A Relational Agent for Alcohol Misuse Screening and Intervention in Primary Care

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Abstract
We report the design of a relational agent system that provides alcohol misuse screening and brief intervention to primary care patients. We describe our methodology for intervention design and system development, along with results from pilot studies and an ongoing clinical trial. Preliminary results from the clinical trial demonstrate that the relational agent is well accepted among patients in the outpatient care setting, and they are able and willing to converse with the agent about their alcohol use.

Author Keywords
Relational agent; veteran population; alcohol misuse; alcohol screening; brief intervention; medical informatics.

ACM Classification Keywords
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Introduction
Global prevalence of alcohol use disorder (AUD) among adults is estimated to range from 0% to 16% in 2004 [17], and alcohol misuse is the fifth leading risk factor

Figure 1: The selected relational agent in an office setting

globally for premature death and disability [9]. In the US, 6.2% of adults aged 18 and older have AUD [14].

Among US military veterans, the prevalence for risky drinking and AUD are even higher, ranging from 20% to 40% [4]. Consequently, there is a great need for implementing effective methods for screening and intervention for alcohol misuse for veteran patients. As most veterans come to primary care clinics at least once a year, carrying out screening and brief intervention in these outpatient clinics can be a low-cost and effective way to reach out to veterans, and also make productive use of their wait time during their primary care visit.

In this project, we are developing and evaluating a relational agent that counsels veterans on AUD. Relational agents are animated computer characters that use speech, gaze, and other non-verbal behavior to simulate face-to-face conversation with a counselor (Figure 1). Relational agents may be a particularly effective medium for delivering an automated intervention for AUD in this population. Given the potentially stigmatizing topic, relational agents can use rapport and trust-building behaviors to enhance patient trust, potentially leading to greater rates of disclosure and adherence to recommendations. Previous studies have shown that users are more willing to disclose to computers compared to human interviewers [16], especially when a sensitive topic such as substance use is involved. The conversational format is also less intimidating and more accessible to patients with limited health and computer literacy, which may be important given the older age of the US veteran population (72% of veterans are 50 or older [15]). A conversational agent also provides a more flexible, personalized, and tailored multi-channel communication medium compared to more conventional media, such as web-based interventions or videotaped lectures.

In this paper, we report the design of a relational agent system that provides general education, screening and brief intervention for alcohol misuse, as well as preliminary results from an ongoing clinical trial at Boston Veteran's Administration Medical Center (VA Boston).

Related Work

Relational agents have been proven to be effective health counselors in several other areas of behavioral medicine. For example, in a clinical trial promoting physical activity in sedentary older adults, 263 participants (mean age 71.3, 61% female, 40% inadequate health literacy) were randomized to either a relational agent exercise coach or a pedometer-only control condition, with the agent group significantly outperforming the controls at two months [1]. Another study evaluated a culturally and linguistically adapted relational agent that provided tailored physical activity advice and support to low-income inactive older Latino adults (aged 55 and older), demonstrating significant 4-month increases in walking, compared to controls [7].

Several technology-based tools have been developed in recent years for alcohol screening and intervention, but these are mostly conventional approaches, such as a web-based method targeting college students [8], and a computer-delivered program using pre-recorded audios and videos targeting women in pregnancy [12].

Figure 2: The agent is showing compassion for the patient

Pilot Evaluation Studies

We conducted several pilot studies to evaluate the effectiveness of relational agents for substance use screening. We developed a relational agent system that administers the NIDA-Modified Alcohol, Smoking and Substance Involvement Screening Test (NM-ASSIST) instrument on a touch screen tablet computer. The NM-ASSIST [11] is a standard instrument for substance use screening in general medical settings. The agent was designed to reproduce the dialogue that a primary care clinician would use in verbally administering the instrument, including options for repeating and clarifying questions, and logic branching to minimize the number of questions asked and to maintain topic coherence. The agent simulates human conversational behavior, with speech produced with a commercial speech synthesizer, and synchronized non-verbal behaviors generated using BEAT [5], including hand gestures for emphasis, head nods for acknowledging user input, gaze away behaviors for signaling turn-taking, and facial expressions for empathy (Figure 2). User input is made via multiple-choice selection of utterances.

An initial pilot feasibility and validation study was conducted in a primary care setting in Rhode Island in 2010-11, and compared the agent-administered NM-ASSIST to a physician-administered NM-ASSIST among 20 patients in a counter-balanced within-subject experiment. Results showed fair agreement for detecting moderate or greater risk problems, with the physician finding 5 patients at risk and the agent finding 7 (agreeing on 4). Both versions identified presence of marijuana risk similarly; however, the relational agent identified patients with moderate levels of methamphetamine, sedative and prescription drug misuse that were not identified by the physician.

We replicated this study at VA Boston in 2012-13, to determine acceptance by veterans, comparing the relational agent to a research assistant. We found that veterans' responses to the NM-ASSIST were generally similar when asked by the agent and by the research assistant. Overall inter-rater kappa was 0.9, with kappa scores of 0.78, 1.0 and 1.0 for ascertaining tobacco, cannabis and cocaine, respectively. Twenty of the 30 participants had completely identical responses on both methods of screening. Among the other 10 veterans, there were a total of 16 discordant responses between the relational agent and the research assistant; of these 16 discordances, 12 (75%) were cases of the veteran reporting substance use to the relational agent but not to the research assistant.

Analysis of post-screening interview transcripts revealed that veterans found the relational agent was "easier to understand, simple to use, and quick." Veterans also appreciated that the agent conducted the screening in a non-judgmental, non-threatening manner: "I know for a fact the computer is not being judgmental…having a real person could be a little...intimidating…"

Design of a Relational Agent for Alcohol Screening and Brief Intervention

Given the promising results from our pilot studies, we expanded the relational agent system to provide brief intervention to those who screened positive for AUD, providing counseling on two consecutive visits to primary care, and to provide referrals to specialty care when warranted. This agent was deployed on touch

Figure 3: The agent is explaining the concept of standard drinks

screen tablet computers in a private room in outpatient clinics.

Character Selection

In order to tailor the relational agent intervention to the veteran population, we conducted a design study to examine veterans' preference for the agent's physical appearance. In total, 19 veterans were recruited. Participants were asked to view 8-10 short video clips displaying different agent characters, and then to rank the characters in order of preference and provide feedback. Feedback was also collected on the agent's attire, background settings, and synthesized voice. The chosen character is as shown in Figure 1, 2, 3.

Agent Dialogue

Conversation with the relational agent is the primary component of system. The agent's dialogue was designed by our interdisciplinary design team, comprised of a psychologist, a physician, behavioral scientists, and computer scientists. We used the FRAMES model (Feedback, Responsibility, Advice, Menu, Empathy, & Self-Efficacy) [2] as a basis for the brief intervention design, and also incorporated techniques from Motivational Interviewing [10], and elements from the Transtheoretical Model.

Intervention Design

The intervention with the relational agent consists of two sessions. The initial session is designed to be a 30-minute interaction with the agent. After screening the patient and giving feedback on his/her drinking, the agent provides some general education, including guidelines for safe drinking and risks associated with alcohol. The agent then takes the patient through a decisional balance exercise, asks the patient to make a commitment to change, and offers help in an empathic manner. Referral to specialty care is offered by the agent, if warranted. A personal feedback report is printed out for the patient at the end of the session. A second follow-up conversation was designed to be held with patients one month later, in which the agent primarily reinforces the earlier material.

All dialogues are personalized (e.g., calling the patient by name) and tailored based on the patient's gender, age, and drinking status, as well as the context of the current conversation. Social dialogue and empathy is used throughout to establish rapport and increase adherence.

Ongoing Clinical Trial

We are currently conducting a randomized controlled trial at VA Boston to evaluate the relational agent system. The trial compares patients who receive Treatment As Usual (TAU) with patients who receive the relational agent intervention in addition to TAU (TAU+RA), on self-reported frequency and quantity of alcohol use as primary outcomes. Rate of referral to specialty care is a secondary outcome measure.

Procedure

Participants are recruited through VA Boston, and must score positive on the Audit-C AUD questionnaire [3] to be eligible for the study. Participants in both conditions are asked to have a follow-up interview by telephone three months after their initial visit.

Measures

Quick Drink Screen (QDS). The QDS questionnaire is used to assess quantity and frequency of drinking over

	Questions
1	How satisfied were you with Laura?
2	How easy was talking to Laura?
3	How much would you like to continue working with Laura?
4	How much do you like Laura?
5	How much do you trust Laura?
6	How much do you feel that Laura cares about you?
7	Would you rather have talked to your doctor or nurse than Laura?
8	How likely is it that you will follow Laura's advice?

Table 1: Sample single item scales used to assess patients' satisfaction with the agent, and attitudes towards the agent

the past 30 days [13]. This measure is assessed at both baseline and 3-month follow-up.

Participants who received the relational agent intervention also completed a self-report 12-item questionnaire assessing working alliance [6], as well as additional single item scales (sample questions shown in Table 1) to report their satisfaction with, and their attitude towards the agent (scores ranging from 1-7).

Preliminary Clinical Trial Results

The study is ongoing. A total of 17 participants have been recruited so far, 9 randomized into the TAU+RA condition, and 8 in the control condition. Participants are all males, aged 27 to 82 years old (mean=54.2, SD=14.0), are 52.9% African-American, 35.3% Caucasian, and 47.1% reported that they have used computers only a few times, or never used one. Four participants in the TAU+RA condition, and four participants in the TAU condition, have completed the study to date, thus our preliminary analysis is based on these eight participants only.

Table 2 shows the mean and standard deviation for all self-report measures, for the 4 participants who completed the study in the intervention group. For single-item measures, one-sample non-parametric tests (Wilcoxon) are carried out to determine whether the sample median is equal to neutral (=4). One sample t-test is used for the working alliance composite measure. The results show significantly higher working alliance ratings compared to neutral, and participants' attitudes towards the agent are also trending at higher than neutral. All four participants rated the highest score possible (=7) when asked whether they were satisfied with the agent.

Measures	Mean (SD)	P-value
Working Alliance	6.2 (0.6)	0.008*
Satisfaction	7 (0)	0.07
Easy to talk to	7 (0)	0.07
Like the agent	6 (1.2)	0.17
Trust the agent	4.8 (1.3)	n.s.
Care about me	6.5 (0.9)	0.09
Prefer the agent	6.25 (1.3)	0.15
Follow advice	6.75 (0.4)	0.09

Table 2: Mean (SD) for self-report measures, with statistical significance ($p<.05$) marked with asterisk

Table 3 shows the quantity and frequency of drinking assessed by the QDS questionnaire for both groups, at baseline and 3-month follow-up. The results show that participants in both groups have reduced their drinking.

	Agent	Control
	Drinks per week	
Baseline	18(4.9)	39.5(16.5)
Follow-up	4.8(3.3)	17.3(14.9)
	Days had 5 or more drinks*	
Baseline	6.3(5.1)	19.3(10.8)
Follow-up	1(1)	9.8(11.8)
	Greatest # of drinks in one day	
Baseline	7.3(2.8)	10.8(2.2)
Follow-up	3.5(2.1)	6(3.7)

Table 3: Mean (SD) for both intervention and control groups at baseline and 3-month follow-up from the QDS questionnaire (*this item should be 4 or more drinks for women)

Conclusion

Relational agents provide an effective medium for substance use screening in primary care, and appear to

be well accepted as an intervention modality. Veterans, in particular, are comfortable with the technology and willing to disclose sensitive information about alcohol use to the agent. Final clinical trial results are forthcoming in a year.

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