Charlie: A chatbot to improve the elderly quality of life and to make them more active to fight their sense of loneliness

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ABSTRACT

The development of a conversation agent in the healthcare domain presents several technical, design and linguistic challenges. In our paper, we describe a chatbot conversing with elderly people, with age-related problems. A chatbot, named Charlie, able to remember commitments and medicines, connect remotely with doctors, family, entertain and assist elders. The idea is to investigate solutions to increase their quality of life by providing companionship through innovative strategies based on gamification, active notifications, and promotion of self-compassion that can be explored for preventive mental healthcare. The hope of helping the elderly is more needed than ever today due to the Covid-19 pandemic since lockdowns and isolation have disrupted social lives, affecting their mental health due to loneliness. In this paper, we also describe a preliminary evaluation of Charlie's personality and its level di acceptability by older people.

CCS CONCEPTS

• **Human-centered computing** → Accessibility; Empirical studies in accessibility; Human computer interaction (HCI); Interaction paradigms; Natural language interfaces; • **Hardware** → Emerging technologies; Emerging interfaces.

KEYWORDS

Chatbots, Conversational interfaces, Usability, Interaction design strategy for the elderly

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1 INTRODUCTION

Covid-19 pandemic has affected our lives in unexpected ways. For many, especially the elderly and frail, lockdown and isolation have disrupted social life, affected mental health causing loneliness, sometimes depression or anxiety disorders. The meaning of home, how to manage their medicines, the compromise between being independent and feeling alone, thoughts about death, requests for help or simple company, are just some aspects of the elderly's daily routines that are important for their perception of their life quality. This view of the quality of life is complex and goes beyond mere indices of health. The elderly need assistance with medication management, to be engaged in stimulating daily activities, and to be entertained. In these cases, the use of a chatbot can pave the way for existential help for people who have to stay in their homes.

The goal of the paper is to investigate interaction design strategies for developing a chatbot, named Charlie that can dialogue with the elderly and helps them improve the quality of their life in psychosocial terms. A chatbot capable to remember commitments and medications, recommend healthy activities and entertain the elderly through gamification strategies, active notifications, and promotion of self-compassion that can be useful for the prevention of age-related problems. According to these considerations in the next section, we present an overview of relevant studies we used as a base for motivating the adoption of a conversation agent in our context of use. Then in section 3, we describe our audience, its wishes and necessities according to which in section 4, the functionalities we implemented in our chatbot to investigate different assistive strategies are presented. Section 5 focuses on a preliminary evaluation of Charlie's personality and level of acceptability. Finally, the last Section tracks some conclusions and future works.

2 OVERVIEW OF RELATED STUDIES

Approximately one person in ten lives in a fragile situation and needs psychiatric care worldwide [1][2]. These numbers tend to grow if we take into account the elderly people who, though do not suffer specific psychiatric illnesses, need care due to their state of loneliness or fragile situations. Nowadays, technology offers promising means for treating mental illnesses like depression, for example through mobile apps [3][4] , chatbots [5], or virtual reality [6]. In particular, messaging applications are becoming the new generation of digital products due to the simplicity offered by conversational user interfaces or chatbots, compared to web or mobile application [7]. In addition, conversational agents are moving from the textual to the spoken channel, attempting to recognize user speech and offer satisfying spoken answers. Examples of this type of bots named voice-bots are Apple's Siri, Microsoft's Cortana, Google Assistant, and Amazon Alexa [8]. The efficiency of voice-bots is based on dialogue features that include nuance and tone, emphasis and pacing. Chatbots are less dependent on the need to provide a bot with "human abilities" such as a personalised tone of voice or a speech fuelled by emotion and they are more focused on providing a chat-based conversation. Moreover, the studies carried

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out in [9] highlight how text-based chatbots may be capable of eliciting a sense of humanness even without providing the user with any "sensorial stimuli".

According to these considerations, in this work, we take into account the use of chatbots as virtual agents specifically designed to help and assist the elderly. Several studies such as [3][9] describe how people can successfully experience the chatbot in terms of satisfaction, engagement, and trust. In the medical domain, studies such as [3][10][11][12][13][14] and commercial systems such as [15][16][17] promote chatbots to the role of assistant able to motivate users for exercising more, or for having healthy behaviour. Other works [18][19][20] focused on investigating how patients respond to a medical chatbot that provides them empathic support or how it can be used to promote behaviour changes or simply how it could establish long-term relationships with older adults. In this line, our main research question concerns the investigation of chatbots' communication characteristics and interaction strategies that encourage their use and acceptance, specifically for the elderly. The technological solutions presented in the literature, often miss in addressing pre-emptive care for strengthening mental health or improving the quality of life. Usually, the focus is on what should be "fixed", e.g. depressive symptoms, or suicidal tendencies, and the target is the person with these problems [21][22]. Without necessarily assuming the presence of diagnosed disorders to fix, we aim to understand if it is possible to use chatbots for filling a void for lonely pensioners and helping them to increase the perception of their quality of life.

3 CHATBOT DESIGN: REQUIREMENT ANALYSIS

The starting phase of the work focused on a preliminary socio-technical study aimed to explore the experiences and expectations of senior people regarding their daily life, ageing and health services, and the factors that might improve their quality of care and entertainment activities. To carry out this pre-test, we involved six participants. Four students of the bachelor degree in Computer Science for New Media communications and two students of master degree in Computer Science at the University of Milano. All participants tried to devise the main functionalities of the Chabot by defining key user intents. The scope was to carefully define what bot should cover and what not. Since chatbots are conversational, the students tried to define the interactions basing on an actual conversation. Therefore, each student involved a couple of aged relatives in a quick activity which the aim to identify their key intents and inputs required for each intent.

All senior participants (12 in total, 6 male and 6 female, aged 60 through 70 years old) live in pairs or alone, and have quite good skill and inclination in using technology (all have a smartphone and use it to chat, see videos on YouTube, browse the Web). Before being involved in our test, they signed informed consent and participated without payment. The students asked their relatives to think of them as an assistant who can help them to start a dialogue. While the students were performing this activity, they noted down the dialogue flows. Figure 1. presents an example of dialogue used to set up a reminder. Students drew some flowcharts representing different dialogue they had with their relatives and that led us to design the chatbot's features.

Starting from the results of the pre-test carried out by the students, we defined the bot personality and the flows of dialogue that allowed us to define which interaction strategies to implement. Taking into account the results of the pre-test and the related literature review [23][24][25][26][27][28][29] we designed a set of functionalities to bring alive our chatbot. Charlie's personality was specifically designed to promote easy connections with older users. For this reason, we decided to design Charlie as an empathetic, sensitive, sociable and friendly child robot. Often misfortunes happen to him, but it takes what comes his way with humour. Such context of use should feel friendly since Charlie invites the elderly into an intimate one-on-one chat space. Some studies (e.g. [3][25][26]) suggest avoiding defining a chatbot default gender. Even the students encountered how their relatives did not feel embarrassed by interacting with a robotic agent. Indeed overly humanized the bot could create a higher expectation on users, which eventually leads to more frustration when it fails [3]. Despite the name borrowed from nice characters of films and comics, we designed Charlie as a robot (as shown in Charlie's icons in Figure 2). About Charlie's choice of age, we decided to give it child traits. First, because students discovered their related prefer to interact with a sort of robotic grandson and then because children and the elderly can in some ways be very similar. They both need to be looked after, taken by the hand, helped to cheer up or relax. Like for all children, mamabot, Charlie's mum, can scold him in the same way as elder persons can be scolded by their children. Thus, a sort of complicity arises between the user and Charlie since, besides receiving assistance, the elder feels helpful and keeps himself busy with caring for a small creature.

4 CHATBOT FUNCTIONALITIES

As depicted in Figure 2. (screenshot A), the first functionality Charlie presents to the users, concerns the possibility to discuss specific topics based on their preferences such as sports or the world of celebrities. Charlie asks the user's opinion and shows the latest news on this topic.

Then, Charlie can also offer the user short quizzes on these topics to stimulate her/him and to satisfy her/his need for entertainment. Through a second functionality, Charlie can send healthy tips to the user. Adopting a gamification strategy, Charlie monitors if the user followed his suggestion and if so, he gives the user a "bot-coin" (a sort of recognition/prize). In exchange for rewards, this approach aims at helping users to follow a healthy life. Charlie can then help if the user is subject to cognitive impairment and memory reduction. As depicted in Figure 2- screenshot B, Charlie can ask the user if she/he needs help to remember something and helps her/him to fix a timetable. Another functionality allows Charlie to involve the user in solving some riddles or quizzes (Figure 2. – screenshot C). Charlie can also simply talk about an anecdote, related to unfortunate or unpleasant events that can generate self-compassion in the user (Figure 2. – screenshot D). According to some studies [20], self-compassion can stimulus the elderly to reflect on their life and through a sense of identification to satisfy the need to be heard and understood.

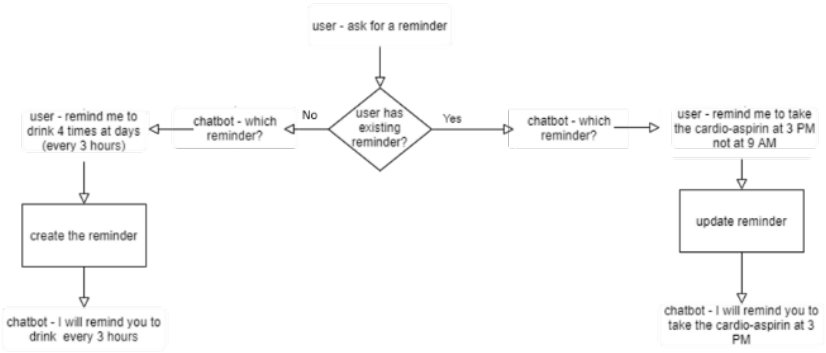

Figure 1: Sketch of dialogue flow designed by a student during the pre-test by using Draw.io (A diagram editor that enables to create flowcharts - https://drawio-app.com/).

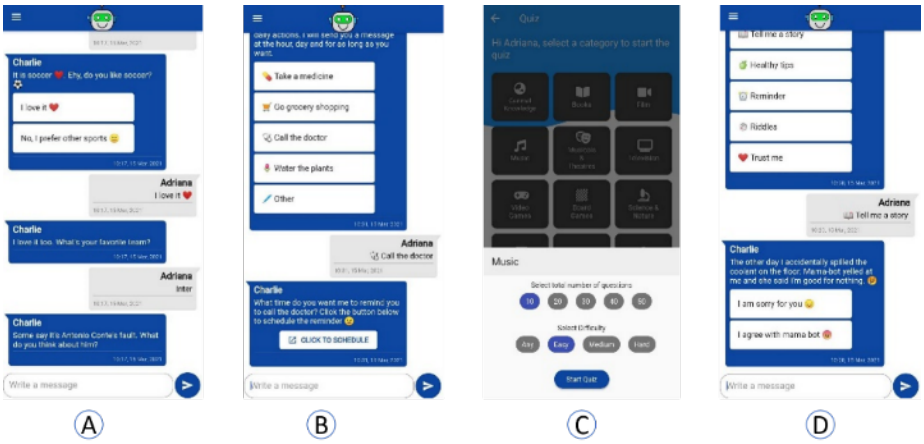

Figure 2: Image A presents an example of the engagement interaction strategy provided by Charlie. In image B, Charlie asks if the user needs help to remember something and helps her/him to fix a timetable. In image C, the user can select the number of questions and the difficulties of the quiz. Finally, image D shows an example of a self-compassion strategy.

4.1 Technical implementation

From a technical point of view, we designed our bot using a rules-based approach applied to the last user utterance. Charlie interprets the intent of users' utterances and according to it provides the most relevant response about the context of the conversation. To implement this approach, the chatbot has been designed by using Dialogflow [30]. Except for the AI strategies DialoFlow provides to catch the user's intent, we did not use other machine learning-based solutions to drive the flow of dialogue. Indeed, AI algorithms might provide users with unexpected answers difficult to explain since the bot acts as a "black-box" preventing us to trust him [31]. For this reason, we preferred to use a more simplistic approach based on a list of options that users can select by using the chatbot interface. Even the students experienced how their relatives prefer a limited range of options that allows them to be led down the right flow of dialogue. Moreover, our goal is to test the acceptance of using a chatbot designed to keep company with and assist senior users without getting lost in problems related to language compression or techniques to hang up the dialogue.

5 EVALUATION OF CHARLIE'S PERSONALITY AND ACCEPTANCE

To evaluate the personality and acceptance of Charlie by older adults we conducted a test involving the same students and relatives recruited for the pre-test. We asked testers to interact with the agents daily in their homes for a week. After that, students carried a set of a structured interview and accordingly defined an affinity diagram [32] (Figure 3) to group keywords and recurring themes that have meanings considering the experimented interactions.

The adopted structured interview is based on the Unified Theory of Acceptance and Use of Technology (UTAUT) model, a model based on TAM [33], that has been tested extensively in various fields and promises to be a great tool for analyzing users acceptance of health technology [34][35][36]. In [37] authors demonstrate how this model can effectively measure older users' perceptions and their level of acceptance in using healthcare applications. According to this study, we designed specific questions to investigate the "Behavioral Intention to Use (BI)" factor that aims at measuring the

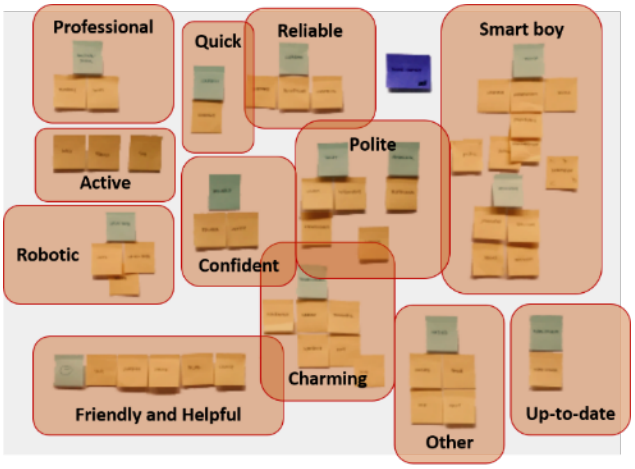

Figure 3: Affinity diagram to sort cues that shape Charlie's personality

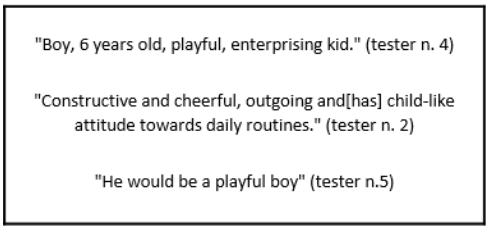

Figure 4: Examples of answers about Charlie's personality of participants at the test

strength of one's intention to perform a specified behaviour [38]. To measure this factor we defined questions for exploring how much by using Charlie users perceived benefits in performing certain activities. Then we investigated how much users considered easy to use Charlie and how much was important for them the social influence that is, the suggestions or options of their friends and relatives. The authors in [37] suggest integrating UTAUT model with three other types of questions specifically addressed to study the elderly's technology acceptance.

Therefore we added to our questionnaire another question for measuring the evoking anxious or emotional reactions a user experimented with when she/he used our chatbot. A second question for measuring the user's trust in Charlie in terms of safety (data security) and reliability (whether technology functions properly). Finally, a third question to measure how much physicians' opinion can influence the perception of technology as useful.

Although the number of interviews makes it impossible to present a statistically significant analysis, we carried out a qualitative study that allowed us to define a set of keywords or themes that are used to assess the perception of Charlie's personality and his level of acceptability by users. In details, when it comes to Charlie's personality, testers described him as a young, cheerful, active, friendly and smart assist (Figure 4). The perceived age of Charlie varied, but most of the participants agreed that he had the innocence of childhood regardless of age. Some people perceived Charlie as a robot rather than a human although this did not prevent a useful and pleasant interaction. Instead, this contributed to give Charlie smart traits.

For what concerns the level of acceptability, several senior users mentioned that the chatbot was efficient and helpful, while other people described the chatbot as imaginative or creative. They reported that they felt the chatbot was warm-hearted, energetic, or cheerful. Nevertheless, a few participants mentioned that the number of messages that the chatbot sent led to perceptions that the chatbot was pushy and compulsive.

Another important cue upon which the research participants when judging the chatbot's personality and its acceptance was the visual cues. In particular, emojis played a crucial role in affecting participants' judgment of the chatbot's characteristics. Several interviewees mentioned that the emojis made them feel that the chatbot was cheerful, friendly, and approachable. In general, the affinity diagram (Figure 3) highlight how Charlie is considered polite, smart, charming, helpful and reliable.

We are aware of the main limitations, well-known in literature [39][40]that affect our study. Firstly, the sample size of participants at our test. Secondly, we are not able to present statistic confirmation and validation about the reliability of the collected data. We know the senior relatives may have indulged their grandchildren during the interviews. Thirdly, the design of the dialogues did not focus on specific studies about the regard words to use, the right methods of interaction that better fit with the senior user's expectations. Finally, the chatbot's implementation lacks direct user involvement in requirement definition and design.

Nevertheless, this study aims at providing a first investigation about the senior user's experiences when chatting with a virtual agent designed to assist and entertain them in their daily routine. The idea is to study the attitude, acceptance, pleasure and utility of using a set of specific functionalities mediated by a chatbot to foster a desire of feeling good and doing good as reported in [40].

Due to the pandemic situation, we were able to carry out only a first qualitative study based on the UTAUT model. At the moment we are in contact with health assistance residences for the elderly that we can involve in further studies. As soon as we can carry out these usability evaluations in real contexts of use whit the involvement of a larger number of participants, we will be able to evaluation the difficulties or the appreciation in using each functionality and redesign Charlie's flows of dialogues or linguistic aspects with the user involvement as well.

6 CONCLUSIONS AND FUTURE WORKS

After a preliminary test with the involvement of students of the University of Milano and their aged relatives, we were able to define a personality for Charlie and the main functionalities he needs to cover. Currently, Charlie is an empathetic, sensitive, sociable and friendly child robot and provides the elderly with interactive activities based on s gamification, active notifications, and promotion of self-compassion. According to the analysis of discussions carried out with the elderly involved in the preliminary test, we can conclude that Charlie is considered by users polite, smart, charming,

helpful and reliable. This solution can offer a pool of interactive strategies that can relieve the state of loneliness the aged people live. The results of the performed analysis have shown very comforting outcomes even if it is necessary to carry out more detailed tests with real users to be able to give clearer and more truthful information in the middle and long period. Unfortunately, due to the current situation linked to the COVID 19 pandemic, these tests are still to be carried out.

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