 pandemic. Situations tended to be narratives focused on risks that the participant was exposed to and how the participant managed the risk. Participants who provided comments rather than described situations related to COVID risk might do so because they perceive lower levels of risk related to the pandemic. We explored this possibility by comparing perceived risk of participants who provided comments and those who described situations, but the results were equivocal, with a nonsignificant difference in the predicted direction (mean composite risk score, Comment= 53.7; Situation= 58.3 t (80.3)=1.1, p>.10).

3. Reflecting these differences in content and function, Table 1 suggests the two types of responses had different linguistic properties. Situations often contained temporally ordered sequences of events indicated by past tense action verbs with first person subject (elided in the first situation in Table 1), and with a place or event noun (e.g., store, restaurant) as its indirect object or as the noun in an attached prepositional phrase. They also contained temporal expressions (e.g., ‘at the time’; ‘earlier/later’) Comments, on the other hand, contained action verbs only if they had third-person subjects (as in the first, second and fourth comments in Table 1) or disambiguating qualifiers (as in the first comment in Table 1); some comments contained no action verbs (as in the third comment in Table 1).

4. To examine how the language of situations varies from comments in more detail, we attempted to quantify how strongly individual word lemmas (dictionary forms of the words, used here to conflate morphological variants, such as shopper and shoppers to the same form shopper) were associated with text from situations versus that from comments. Operating on a combined vocabulary created from the words belonging to a concatenation of the situations and comments, we used the lemmatizer in Python’s spaCy library to lemmatize the words. We then used the log-odds ratio as a metric (Nye and Nenkova, 2015) to compare the log-odds of the occurrence of the lemmas in situations versus comments. Despite lemmatizing and collapsing the morphological variants to their common form, we found that owing to the limited sample size relative to the richness of the expressions in situations and comments, the log-odds comparison was not meaningful. Figure 1 shows the histograms of the frequencies of the lemmas in the situations and the comments subcorpus.

From the histograms we make the following observations. First, many lemmas are exclusive to either comments or to situations (shown by the number of lemmas with zero frequency). Second, we see that a majority of the lemmas occur only once, and the largest frequency is three. This suggests that we will need a larger sample

Table 1 shows examples of the comments and situations provided by participants. Situations were (1) temporally and (2) spatially located events or activities, 3) that were organized around participant goals. This general characterization of situations is consistent with theories of narrative comprehension (Zwaan Langston & Graesser, 1995) and social psychology (Rauthman & Sherman, 2020). Some comments met only one of the criteria for a situation. For example, the first comment is (1) temporally located, while the second is (2) spatially located. Other comments are qualitatively different from situations, e.g., the last two comments are located in neither time nor space. These examples suggest that the comments were responsive to the phrase “concerns related to COVID infection” in our prompt, but that they interpreted the phrases “recently experienced situation” or “upcoming situation” in a manner less precise than we expected.

<table>
<thead>
<tr>
<th>Comments</th>
<th>Situations</th>
</tr>
</thead>
<tbody>
<tr>
<td>My direct neighbors next door got the virus, and I was concerned that I may catch it from going to places like the mailbox where they had been.</td>
<td>Going to my daughter’s field hockey games and the other parents are not wearing masks. They also do not social distance as they should.</td>
</tr>
<tr>
<td>I am concerned about the increasing amount of employees returning to the office. I don’t feel that we have enough safety protocols in place.</td>
<td>I had recently visited New Orleans to visit family and friends and saw that very few—people were wearing masks. It made me feel quite nervous and concerned about COVID spread.</td>
</tr>
<tr>
<td>My main concern is that people won’t wake up and realize they are being fooled, and the way people put up with being muzzled and isolated.</td>
<td>I was attending a family meeting. I am worried someone has the virus, but I’m taking all the necessary precautions.</td>
</tr>
<tr>
<td></td>
<td>I was getting a few groceries at a local store and our county was in the red when I walked into the store there was several younger people in the back not social distancing with no mask on at all. I was really worried if I should get what I needed from that part, so I did not get anything. I put my cart back and left. I felt so worried that I would get something from them, if I did get it, how it would affect me.</td>
</tr>
</tbody>
</table>

Table 1. Sample Comments & Situations
for a more meaningful comparison of the two subcorpora in terms of their associated lemmas.

Figure 1

![Figure 1](image1.png)

Figure 2

![Figure 2](image2.png)

5. Spurred by the apparent diversity in goals and linguistic properties of comments and situation, we further examined them in order to determine whether they clustered into different sub-types. We found that comments included observations that expressed concern related to the pandemic (54% of the comments), opinions about the pandemic, often motivated by political beliefs (31%), and recounting conversations about the pandemic (6%).

There was more variety in the types of situations described compared to the comments. These situations tended to be objectively risky, with many involving indoor activities (77% experienced situations; 73% upcoming situations) lasting over an hour (68% experienced; 64% upcoming) and involving strangers (56% experienced, 66% upcoming) and people who did not practice social distancing (56% experienced, 22% upcoming), many with unknown COVID test status. Many of the participants (70%) reported moderate to extreme levels of concern about these situations. These were generally consistent with the set of situations identified by the Texas Medical Association (Doolittle, 2020).

While situations have been conceptualized and categorized using a range of methods in the literature, we adopted an approach that distinguishes situations in terms of participant goals, such as entertainment or travel (Morris & Murphy, 1990; Yang et al. 2009). Our analysis resulted in the following situation taxonomy: Sports, shopping, dining out, travel, school activities, work activities, events (social, health care, entertainment, service) and other. A subset of 20 descriptions were coded using this scheme to establish inter-rater reliability (Kappa=.89). The most frequent categories were social events, general public safety, and transportation. We plan to explore whether these situation types differ in terms of the risk-related dimensions probed in the survey, participants’ reported level of concern, and the kinds of words used to indicate concern. We also plan to model the risk associated with different situations in terms of the goals that define the situations (Yang et al., 2009); we hypothesize that the language individuals use to describe risk assessment will indicate a tradeoff between perceived risk and perceived goal process affordance.

Discussion

Our survey results are important in two ways. First, they contribute to theories of risk perception as they relate to the pandemic by helping to integrate analysis of dimensions of risk with theories of how people mentally represent everyday situations, especially with respect to goals. Second, the results contribute to developing our automated risk counselor tool. An important goal of the survey is to elicit situation descriptions written in everyday language in order to collect training data for our interactive counselor. The descriptions seem to cluster into coherent, activity-based categories, and so we will next seek to confirm our intuitions that the data set enable reliable classification of user situation descriptions. The classifiers will enable the agent to recognize types of daily situations with known risk attributes related to the pandemic, so that the agent can ask questions that will help the users evaluate situational risk. User responses will in turn allow the agent to educate the users about sources of risk and prompt them to consider the most relevant mitigating behaviors.

Our results also suggest that our agent will need to be capable of doing more than helping users evaluate the risk of daily situations. Nearly 30% of users chose to ignore the prompt to describe a situation and, instead, shared an opinion or observation about the pandemic instead (which are decidedly not situations). From an educational and behavior change point of view, this suggests a radically different strategy may be needed by the agent to achieve its goals of informing risk assessments in some cases. Simply sharing facts and data may result in a backfire effect (Nyhan & Reifler, 2010) thus pushing the user even further away from making valid risk assessments. Thus, in these cases, the agent may decide to bring up a specific example of risk and hope that the user would be willing to provide their assessment and engage in a discussion of risks. Another possibility would be to share stories that get the user’s attention (e.g., hospital ICU stress or COVID deaths of prominent radio talk show hosts). Ultimately, we hope to
implement and assess a range of dialogue-based strategies for engaging users in productive conversations about risk. We are encouraged by evidence that computer-based interactions have been found to increase self-disclosure over interactions with humans (Weisband & Kiesler, 1996), which suggests to us that COVID skeptics may be more willing to open up about perceived risks with a chatbot than with a fellow human.

Looking ahead, we will use our manual classification of the descriptions into comments and situations (and different situation types) to train supervised machine learning models (e.g., a naïve Bayes classifier or SVM) that will automatically perform this classification. This classifier will enable the agent to differentially engage in dialog with the users. For instance, when the agent detects a user’s input as a comment, it can further engage with the user to elicit a situation of concern by explicitly prompting the user to do so. A situation type classifier can also be used to relate a user’s situation description with an associated risk based on the risk-levels inferred from the survey responses, apart from the associated level of concern.

The machine learning model will be trained using data augmentation methods to enlarge the survey responses by collecting user generated risk-related questions expressed in social forums (e.g., Reddit). Toward this, we will rely on semi-supervised or active learning approaches (Miyato et al., 2016; Settles, 1995). Informal observations sketched in this paper suggest that the differences between comments and situations are not in the words themselves, but in the choices of subject and indirect object for each action verb, therefore we will explore features extracted from parsers trained to be robust to the types of social-media text elisions observed in these data.

References


