# User Gaze Behavior while Discussing Substance Use with a Virtual Agent

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## ABSTRACT

Substance misuse is a significant public health problem worldwide, and substance use counseling represents an important application domain for virtual agents. We report the design of a virtual counseling agent for alcohol use disorder, and a study of user gaze for individuals with different levels of alcohol use.

## CCS CONCEPTS

• **Human-centered computing** → Human computer interaction

## KEYWORDS

Virtual agent, eye tracking, gaze pattern, alcohol misuse, alcohol screening, brief intervention, medical informatics

## 1 INTRODUCTION

With growing epidemics in substance use throughout the world, one particularly important application is the use of agents for substance use counseling. The global prevalence of alcohol use disorder (AUD) among adults is estimated to be as high as 16% in 2004 [1], and alcohol misuse is the fifth leading risk factor globally for premature death and disability [2]. In the US, 6.2% of adults aged 18 and older have AUD [3].

In our work, we are developing and evaluating a virtual agent that diagnoses and counsels people on AUD. Substance use counseling represents challenging applications for virtual agents, given the potentially stigmatizing topic. Nonverbal behavior, and gaze specifically, is known to play a role in self-disclosure of intimate information, such as substance use. Several studies have demonstrated that people gaze less at interviewers who ask personal and embarrassing questions, and exhibit less gaze behaviors when disclosing intimate information [4].

In our current effort we focus on user gaze behavior while they interact with a virtual AUD counselor, to determine whether there are nonverbal markers of therapeutic rapport and substance use (drinking behavior). Such markers could enable the agent to identify those users who need extra attention in the establishment of the user-agent therapeutic relationship, or whose self-disclosed drinking behavior may be inaccurate.

## 2 AUD COUNSELING AGENT

We developed a virtual agent system that administers alcohol use screening and brief intervention (Fig. 1). The agent speaks using a speech synthesizer, synchronized with a variety of nonverbal behaviors generated using BEAT [5], including facial displays for happiness or concern, head nods for acknowledging user input, hand gestures for emphasis, gaze shifts to signal turn-taking, and body posture shifts to signal topic changes. User input is made by selecting utterance options from a multiple-choice menu on the screen, updated at each turn of the conversation.

In the agent's dialogue, we incorporated theories and concepts from the Transtheoretical Model (TTM), and techniques from Motivational Interviewing (MI). Agent utterances are tailored based on a patient's given name, gender, age, drinking status, as well as the discourse context. The agent uses empathy throughout the interaction to establish rapport with the patient.

The system is currently being evaluated in a randomized controlled trial (RCT) in primary care clinics at several US Veteran's Administration hospitals, with 74 participants recruited to date. In general, patients like the agent, are comfortable interacting with it, and are willing to disclose alcohol use to the agent. Preliminary analysis reveals that patients' drinking decreases over the 3 months of the intervention. The agent has successfully referred 18 patients to specialty care, whereas only one patient in the standard care control condition was referred [6].

In parallel with the clinical trial, we conducted an exploratory study to investigate whether it is possible to predict participants' rapport and engagement with the agent, drinking behavior, and attitudes towards drinking, based on their gaze patterns using a desktop computer with an eye tracking device (Tobii X3-120).

## 3 GAZE STUDY

Participants were recruited via flyers and an online job posting site, and were required to speak and read English, and "drink alcohol". We recruited 20 participants, 45% female, aged 19 to 27 years old (mean=22.8, SD=2.5).

**Measures.** Drinking behavior was measured using self-reported average number of drinks consumed per week over the past 30 days, and the Alcohol Use Disorders Identification Test (AUDIT) [7]. Willingness to continue working with the agent, and follow its advice, were assessed using single item scale measures.

**Eye-tracking measures.** All eye tracking metrics were calculated using the Tobii Studio software, version 3.4.8. Areas of Interest (AOI) on the screen were defined for the agent's face, and the side button panel for user input. Primary measures computed

included mean fixation durations and visit durations on various AOIs. Visit duration was defined as the duration of each visit within a specific AOI, where a visit was defined as the time interval between the first fixation on the AOI and the first subsequent fixation outside the same AOI. We also calculated the total percentage of time fixating on either the agent's face or the button panel for each participant, dividing the total visit duration (sum of all visit durations) on each AOI by the total time duration of his or her entire interaction with the agent.

**Procedure.** After informed consent, participants were seated in front of the computer and guided through the calibration process. Participants were then asked to interact with the agent (lasting approximately 20 to 30 minutes), during which their eye movements were recorded. The self-report questionnaires were then administered, and a semi-structured interview conducted, focusing on participants' overall impression of the agent, and how they felt about talking with the agent regarding alcohol.



**Figure 1: Virtual Agent Counselor for AUD**

## 4  RESULTS

Out of all participants, we found a significant positive correlation (Spearman's rho=0.50, p<.05) between participants' mean fixation durations on the agent's face, and their willingness to continue working with the agent; and a significant positive correlation (rho=0.48, p<.05) between mean fixation durations on the agent's face, and participants' self-reported willingness to follow the agent's advice.

Nine participants finished their sessions early, being deemed not at risk for AUD by the agent. For the rest who went through the full session, there was a significant positive correlation (rho=0.64, p<.05) between participants' mean fixation durations on the agent's face and their willingness to follow the agent's advice; and a significant positive correlation (rho=0.67, p<.05) between participants' percentage of time fixating on the button panel, and their willingness to follow advice.

We also found evidence that participants' gaze patterns could be used to predict their drinking behavior, in terms of their self-reported number of drinks consumed per week over the past 30 days, and their AUDIT total scores. We found a significant negative correlation (rho=-0.51, p<.05) between participants' percentage of time fixating on the buttons, and their AUDIT total scores; as well as a significant negative correlation (rho=-0.45, p<.05) between participants' percentage of time fixating on the buttons, and their self-reported drinks per week in the past month.

Similarly, for participants who completed the full session, we found a significant negative correlation (rho=-0.67, p<.05) between their percentage of time fixating on the buttons, and their self-reported drinks per week. Thus, the more participants drank per week, especially when they were at risk for AUD, the less time they focused on selecting what they wanted to say to the agent at each turn of the conversation.

## 5  DISCUSSION AND CONCLUSIONS

We found that gaze patterns could be used to predict engagement. We found that the longer either a participant's mean fixation duration on the agent's face during the interaction, or the total percentage of time he or she was focusing on the utterance choice buttons, the more engaged the participant was, reflected in both willingness to work with the agent in the future (intervention retention), and to follow its advice (adherence).

We also found that participants' gaze patterns could be used to predict their drinking behavior. Particularly for participants who were at risk for AUD, their percentage of time fixating on the buttons had a negative association with the number of drinks they consumed every week. This finding might be used to detect whether a person was at risk, without triggering negative emotions by asking about alcohol directly.

## ACKNOWLEDGMENTS

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