CUIs for older adults

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ABSTRACT

In this position paper, we examine the benefits and shortcomings of conversational user interfaces (CUIs) for older adults, including those with mild cognitive impairment, and dementia-family diseases. Our position is informed by empirical studies and meta analyses in the literature, as well as a series of expert interviews we have conducted. We argue that CUIs have considerable merit, i.e., more advantages than disadvantages for this specific demographic group.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; **Accessibility**; • **Social and professional topics** → **Seniors**.

KEYWORDS

CUI, chatbots, user acceptance, cognitive training/interventions, dementia, Alzheimer's

INTRODUCTION

Making technologies that govern our lives accessible to older people is more relevant today than ever before as the population grows older with every passing year. Even in healthy-aging, perceptual, motor and cognitive abilities decline, which are all important for human-computer interaction (HCI). Advances in computer science enables assessing people's cognitive and functional abilities, and even predict cognitive impairment [4], optimizing interfaces and interactions, and creating digital cognitive interventions for older adults. For this purpose, some HCI approaches, such as CUIs, may be overall more usable and desirable, and may increase adherence. Adherence to treatments is important in

chronic conditions, in fact, it has been suggested that increased adherence may have a greater impact than improved treatments [17], and the same may be true for digital interventions. Even though new technologies can be challenging to learn and use effectively for older adults [11], simplicity and familiarity of messaging platforms seem to render them easy to use [19]. It has been shown that chatbots and messaging applications can be highly effective in increasing treatment adherence [12], e.g., in antiretroviral HIV/AIDS treatment [14], and medication after coronary heart disease [13]. It is clear for technical, medical, and legal reasons that CUIs cannot and should not attempt to replace healthcare personnel, but they can be of value in assisting patients, enabling them to search for information that they need, motivating them to follow a schedule, monitoring their vitals and adherence to e.g., medication, sleep, diet, etc., and alert professionals when necessary, thus relieving some of the demands on medical professionals and caregivers. In sum, CUIs offer high levels of usability and usefulness, and given that verbal communication is deeply embedded in human nature, this is not surprising. To live up to their promise, however, the design of CUIs is critically important. For example, adding gamification and personalized interactions can further improve adherence to chatbots and underlying health goals, e.g., by customizing reminders, displaying encouraging messages, chatting with the user, and careful use of playfulness [8], [16]. These design measures can go a long way in ensuring user uptake, engagement and retention, and they can be provided by artificial intelligence (AI) CUIs. Given the above, CUIs and virtual assistant/companion apps are promising *and* viable solutions to make digital health applications more accessible (usable, learnable, desirable) for older adults, and may have value especially for those with age-related cognitive decline. Although empirical evidence is only accumulating at this point in time, we believe that CUIs may increase adherence of older adults to helpful software such as e-coaches and other cognitive/physical training interventions. We present more specific arguments in support of this position in following sections based on a brief critical review of the related research, and insights gained from expert interviews we have conducted with 8 experts (see Table 1).

Table 1: Professional background of the experts we interviewed.

#	professional background
E1	neuroscientist specialising in cognitive training across the lifespan and brain disorders
E2	neuroscientist working with people with brain injuries and geriatric rehabilitation
E3	neuroscientist specialised in cerebrovascular and neurodegenerative markers of AD
E4	psychologist focusing on dynamics of healthy aging
E5	neurologist, brain health and computational biomarkers expert
E6	developer of computer games for older people
E7	general practitioner
E8	nurse with work experience in a dementia ward

CUIS FOR OLDER ADULTS: PROS AND CONS

Although CUIs can assist in various domains and may be usable for older adults [7, 19], there are also valid arguments against them based on technological (e.g., limits in a CUI's operational capacity), or psychological factors (e.g., lack of user acceptance). Below we highlight concerns as well as opportunities pointed out in previous research and in our expert interviews.

CUI's expertise. Even though AI solutions can outperform physicians in certain tasks, people trust human counterparts more than AI [7]. Current CUIs come off unnatural and cannot properly interpret emotional and non-verbal components of human interactions. Importantly, the domain is loaded with ethical and legal questions which are still mostly open, e.g., is it OK to 'fool' humans so that they do not know they are talking to a machine, or who is responsible for the mistakes an algorithm

might make? An in-depth treatment of these questions are beyond the scope of this paper, however, a carefully designed CUI acting as a *helper*, i.e., an assistant or companion, can provide people with a relatively uncomplicated and cost-effective solution that has unique strengths. For example, due to its constant availability, a CUI can continuously monitor and analyze conversation content, and pick up subtle changes much earlier than a physician using traditional methods, capturing patient data only at a particular moment in time. Assuming a CUI might improve adherence too, data produced by a CUI should be considerably richer than those produced by humans or other apps.

CUI's intelligence. Many CUIs are based on decision tree models, and can only interact with the user based on predefined questions and answers, thus can be perceived as incompetent, boring, rigid, impersonal, and frustrate users. On the other hand, a structured, somewhat predictable conversation can support patients with mild cognitive impairment (MCI), Alzheimer's disease (AD) or post-operative cognitive dysfunction (POCD), as structure and repetition makes them feel secure [E7]. Also importantly, many older adults with cognitive issues might be embarrassed by their condition [E8], and may be more willing to ask and accept help from an anonymous, machine-like device than from a human. It has indeed been demonstrated that in some cases (e.g., depressive disorder), the use of chatbots result in a higher rating of therapeutic alliance between patient-and-chatbot than between patient-and-clinician [3]. Future CUIs based on machine learning (ML) and AI will be smarter than their counterparts today, especially given the unprecedented progress in natural language processing (NLP). These next generation CUIs will understand a user's context, behavior patterns and preferences, thus can tailor content and timing of prescribed interventions or necessary assistance in a personalized manner. An ideal CUI should be configured to be discreet, respect user's privacy, while automatically adapting to users' needs and mood (e.g., through sentiment detection) which might give a feeling of being understood and increase adherence [E2], *and* offer options to manually adjust settings. Personalization is also relevant to caregivers and family members, a CUI can also learn their communication patterns and lead to insights into a patient's experience. However, the experts expressed contrasting views on what level of personal rapport between patient and chatbot is desired: some believe that emotional connection strengthens adherence to interventions [E4], while others expressed concerns about emotionally loaded conversations, as a machine is likely not able to respond to human emotions appropriately [E6, E7, E8].

Most promising CUI features. Experts pointed to *encouraging* patients, *reminding* them of tasks (e.g., following prescriptions and exercises), and *animating* or *nudging* them to engage in activities as the most promising features. *Encouraging* patients, and *rewarding* them for their efforts were mentioned by all experts. Messages should not be too repetitive nor patronizing though, and a variety of sincere, specific motivational messages and compliments should be configured, worded to reassure and foster a sense of self-efficacy. Similarly, acceptance commitment therapy (ACT) messages have great potential, which have improved treatment outcomes in various chronic conditions [1], and lend

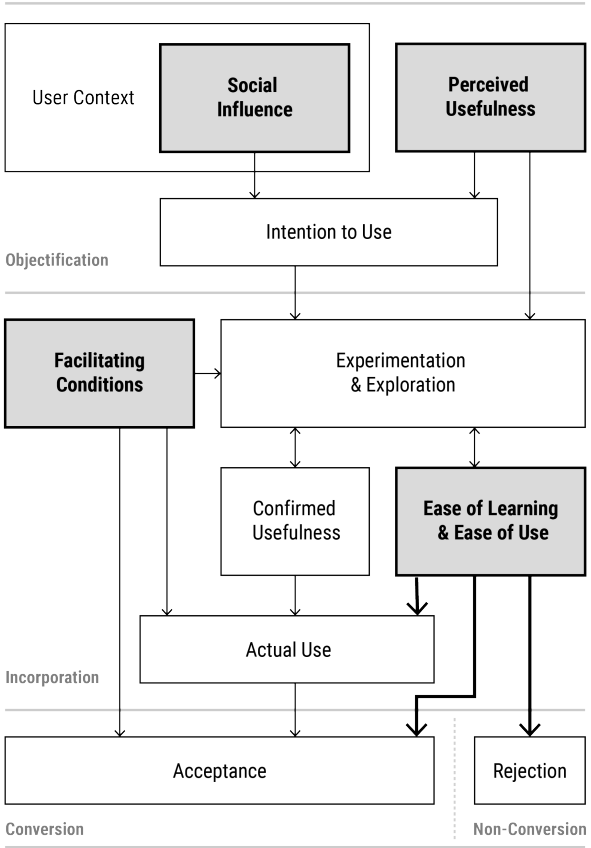

Figure 1: Senior Technology Acceptance Adoption Model (STAM) by Renaud and Van Biljon [15]. Figure redrawn and emphasis added by the authors.

themselves well for digital interventions. Several experts [E2, E3, E6, E8] mentioned integrating *social features*, as human interactions can feel much more authentic and rewarding than e.g., a compliment given by a chatbot. In this context, psychological mechanisms involved in interaction with machines can be complex; e.g., algorithmic rewards in computer games can be addictive (as in gambling), and people can humanize robots and software, and develop affection or attachment for them. The key is designing an *appropriate* reward system, and for that, it is important to understand what motivates the individual user [20]. Additionally, for many chronic health issues, *adherence* to prescribed protocols (e.g., medication, exercise, nutrition, cognitive interventions) is a 'wicked problem'. In the context of older adults' adherence to digital interventions, we must also consider memory lapses. Experts expressed that even the simple, customizable *reminder* functionalities aligned to a patient's daily routines (to support building new habits) bear great potential. It is important that the user does not feel *controlled* by the bot in general, nor this feature in particular, as negative feelings can lead to a decline in user acceptance. The third highly recommended CUI feature is to *animate* or *nudge* patients (plus caregivers, family members) to e.g., contact others, play an active game, go for a walk or initiate dancing. Such prompts could be aligned to some predefined targets (e.g., social engagement, cognitive training, physical activities) and the degree of challenge should adapt to the user's current social, mental and physical 'fitness level', context and capabilities. Combining physical and cognitive exercises (as in exergames and multi-domain training) have positive effects as well [9], and experts posited that adding social components in such interventions may have an even greater effect [E3, E6]. Plus, explaining why a particular activity is beneficial also increases adherence [E4, E5, E8]. These insights overlap substantially with a recent meta analyses study [7].

Factors of user acceptance. Adoption of new technologies, including smartphones, is generally lower in older adults than the younger adults [11]. This is no surprise since interfaces or interactions are nearly never tested with older adults, rendering app and device use unnecessarily difficult for them. CUIs aimed at older adults should be subjected to high usability standards, and tested in carefully designed experiments. Privacy and security issues may also require special attention with older adults to prevent exploitation of especially those in more vulnerable states (MCI, AD, POCD). Less tech-savvy users may not feel confident about configuring a device listening to them, and speech can contain sensitive information. Evidently, there are large differences in technology competence depending on e.g., level of education [10], type of technology [12], incentive [2], or if it enhances engagement with family [E2]. User acceptance of CUIs surfaced as an important theme in our interviews, for which practical, social and psychological reasons were mentioned, matching with the technology acceptance models (TAM) [5] and senior TAM (STAM) adaptation [15] (see Figure 1). Additionally, questions were raised regarding subjective norms and social/cultural context of users: Is it respectful and dignified that a patient is cared for or treated by a CUI? To what degree can a chatbot help against the issue of loneliness that many older adults experience? Is it (un)ethical if the chatbot would

Table 2: Practical advice by our experts concerning ease of use of CUI/chatbot.

Content and structure	To accelerate technology adaptation, the application must be clearly structured and self explanatory, not overloaded (too many features or sensory stimuli at once), and should not intimidate the user.
Language	Messages must be simple and unambiguous, complex syntax should be avoided and the wording should never make the patient feel 'talked down' or unintelligent.
Interface and interaction design	Beyond the obvious (large font and target size, high contrast) the application should be characterized by high fault tolerance (for touch and voice interaction).
Voice	Although voice interaction causes less friction than a visuospatial interface, it should be noted that a combination of text and voice might increase intelligibility for patients with visual or hearing impairments.

provide a (fake) sense of companionship to a patient? While some people resist such tech-driven solutions due to their potentially deceptive nature, others are more optimistic about technology, may encourage its use and be early adopters themselves. Linked to these issues, some experts consider loneliness as one of the biggest problems of MCI patents [E3, E8], for which CUIs *can* help, i.e., they might not only assist and entertain, but also reinforce social contact. As mentioned earlier, some patients might not be ready to accept their need for support [E8], they might reject interventions, or may not be aware of their condition (mainly advanced AD), and thus may not cooperate with other humans. Well-designed CUIs offer great potential in these situations as they can empower patients and increase their independence. Experts recommend to frame interventions around personal well-being [E1], and explain why proposed CUIs are beneficial [E4, E5, E8]. Feedback mechanisms add value too, supporting self-reflection, empowerment and self-efficacy [E4]. A clear benefit of a CUI is its constant and continuous availability to the patient. Also, CUIs do not get impatient, tired or stressed. However, their 'personality' should be designed carefully too: experts mentioned *friendly, helpful, patient, empathetic, comforting, reassuring, encouraging*, and *motivating* as positive attributes, but emphasized the importance of personalization, and fine-tuning for cultural differences. If patients *like* a CUI's personality, they are likely more comfortable and their anxiety levels may be reduced [E3]. This is extremely important, as anxiety can have negative impact on treatment outcomes. Empathetic CUIs that display a positive tenor can increase adherence [6], however, severeness of a patient's condition should not be downplayed [E3], rather, CUI should offer coping strategies that support the patient in dealing with the condition. A specific type of conversation, i.e., the solicitation of stories from the user's own lives appear to help exercise speech and memory, and stands out as an especially promising approach [18]. Such an approach also builds knowledge about the individual, which can help personalizing CUI's dialogs, and, non-verbal communication could be a part of an animated onscreen or augmented reality assistant/companion.

CONCLUSIONS

We argue that CUIs may be especially well suited for older adults, particularly for those with cognitive issues such as MCI, POCD or AD. However, importance of usability cannot be overstated when designing CUIs for this target group (see Table 2). Aging can lead to reduced visual, hearing, motor abilities, attention and memory glitches and consequently, a decline in learning speed too. Acknowledging these challenges, thoughtfully designed CUIs that are adjusted to users' context and needs are effective means to increase adherence to cognitive and lifestyle interventions. User acceptance of a CUI should increase if their design is adjusted specifically for healthy-aging adults, MCI, POCD and AD patients, and as the CUI is personalized over time. Thus, we expect that CUIs will be easier to use than visuospatial interfaces for this group. We plan to follow the key ideas in this paper with a series of user experiments for further validation.

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