

Special Communication

“Hey assistant, how can I become a donor?” The case of a conversational agent designed to engage people in blood donation

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ABSTRACT

Background: People have insufficient knowledge and many misconceptions about the blood donation process, which hampers donors recruitment. Therefore, novel strategies and resources are needed to provide information and improve these circumstances.

Objective: We aimed at an interactive conversational agent to explain about blood donation.

Methods: We used the Dialogflow framework to develop a conversational agent and deployed it publicly. Afterward, we conducted an assessment of user experience (UX) with 50 participants who interacted with the agent. We analyzed participants' opinions, the different UX scales, and their association with participants' demographic variables.

Results: The conversational agent is available on the Google Assistant platform in Brazil. It is capable of responding to utterances related to 30 common questions and concerns about donating blood. The user can interact and explore freely and in any order by typing, speaking and selecting interface elements. The agent responds by speaking and displaying visual information, some multimedia content, and suggestions for continuing the dialogue. It enables a conversational sequence in which knowledge is imparted to the user in stages as the dialogue evolves. The overall UX assessed was very satisfactory, and people with specific demographic characteristics were more likely to have better UX. All participants had positive opinions and attitudes towards the conversational agent.

Conclusions: A conversational agent is a creative and captivating strategy of imparting knowledge and engage people regarding blood donation. The findings reaffirm the potential of using this technology for information outreach, especially for socially relevant purposes.

1. Introduction

Blood donation is a global concern. Many countries face the challenge of an increasing need for blood and suffer from its chronic or seasonal shortage [1,2]. Providing safe and adequate blood supplies should be an integral part of every country's national health care policy and infrastructure [3]. This situation requires that blood donation services concentrate efforts to increase donor recruitment and retention [4]. However, engaging donors is another challenge. Previous reports have shown that people have insufficient knowledge, diverse attitude and many misconceptions about the blood donation process, which may

be a factor for not being a blood donor [5,6]. To increase the level of knowledge towards blood donation, health education to communities is recommended [6]. In this context, advertising campaigns emerge as an opportunity to contribute to donor recruitment and imparting relevant information [7,8].

Advertising and informing strategies can benefit from interactive technological features capable of drawing attention and engaging users with health and social issues [9]. Among these resources are conversational agents, also called chatbots, which are computer programs designed to interact with people in the form of natural language dialogue [10]. One benefit of this interaction style is that it enables people

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to interact with a system in a familiar way [11]. The conversational style makes users' interactions with the virtual environment more appealing and intuitive, providing a gratifying user experience [12,13]. Furthermore, conversational agents have social and anthropomorphic cues [14] and may elicit social behavior and emotional connection on the part of the human interlocutor [15,16].

In the health domain, conversational agents can create bidirectional information exchange with people, providing counseling, follow-up, screening, among others [17]. The potential of this technology is becoming increasingly evident, including its use for informative, instructional, and social purposes [18,19]. Social media may become increasingly important for transfusion services to attract first-time donors and to remind repeat donors [20]. From this perspective, this study reports the development and assessment of a conversational agent aimed at engaging people in blood donation by explaining related doubts and asked questions.

2. Methods

2.1. Development of conversational agent

This project was developed in a partnership between the University of Passo Fundo (UPF) and the Blood Donation Center of the São Vicente de Paulo Hospital (SHHSVP) in the city of Passo Fundo, Rio Grande do Sul, Brazil [21]. SHHSVP sought help from UPF to deal with a problem: the lack of an effective advertising channel to inform people. SHHSVP professionals reported that everyday customer service had been receiving many calls and email messages with simple questions about the requirements and aspects of the blood donation process. These questions were often repetitive and had many details and complex specifications that required substantial time to explain, which was overwhelming to the SHHSVP. In addition, many people had been waiting too long for answers, which was hampering the recruitment of potential donors.

We realized that a conversational agent could be helpful in this scenario, hence, we decided to develop one. In addition, we assumed that interacting with an agent tailored to the conversation might be better than browsing information in a conventional manner such as on websites and printed materials [22]. For the development, we opted for a User-centered Design approach [23]. Our multidisciplinary development team was composed of professionals from the areas of human-computer interaction, health informatics, medicine, nursing, and social work. Throughout the conversational agent's design, we conducted brainstorming meetings and partial assessments involving team members, patients, and donors from SHHSVP.

We planned the natural language dialogues and the conversational agent's domain knowledge. For this, we used a frequently asked questions booklet from SHHSVP, which was previously developed and validated by healthcare and marketing professionals. Consequently, the chatbot responses contain parts of the booklet and benefit from the knowledge base already created. We also selected other common people's questions reported by SHHSVP customer service professionals.

Considering that short utterance varies with speaker, channel and utterance information [24], we performed an online survey using Google Forms to gather further sample user's utterances for the questions we selected. For this task, we invited 9 people at UPF and SHHSVP by non-probabilistic sampling for convenience. The users wrote from 2 to 5 utterance variations and synonyms that they would use to ask each question according to their own vocabulary.

The set of questions and responses selected for the agent underwent a language review to standardize its conversational style. We selected multimedia content to include in the responses. This content incorporated some images from the SHHSVP booklet and website, along with links to videos on the SHHSVP website. We also considered the inclusion of dialogue continuity suggestions. We used a card sorting method to create a diagram of connections among the questions. Except

for the introductory dialogue, each question was linked to at least 3 others whose contents had some kind of association or dependence. In this way, each question's response would contain, in the form of buttons and lists, at least 3 suggestions for triggering the follow-up or the next question.

To implement the conversational agent, we used the artificial intelligence-based suite Dialogflow [25]. It enables intent detection programming through a set of examples of user utterances for intents, contexts, and entities. We adjusted the agent according to these specifications. Each intent is associated with one or multiple programmed responses, which may include suggestions for continuity of dialogue. Contexts are used to instruct the intent classifier to interlink the dialogue, understand references to previous intentions, and distinguish similar entries. Entities are annotations for parameters, objects, or synonyms mentioned during the dialogue.

Intents were trained as literal questions from the list of frequently asked questions obtained from the SHHSVP booklet, reports from the SHHSVP customer service, and the utterance variations collected. Intents contained entities mapped to match synonyms for most frequent terms and names of objects and nouns mentioned, such as genders, disease names, ages, among others. Contexts were programmed to enable sequences of dialogues in episodes where the user responds simply with "yes" or "no". Contexts were also used to program the detection of a current topic within intents with context-dependent utterances. For instance, the context "*self_disease*" allows interpreting the question "*And if I have diabetes?*" following the question "*Can I donate blood if I have heart disease?*".

Dialogflow allows the invocation of the agent through web services with HTTP requests containing a user utterance in text format or voice record. The service interprets the utterance and returns the programmed response to the detected user intent. The suite also enables agent deployment and integration with messaging platforms. Accordingly, we performed the setup steps and got the approval to upload our project, making our agent available through Google Assistant.

2.2. User testing

User experience (UX) is dynamic and context-dependent. Zarour and Alharbi [26] summarized the concept in three ways: (1) Elaboration of usability: usability has different characteristics such as effectiveness and satisfaction. User satisfaction rest on existing needs, pleasure, expectations, trust and other attributes, all extended by UX; (2) Subjective aspects: UX emphasizes subjective measures, while usability highlights objective measures; (3) Users' perceptions: UX has a subjective nature since it deals with users' perceptions, emotions, and thoughts [27], which can be measured objectively or subjectively. Therefore, we decided to conduct a UX assessment study to verify users' perceptions and attitudes towards the conversational agent. All procedures involving human subjects were approved by the UPF's ethics committee under opinion number 20468919.3.0000.5342. All participants signed the written informed consent form.

2.2.1. Sampling

By non-probabilistic sampling for convenience, we selected 50 participants, of which 16 men (32%) and 34 women (68%), aged between 19 and 65 years (mean 28 ± 9.97). To reach a sample with different profiles, we invited students and professors from UPF, and also staff, patients, and donors from SHHSVP.

2.2.2. Assessment frameworks

We applied a sample characterization questionnaire with basic demographic questions. To assess UX, we used the User Experience Questionnaire (UEQ) [28]. UEQ is composed of 26 items of semantic differential rating scale of 7 points. The items are related to the 6 UX scales of attractiveness, perspicuity, efficiency, dependability,

stimulation, novelty. All aspects covered by the questionnaire are also mentioned in the UX framework elaborated by Zarour and Alharbi [26]. Attractiveness is a pure valence dimension. Perspicuity, efficiency, and dependability are pragmatic quality aspects (goal-directed), while stimulation and novelty are hedonic quality aspects (not goal-directed). We also elaborated 3 descriptive questions for participants to report their opinions and attitudes towards the agent:

1. How was your experience interacting with the agent?
2. Would you use the agent again, and why?
3. Would you recommend the agent to others, and why?

2.2.3. Procedure

First, we instructed each participant on the objectives of the assessment and collected the signed consent forms. Afterward, the participant answered the sample characterization questionnaire. Then, the researcher provided the participant with a smartphone and briefly guided him/her on how to interact. Each participant interacted freely with the conversational agent for 6 min using voice, text and visual elements. After the interaction, the participant answered the UEQ and the three descriptive questions. The entire procedure was conducted in an isolated observation room.

2.2.4. Data analysis

First, we inserted UEQ's responses into UEQ's data analysis tool [29] to obtain scores for hedonic and pragmatic overall qualities, 6 user experience scales, and the 26 rating items. From responses in 7 semantic differential points, the scores generated by the UEQ range from -3.000 to 3.000 (referring to -3 , -2 , -1 , 0 , 1 , 2 , 3). A result less than -0.800 indicates a negative user experience; a result between -0.800 and 0.800 indicates a neutral user experience; a result greater than 0.800 indicates a positive user experience. UEQ's analysis tool also compares the measured scale means in relation to existing values from a benchmark data set from 18483 persons of 401 UX studies concerning different products. We generated the scores for the entire sample and the scores categorized by demographic variables. Then we used the SPSS 22.3 statistical package for Windows to perform the Mann-Whitney U Test and Kruskal-Wallis Test comparing the association between scores and demographic variables.

3. Results

3.1. The conversational agent

Brazilian Institute of Industrial Property (INPI) granted us the software copyright registration code BR5120200001637. The conversational agent is available on the Google Assistant platform [30] in Brazilian Portuguese. It can be accessed through a variety of supported devices, such as phones, tablets, laptops, speakers, and other smart devices. The invocation phrase is "*Falar com Hemoterapia HSVP*".

Once invoked, the agent is instantiated and instantly initiates dialogue using a non-formal first-person narrative. In the first stage of the dialogue, the agent introduces himself as the character Hemozito, the SHHSVP mascot. The agent lists the topics he can talk about and encourages the user to continue the dialogue about the blood donation process. Throughout the dialogue, the agent presents multimedia content to illustrate and better explain certain topics and entertain the user. For instance, this content contains illustrations of objects, the agent's character, and speech balloons. Fig. 1 shows some dialogue screenshots and interface elements.

After the initial stage, the user can interact freely and in any order by typing, speaking and selecting interface elements. The agent has multimodal support and always responds by displaying visual information. If the user interacts by speaking, the agent responds using speech synthesis technology with a male voice. At all stages, the agent displays a help option, so that the user can review the list of available

topics and other suggestions for continuing the dialogue. The premise for it is to interlink a conversational sequence or flow in which knowledge is imparted to the interlocutor in stages as the dialogue evolves. The suggestions also allow the interlocutor to interact with the agent even without knowing what to ask, since it is possible to explore the content through the suggestions. Throughout the dialogue, the agent also encourages the user to become a blood donor by presenting motivating and guiding messages. The conversational agent knowledge base has been programmed to respond to variations of 30 questions or topics, which are presented in Table 1.

3.2. User's perceptions

Overall hedonic quality had a mean of 2.255, while the overall pragmatic quality had a mean of 2.447. Fig. 2 presents the distribution of answers per item to the UEQ. Most of the responses (about 65%) was on the best point. According to UEQ's benchmark analysis tool, all 6 scale means of our assessment were in the range of the 10% best results. Table 2 shows the results of UEQ's items and scales. Regarding the mean responses to UEQ items and its calculated scales, all ratings obtained an excellent score (greater than 0.800). In addition, we identified some statistically significant associations among the scores of UX scales and the participants' demographic variables (Table 3).

Responding to the descriptive questions, all participants expressed a positive and satisfying experience. Most opinions mentioned that the agent was interesting and innovative. Other terms mentioned by the participants stated the agent as amusing, enlightening, helpful, easy to interact, and quick to get information. All participants also stated that they would use the agent again and recommend it to others. Their justifications for this were analogous in both questions and referred to the agent's content, the interaction style, and the perceived implications and benefits of using the agent.

Regarding the content, the agent was considered interesting for its way of presenting information in stages, in a didactic and captivating manner, including diversified resources of text, image, and voice. Some participants said that the agent appeared to be a complete tool that included all the necessary information. Others stated that they would interact with the agent again to learn more, as it is a practical and useful tool. The conversational style of interaction was also perceived as advantageous. Some participants understood that people who have limitations or difficulties in reading or typing can interact by speaking, which makes the agent an accessible resource. Others mentioned that asking the agent could be faster and more efficient than searching online or contacting the blood center by phone or email. Finally, some participants noticed that the agent can encourage a potential donor by explaining the importance of donating blood with all the information needed to do so.

4. Discussion

Since 2008, the World Health Organization [31] has emphasized that information and communication technologies enable people to have access to knowledge that would not be available otherwise. The widespread utilization of the Internet and its related services has aided in the democratization of knowledge [32,33]. Social media and technology usage have been advantageous approaches to assist in blood donation – from requesting donations online in an automated manner to imparting the right information to the right people at the right time [34,35].

There have been several initiatives concerning the use of technology for blood donation. For example, Brislin et al. [36] created an app to locate blood donors near the user. The app also provides a list of donors in the user's area. Likewise, Dutta et al. [37] developed a web-based application system to manage blood donation campaigns, in which donors can plan campaign activities according to their preferences. The Canadian Blood Services [38] has developed a chatbot to engage young

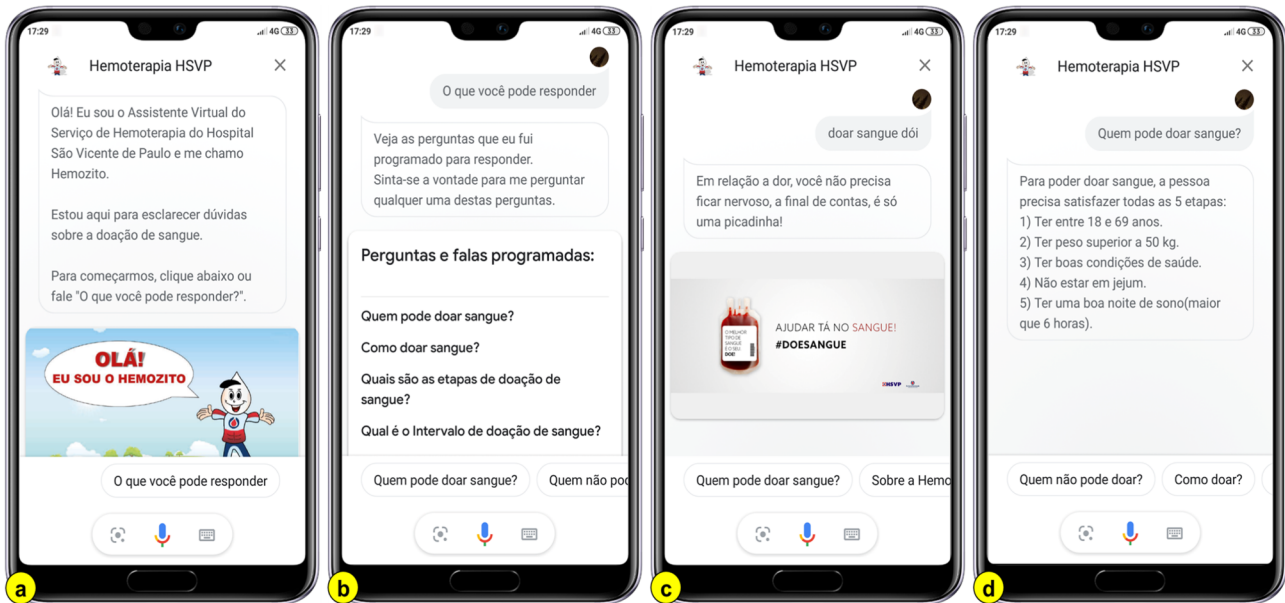


Fig. 1. Screenshots of the conversational agent on the Google Assistant platform: (a) Hello! My name is Hemozito and I'm the virtual assistant of the Blood Center at São Vicente de Paulo Hospital. I'm here to answer questions about blood donation. To get started, click below or say "What can you answer?". (b) "What can you answer?" See the questions I was programmed to answer. Feel free to ask me any of these questions. Who can give blood? How to donate blood? What are the steps to the blood donation process? What is the blood donation interval?; (c) "Does donating blood hurt?" There's no need need to be nervous. You won't feel any pain, after all, it's just a little sting!; (d) "Who can donate blood?" In order to donate blood, a person must meet all 5 requirements [...].

Table 1
Sample utterances supported by the conversational agent.

| Question or topic about the blood donation process |
|--|
| Who can give blood? |
| Who had surgery can donate? |
| How to donate blood? |
| What can you answer? |
| How can I become a donor? |
| What are the mandatory tests performed? |
| What are the steps to the blood donation process? |
| What is the blood donation interval? |
| Does donating blood hurt? |
| What are reasons you can't give blood? |
| What is the most needed blood type? |
| Do I have to donate blood in someone's name? |
| Can I give blood if I've had a transfusion? |
| How much blood is collected during a regular donation? |
| What should I do before donating blood? |
| Can I donate blood while fasting? |
| About SHHSVP Hemotherapy |
| Can I donate blood if I lack sleep? |
| What are your business hours? |
| Can I donate blood if I have diabetes? |
| Do I need to schedule an appointment to donate blood? |
| Can I donate blood if I have heart disease? |
| Can a person with tattoos donate blood? |
| Can I donate blood if I have a thyroid problem? |
| What will disqualify you from donating blood? |
| Can I donate blood if I am taking medication? |
| What is the hemotherapy service phone number? |
| What is the location of the hemotherapy service? |
| I will make a blood donation! |
| End the conversation |

donors on Facebook Messenger. It helps users learn more about the donation process and the people who benefit from it. In Copenhagen, a company created a platform called BloodLink [39], aiming to connect donors, blood banks and hospitals to minimize blood wastage. Another work developed in this domain is the Donor Finder, a chatbot that allows users to request and donate blood from other nearby users [40]. Despite the limited information available on these works for

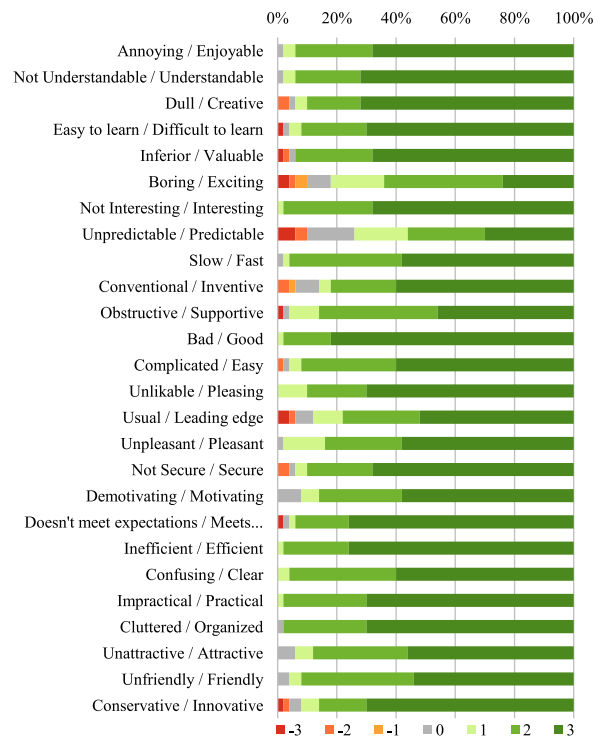


Fig. 2. Distribution of answers per item to the User Experience Questionnaire assessing the conversational agent.

comparison, we can conclude that there are still few initiatives that use conversational agents and other technologies to spread information about blood donation. Meanwhile, our conversational agent is among the first similar initiatives that address the development and use of these solutions in Brazil.

We chose to deploy the conversational agent on the Google Assistant platform to facilitate its dissemination. This platform is available for a variety of smart devices and operating systems, and it is also a native

Table 2

Results of items and scales of the User Experience Questionnaire assessing the conversational agent.

| Semantic differential rating | Mean \pm SD | 95% CI | Scale/Quality |
|--|-------------------|--------|----------------|
| Annoying/ Enjoyable | 2.600 \pm 0.670 | 0.186 | Attractiveness |
| Not Understandable / Understandable | 2.640 \pm 0.663 | 0.184 | Perspicuity |
| Dull/ Creative | 2.480 \pm 1.129 | 0.313 | Novelty |
| Easy to learn/ Difficult to learn | 2.520 \pm 1.035 | 0.287 | Perspicuity |
| Inferior/ Valuable | 2.460 \pm 1.182 | 0.328 | Stimulation |
| Boring/ Exciting | 1.500 \pm 1.488 | 0.412 | Stimulation |
| Not Interesting/ Interesting | 2.660 \pm 0.519 | 0.144 | Stimulation |
| Unpredictable/ Predictable | 1.340 \pm 1.698 | 0.471 | Dependability |
| Slow/ Fast | 2.520 \pm 0.646 | 0.179 | Efficiency |
| Conventional/ Inventive | 2.180 \pm 1.335 | 0.370 | Novelty |
| Obstructive/ Supportive | 2.220 \pm 1.055 | 0.293 | Dependability |
| Bad/ Good | 2.800 \pm 0.452 | 0.125 | Attractiveness |
| Complicated/ Easy | 2.440 \pm 0.929 | 0.258 | Perspicuity |
| Unlikable/ Pleasing | 2.600 \pm 0.670 | 0.186 | Attractiveness |
| Usual/ Leading edge | 2.020 \pm 1.491 | 0.413 | Novelty |
| Unpleasant/ Pleasant | 2.400 \pm 0.808 | 0.224 | Attractiveness |
| Not Secure/ Secure | 2.440 \pm 1.128 | 0.313 | Dependability |
| Demotivating/ Motivating | 2.360 \pm 0.921 | 0.255 | Stimulation |
| Doesn't meet expectations / Meets expectations | 2.600 \pm 1.010 | 0.280 | Dependability |
| Inefficient/ Efficient | 2.740 \pm 0.487 | 0.135 | Efficiency |
| Confusing/ Clear | 2.560 \pm 0.577 | 0.160 | Perspicuity |
| Impractical/ Practical | 2.680 \pm 0.513 | 0.142 | Efficiency |
| Cluttered/ Organized | 2.660 \pm 0.593 | 0.164 | Efficiency |
| Unattractive/ Attractive | 2.380 \pm 0.855 | 0.237 | Attractiveness |
| Unfriendly/ Friendly | 2.420 \pm 0.758 | 0.210 | Attractiveness |
| Conservative/ Innovative | 2.380 \pm 1.276 | 0.354 | Novelty |
| Overall Attractiveness Scale | 2.533 \pm 0.515 | 0.143 | Attractiveness |
| Overall Perspicuity Scale | 2.540 \pm 0.585 | 0.162 | Pragmatic |
| Overall Efficiency Scale | 2.650 \pm 0.404 | 0.112 | Pragmatic |
| Overall Dependability Scale | 2.150 \pm 0.587 | 0.163 | Pragmatic |
| Overall Stimulation Scale | 2.245 \pm 0.715 | 0.198 | Hedonic |
| Overall Novelty Scale | 2.265 \pm 0.859 | 0.238 | Hedonic |

N = 50.

A value >0.800 indicates positive experience.

app on most Android smartphones. In the public health context, the dissemination of a conversational agent with capabilities for health-related purposes is a beneficial approach. The agent can be available to the entire population, affordably and cost-effectively for any person

who owns a smartphone and has Internet access, which is an encouraging prospect. According to statistics, in Brazil, there are over 230 million smartphones in use [41]. The number of households with Internet access increased to 70% in 2018, where the smartphone was the main device used by 97% of household members [42]. These data support the encouraging reality of the available technology to reach the population.

The conversational agent's main contribution is to facilitate information outreach to improve users' literacy. [43]. Knowledge about the blood donation process is a motivating factor to become a donor [44–46]. In fact, people who have more knowledge about this process are more likely to donate blood [47]. Educational strategies provide more effective results for blood donation and may have short, medium and long term effects [8]. Technologies with persuasion capabilities are a promising approach for promoting desirable behavior [48]. Increasing awareness about the blood donation process is essential to induce a behavior change in the intended audience [49]. In this sense, the agent may help increase the number of donations, while assisting new and infrequent donors to overcome the fear and insecurity related to process [50,51]. For instance, information and clarification during the recruitment of donors could minimize the fear concerning process safety [7].

Health dialogue differs from other conversation styles since continuity of interactions is required and user engagement has to be maintained during the interaction [52]. In this study, we noticed that, from the moment the interaction began, the user increasingly wanted to discover more information by navigating through all the agent's questions and suggestions. We attribute this to the fundamentals of the agent's knowledge base, since we had used previously validated content from the SHHSVP booklet and frequently asked questions.

In the context of SHHSVP, the agent can help facilitate customer service and provide convenience by imparting detailed information without time limitation [53]. By allowing people to interact freely, the agent can keep potential donors engaged longer, conveying more information and being more assertive. The design characteristics of the conversational agent may influence users' perceptions. The usage of human-like cues has a significant influence on emotional connection, leading up to a positive effect on relationship building [16]. In this study, the SHHSVP mascot reduced users' inhibition during the interaction, enhancing the emotional aspect and promoting a more satisfactory UX [54–56].

Table 3

Scales of the User Experience Questionnaire compared by participants' demographic variables.

| Variable | n (%) | Attractiveness | Perspicuity | Efficiency | Dependability | Stimulation | Novelty |
|---|--------|--------------------------|--------------------------|--------------------------|-------------------|--------------------------|--------------------------|
| Gender † | | <i>p</i> = 0.012* | <i>p</i> = 0.074 | <i>p</i> = 0.302 | <i>p</i> = 0.535 | <i>p</i> = 0.004* | <i>p</i> = 0.146 |
| Male | 16(32) | 2.251 \pm 0.624 | 2.500 \pm 0.328 | 2.547 \pm 0.476 | 2.094 \pm 0.480 | 1.859 \pm 0.736 | 2.047 \pm 0.912 |
| Female | 34(68) | 2.667 \pm 0.402 | 2.559 \pm 0.676 | 2.699 \pm 0.361 | 2.177 \pm 0.636 | 2.427 \pm 0.636 | 2.368 \pm 0.828 |
| Education level † | | <i>p</i> = 0.175 | <i>p</i> = 0.630 | <i>p</i> = 0.081 | <i>p</i> = 0.398 | <i>p</i> = 0.868 | <i>p</i> = 0.843 |
| High school or a lower degree | 6(12) | 2.750 \pm 0.419 | 2.500 \pm 0.879 | 2.833 \pm 0.409 | 2.333 \pm 0.701 | 2.292 \pm 0.732 | 2.167 \pm 1.115 |
| Undergraduate or a higher degree | 44(88) | 2.504 \pm 0.524 | 2.546 \pm 0.551 | 2.625 \pm 0.405 | 2.125 \pm 0.577 | 2.239 \pm 0.723 | 2.278 \pm 0.836 |
| Have you ever donated blood? † | | <i>p</i> = 0.904 | <i>p</i> = 0.588 | <i>p</i> = 0.894 | <i>p</i> = 0.937 | <i>p</i> = 0.355 | <i>p</i> = 0.306 |
| Yes | 21(42) | 2.529 \pm 0.440 | 2.535 \pm 0.564 | 2.655 \pm 0.348 | 2.155 \pm 0.504 | 2.310 \pm 0.628 | 2.336 \pm 0.779 |
| No | 29(58) | 2.540 \pm 0.614 | 2.548 \pm 0.560 | 2.643 \pm 0.479 | 2.143 \pm 0.700 | 2.155 \pm 0.808 | 2.167 \pm 0.921 |
| Are you currently a blood donor? † | | <i>p</i> = 0.177 | <i>p</i> = 0.040* | <i>p</i> = 0.103 | <i>p</i> = 0.630 | <i>p</i> = 0.547 | <i>p</i> = 0.046* |
| Yes | 8(16) | 2.271 \pm 0.636 | 2.250 \pm 0.552 | 2.406 \pm 0.481 | 2.031 \pm 0.761 | 2.094 \pm 0.718 | 1.750 \pm 0.846 |
| No | 42(84) | 2.583 \pm 0.480 | 2.595 \pm 0.583 | 2.696 \pm 0.376 | 2.173 \pm 0.557 | 2.274 \pm 0.719 | 2.363 \pm 0.836 |
| Do you know the process of blood donation? † | | <i>p</i> = 0.096 | <i>p</i> = 0.437 | <i>p</i> = 0.120 | <i>p</i> = 0.798 | <i>p</i> = 0.844 | <i>p</i> = 0.789 |
| Yes | 26(52) | 2.436 \pm 0.540 | 2.471 \pm 0.637 | 2.567 \pm 0.428 | 2.154 \pm 0.653 | 2.289 \pm 0.617 | 2.240 \pm 0.857 |
| "Partially" or "No" | 24(48) | 2.639 \pm 0.475 | 2.615 \pm 0.524 | 2.740 \pm 0.363 | 2.146 \pm 0.519 | 2.198 \pm 0.818 | 2.292 \pm 0.877 |
| Do you know what a conversational agent is? § | | <i>p</i> = 0.032* | <i>p</i> = 0.067 | <i>p</i> = 0.008* | <i>p</i> = 0.283 | <i>p</i> = 0.015* | <i>p</i> = 0.105 |
| I've heard about and used it at least once | 18(36) | 2.268 \pm 0.611 | 2.417 \pm 0.484 | 2.431 \pm 0.429 | 2.014 \pm 0.458 | 1.917 \pm 0.674 | 2.028 \pm 0.874 |
| I've heard about but I've never used it | 12(24) | 2.667 \pm 0.471 | 2.688 \pm 0.554 | 2.792 \pm 0.395 | 2.146 \pm 0.679 | 2.521 \pm 0.634 | 2.417 \pm 0.734 |
| I've never heard about it | 20(40) | 2.692 \pm 0.344 | 2.563 \pm 0.684 | 2.763 \pm 0.309 | 2.275 \pm 0.635 | 2.375 \pm 0.711 | 2.388 \pm 0.908 |

Results expressed as mean \pm SD. A value >0.800 indicates positive experience.

**p* \leq 0.050.

† Mann-Whitney U Test.

§ Kruskal-Wallis Test.

A single episode of interaction may not be sufficient to persuade, raise awareness, or educate the participants. Therefore, a first cross-sectional assessment needs to emphasize aspects of users' perception. Our premise for choosing a UX assessment in this study considers that, if users report a positive UX and rate the functionality and content as useful, then they will be inclined to use a service for a longer period of time [12]. Consequently, as the participant may interact with the conversational agent over time, he or she will be able to access more content and gradually learn more and become more engaged in blood donation. In the long term, other studies have shown that people appreciate conversational interface and its simplicity, especially to ask a question and instantly access a valid and concise answer [57]. Conversational agents also have the potential to provide information as efficiently as human professionals [58].

In this study, the conversational agent was well-rated by people with different demographic characteristics. Thus, we can assume that an agent is an applicable tool to any audience, due to the perspicuity of the conversational interaction. Still, homogeneity across all UX scales regarding some demographic variables reveals some findings. For example, regardless of educational level, UX was equivalently positive, suggesting that the language style used in the agent is accessible to all users. Likewise, UX was equivalent to participants who had already donated blood or had never donated, and also for those who knew or did not know the process of blood donation. This fact might mean that event users who have had previous experience or knowledge about blood donation rated the information and the agent's interaction as rewarding.

Some scales of the evaluated UX had significant differences. The attractiveness and stimulation scales had higher means for female participants, who are usually less likely to make a blood donation [59,47,3]. Thereby, the conversational agent is a viable and more attractive alternative for encouraging women to donate blood. Considering the question "Do you know what a conversational agent is?", the means of attractiveness, efficiency, and stimulation scales were inversely proportional to the participants' prior knowledge. As innovativeness is an important construct in users' satisfaction and acceptance [60,61], we believe that this result reflects the greater sense of innovativeness perceived by users who did not know or never had the opportunity to interact with a conversational agent. People who had already interacted had a lower mean, since they are less influenced by the appeal and expectation of the first interaction, as argued by Bellei et al. [62]. Similarly, whether or not the person was currently a donor, the perspicuity and novelty scales were smaller for participants who were donors. We believe this is justified by the lower interest in the information shown by the agent, assuming that these people already had some knowledge about this topic and had established preconceptions about the blood donation process [45].

5. Limitations

This study had some limitations. The conversational agent may not be able to answer all of the people's questions in the various ways they can be uttered. We are still continuously working to enhance the agent's understanding ability. The overall experience, although positive and promising, was assessed cross-sectionally and cannot be generalized or considered in the long term. The interaction time of 6 min may not have been sufficient for all participants to fully understand the agent. Besides, there is a possibility of distortion by the limited sample. The assessment of users' perceptions suggests the potential of the conversational agent as a health information tool. Future studies should evaluate and confirm aspects related to the agent's efficacy.

6. Conclusions and future works

This study presented a conversational agent designed to explain related doubts and asked questions about the blood donation process.

The overall UX assessed was very positive and satisfactory, as well as participants' opinions and attitudes towards the agent. Some of the UX scales were associated with demographic variables, and this can be taken as a starting point for future studies and investigations. A conversational agent is a creative and captivating strategy of information outreach, capable of imparting knowledge, promoting, and encouraging people regarding blood donation. The findings reaffirm the potential of using this technology, especially for socially relevant purposes. Accordingly, our agent remains publicly and freely available in Brazil (see [30]).

In future work, we intend to overcome current limitations. Regarding the agent, we are collecting data from users' free interactions on Google Assistant, such as sessions details, mismatched utterances, and most accessed conversation flows. This data will be used as the basis for new programming routines that will improve the agent's ability to understand. We also intend to add some screening demographic questions at the beginning of the dialogue, to better customize it according to each participant's profile, tailoring the user experience. Nevertheless, future qualitative analyzes will allow syntactic and semantic improvements in the agent's responses. Considering users' perceptions and outcomes, we intend to conduct a controlled trial to verify participants' knowledge before and after the interaction, in which one group will use the booklet, while another will interact with the chatbot. Furthermore, other studies can assess longer time-frames and recurrence effects of the chatbot interaction, analyzing how the user experience and the participants' knowledge evolves.

CRedit authorship contribution statement

Mateus Klein Roman: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Visualization, Writing – original draft. **Ericles Andrei Bellei:** Data curation, Formal analysis, Investigation, Software, Supervision, Validation, Visualization, Writing – original draft, Writing - review & editing. **Daiana Biduski:** Formal analysis, Investigation, Validation, Visualization, Writing – original draft, Writing - review & editing. **Adriano Pasqualotti:** Formal analysis, Methodology, Validation, Visualization, Writing – original draft. **Cristiane Da Silva Rodrigues De Araujo:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Resources, Software, Supervision. **Ana Carolina Bertoletti De Marchi:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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