Relational Agents for Antipsychotic Medication Adherence

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Introduction

Many studies have now demonstrated that automated systems are effective for a wide range of interventions in behavioral medicine [2,8]. Relational agents—conversational agents designed to establish trust and therapeutic alliance with users over time—represent a promising new medium for delivering these interventions, given the significance of therapeutic alliance in predicting patient satisfaction, adherence and outcomes in many areas of health care [3]. Narrowly scoped interventions in mental health, including those for screening and medication adherence, may also represent promising areas of application for automated systems in general and relational agents in particular.

Schizophrenia affects 1% of the population worldwide, and medication adherence to antipsychotic treatments within this population is typically around 50%, leading to higher rates of hospital re-admissions and greater number of inpatient days, higher health care costs and reduced work productivity. Contributing factors to the low adherence rate include medication side effects, psychotic symptoms, insufficient social support, and a lack of understanding of the role of medication for preventing relapse [5,7]. In addition, a positive interpersonal relationship with a health care provider has been shown to lead to improved adherence rates [9].

In this paper, we describe a relational agent system developed to promote antipsychotic medication adherence for patients with Schizophrenia that is currently undergoing clinical evaluation, along with preliminary results from the study.

Relational Agents

Relational agents are computational artifacts designed to build long-term socio-emotional relationships with users, including trust, rapport and therapeutic alliance, for the purpose of enhancing adherence to treatment. These are typically deployed as computer-animated humanoid agents that can simulate face-to-face conversation with patients so that real-time dialogue, speech, gesture, gaze and other verbal and non-verbal channels can be used both to communicate therapeutic information and to establish and maintain a therapeutic alliance relationship. In the typical interface the agent talks using synthetic speech and synchronized nonverbal behavior animation, and the user 'talks' by selecting an utterance from a dynamically-updated multiple-choice menu (Fig 1).

These agents have been tested in two randomized trials for physical activity promotion, one with young adults [3] and one with geriatrics patients [1], both of which demonstrated effectiveness over standard-of-care control conditions. These trials were conducted on home desktop computers for one-to-two month interventions in which the agent talked with patients daily about their physical activity, negotiated short- and long-term behavioral goal-setting, provided positive reinforcement when goals were met and problem-solving to overcome obstacles when they weren't. In addition, the agent engaged patients in relationship-building dialogue including empathic exchanges, social

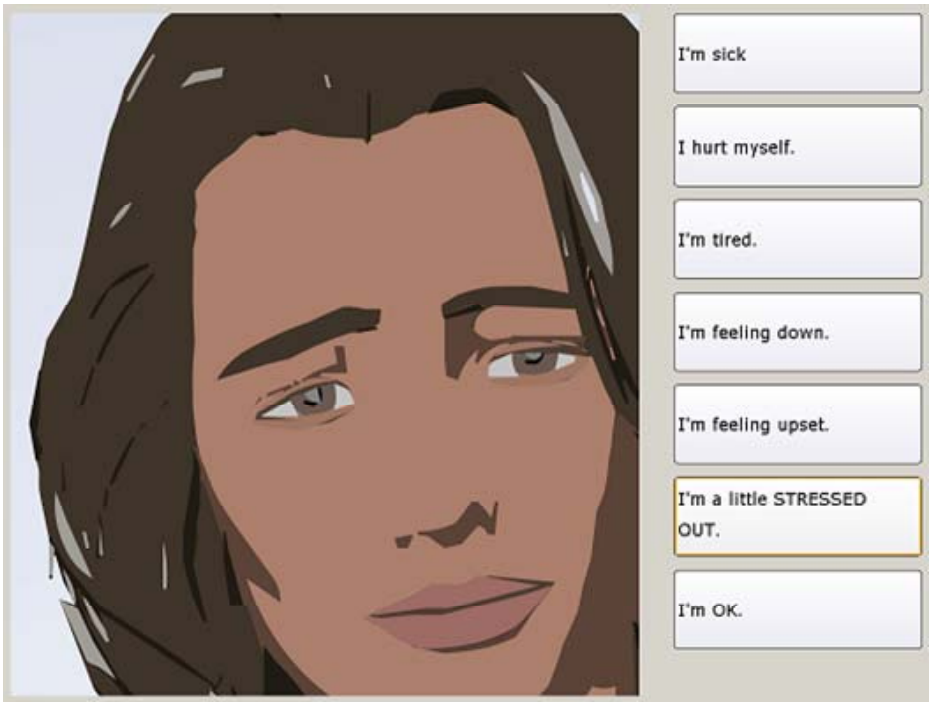

Fig 1. Relational Agent Interface

dialogue, humor, and reciprocal self-disclosure. Additional systems are currently undergoing development to promote other health behaviors and for in-hospital patient education at the time of discharge.

A Relational Agent for Antipsychotic Medication Adherence

In collaboration with researchers from the University of Pittsburgh School of Nursing, we developed a relational agent-based intervention to promote medication adherence among adults with Schizophrenia. The system runs on a laptop computer as a stand-alone system, and is designed for a one-month daily contact intervention. A typical daily conversation lasts ten minutes and includes: (1) the agent walking on screen and greeting the patient; (2) conducting social and empathic chat; (3) assessing the patient's behavior since the last conversation; (4) providing feedback on this behavior (positive reinforcement or problem solving); (5) providing tips or relevant educational material (e.g., managing side effects, coping, etc.); (6) setting new behavioral goals for the patient to work towards before the next conversation; and (7) a farewell exchange, after which the agent walks off the screen. After this, a tip for the day is displayed as a text message, and a few self-report survey questions assessing the patient's attitude towards the agent are automatically administered.

The agent tracks each patient's medication taking behavior for a single antipsychotic taken by mouth in pill or capsule form based on self-report, but she also reminds patients to take all of their other medications as prescribed. In addition to medication adherence, the agent promotes physical activity (walking) and talking to the agent every day. For each of these three behaviors, the agent first asks for a self report of behavior, provides feedback on the behavior (with the aide of self-monitoring charts, Figure 2), and negotiates a behavioral goal. Feedback and goal-setting are also provided

in summary statements that integrate across the behaviors. For example: "Let's review what you said you were going to do before we chat again. You said you were going to take two doses of Prolixin each day, you were going to try to go for a walk, and you said you would talk to me tomorrow." Intervention on each behavior is started and terminated according to a schedule for the 30 day intervention (Fig 3).

Fig 2. Self-Monitoring Charts
Top: System usage (logins). Middle: Medication adherence Bottom: Physical activity

There are several other unique aspects of the medication adherence dialogue used by the agent. Since the system is not networked to a central server, it asks the patient whether or not their prescription has changed at the start of each conversation, so that the agent does not promote an incorrect regimen. The system also keeps track of refill schedules and reminds patients to get refills before they run out of their tracked medication (including problem solving, such as recommending that a friend drive them to the pharmacy if they don't have transportation). Finally, the system uses a form of "direct observation" – a technique used in human medication adherence interventions in which a health provider watches while the patient takes their medication. To accomplish this, the patient is asked to conduct their chats with the agent at one of their prescribed medication taking times. When the agent asks the patient about their medication taking behavior it asks whether they have taken their dose for the current time of day yet (e.g., "Have you taken you evening Prolixin yet today?"). If the patient has not, the agent asks them to go ahead and take it while it waits.

Towards the end of the month, the agent begins instructing patients in techniques

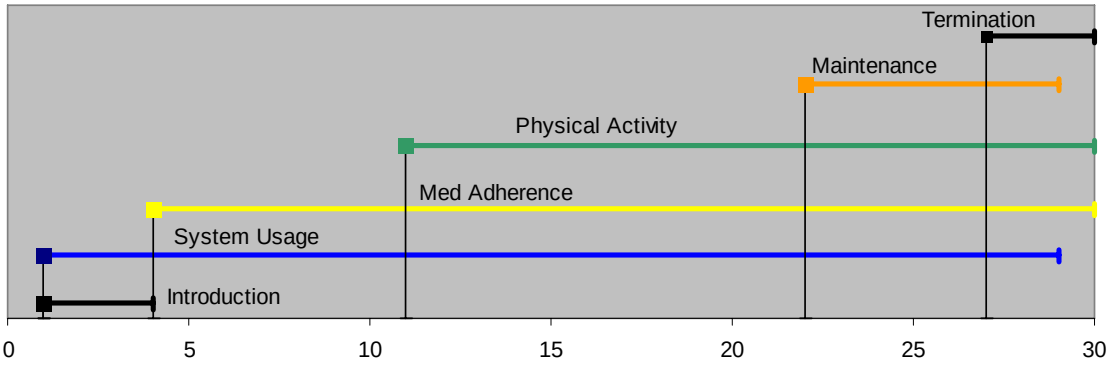

Fig 3. Intervention Schedule by Day

for self-maintenance. It starts by asking patients to obtain a multi-compartment pill box and calendar for self monitoring, then asking patients about this during every conversation until they do so. Once the patient has obtained these, the agent reviews techniques for self monitoring at periodic intervals until the end of the 30-day intervention period.

Special Considerations in Developing Relational Agents for Psychiatric Patients

From the literature on psychiatric nursing care we identified several special considerations that were addressed in our system. In psychiatric nursing, special emphasis is made on the orientation (introductory) and termination phases of the nurse-patient relationship [6]. The orientation phase consists of development rapport, demonstrating caring and interest in the patient, and establishing a contract for the interactions (roles, times of meetings, etc.). We implemented these behaviors by focusing the first several days of the intervention on rapport building and ensuring that the patient logs in every day; deferring any discussion of Schizophrenia or medications until later in the first week (Fig 3). The agent also spends some time in the first interaction defining her role ("My job is to help you set goals and overcome obstacles… You need to keep in mind that I am just a computer character with limited capability…"). The termination phase involves getting the patient ready for the dissolution of the relationship, and includes strategies such as reducing the duration of the interactions, discussing the patient's and provider's feelings about the termination, and expressing confidence in the patient. These strategies were implemented by having the agent begin to remind the patient about the termination several days prior to the termination (Fig 3), and to periodically talk about feelings regarding the termination and confidence in the patient (e.g., "I will miss you, but I know you will do super on your own.").

Relative to other interventions we have developed, we also simplified the language used by the agent, so that it gives simple, concrete directions [6]. Based on discussions with our collaborators at the University of Pittsburgh, we also removed the "gaze away" behavior of the agent, in which it briefly glances away from the user, typically at the start of speaking turns. This behavior is used to signal turn-taking in conversation and our model implements the frequency and timing of gaze aways seen in human conversation [4]. However, our collaborators felt that their patients would interpret this as a cue for untrustworthiness and might make them feel uncomfortable.

We also identified and implemented several conditions in the system in which the patient was directed to call the research coordinator with the phone number displayed on the screen (instead of the agent). The conditions included situations in which the patient was feeling down and thinking of hurting themselves, or in which they had stopped taking their antipsychotic medication altogether for three consecutive days.

Pilot Study

A quasi-experimental pilot study is currently underway to evaluate the medication adherence system, led by researchers at the University of Pittsburgh School of Nursing. Twenty study participants are being recruited from a mental health outpatient clinic who meet the DSM IVR criteria for Schizophrenia, are 18-55 years old, are on any antipsychotic medication, and have had two or more episodes of non-adherence in the 72

hours prior to recruitment. Study participants are provided with a dedicated use laptop computer for the 30 days of the intervention, as well as Medication Event Monitoring (MEMS) caps to provide an objective measure of medication adherence for the one antipsychotic medication targeted by the intervention.

To date, 10 participants have completed the intervention (40% male). Anecdotal feedback from the researchers conducting the study indicate that one of these participants developed paranoia and stopped using the agent after a few days, and another participant expressed concern that the program was somehow relaying their personal information to others.

System logs indicate that study participants talked to the agent on 65.8% of the available days, with six of the participants talking to the agent at least 25 times during the 30 day intervention. Self reported medication adherence (gathered through dialogue with the agent; MEMS data is not yet available) was 97%. Self reported adherence to recommended physical activity (walking) was 89%.

Self reported survey questions on participant attitudes towards the agent are summarized in Table 1. Results indicate that most participants liked and trusted the agent, and 80% of respondents indicated they would have liked to continue working with the agent (Laura) at the end of the 30 day intervention.

Survey Question	Anchor 1	Anchor 5	Mean
How much do you feel that Laura cares about you? *Asked 5 times during the intervention.*	Not at all	Very much	4.28
How much would you like to continue working with Laura? *Asked once on the last day of the intervention.*	Not at all	Very much	4.00
How easy is talking with Laura? *Asked 5 times during the intervention.*	Very difficult	Very easy	4.24
How much do you like Laura? *Asked 5 times during the intervention.*	Not at all	Very much	4.40
How would you characterize your relationship with Laura? *Asked 5 times during the intervention.*	Complete stranger	Close friend	3.34
How satisfied are you with Laura? *Asked 5 times during the intervention.*	Not at all	Very much	4.31
How much do you trust Laura? *Asked 5 times during the intervention.*	Not at all	Very much	4.40

Table 1. Self-Reported Attitude Towards the Agent ("Laura")

Conclusion

On its face, having individuals with Schizophrenia interact with computer-animated characters may not seem like a good idea. However, according to self report measures, most participants liked the agent and the experience, and we have only heard report of one study participant who reacted very negatively to the agent. Final adherence measures and study outcomes have yet to be collected, however, preliminary results indicate that relational agents may be a promising medium to use for certain kinds of mental health interventions such as medication adherence.

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