

Building Affective Embodied Agents to Assist Long-Term Behavior Change: Design and Evaluation Considerations

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Abstract

Recent research has suggested that affective embodied agents that can effectively express simulated emotion have the potential to build and maintain long-term relationships with users. We present our experiences in this space and detail the wide array of design and evaluation issues we had to take into consideration when building an affective embodied agent that assists users with improving poor dietary habits. An overview of our experimental progress is also provided.

1. Introduction

Researchers have been examining the role of embodied agents in interfaces for a number of years. Initial work in this space tended to focus on how such agents could help with work-based tasks such as filtering email and sorting search results (e.g. Maes (1994)), while more recent research has focused on the use of these agents within games (Isbister, 2006) and virtual environments like Second Life (Yee et al., 2006). Another area of growing interest is where relationships are known to be of importance in human-human interactions (e.g. (Bickmore and Picard (2005))). For example, a good quality relationship between a therapist and client is essential in building a strong working alliance, which in turn is critical for increasing the likelihood of a successful outcome. These relationships are normally built over multiple interactions spanning weeks, months, and sometimes years. Developing agents that can effectively build and maintain extended relationships with users is complex and there are numerous design and evaluation considerations that must be made when attempting to do so. In this paper, we present our experiences in designing an affective embodied agent that attempts to simulate the role of a human health professional. We also highlight what we will contribute to the workshop and our primary goals in attending.

2. Designing Long-Term Human-Computer Relationships

Most previous research related to embodied agents and affective interfaces has tended to take place over a single interaction typically lasting less than a couple of hours. As a result, we have a limited understanding of how to design agents that will interact with users on multiple occasions over extended periods of time. Of the few longitudinal studies completed to date, the main approach has been to look at the techniques humans use to maintain long-term relationships. For example, Bickmore and Picard (2005) incorporated a number of "relational strategies" into their embodied agent, Laura. These included social, empathic and polite communication, talking about the relationship, sharing experiences during times apart, humor, appropriate forms of address, and many more. The use of these strategies appeared to enhance users' perceptions of the agent as it was perceived to be more likeable, trustworthy, and caring when compared with an agent that did not utilize these strategies.

Numerous other short-term studies have also highlighted how important human-human relationship building techniques can have a similar influence in human-computer interactions. For example, Brave et al. (2005) examined the effect of simulated empathy on user attitudes and perceptions and found that embodied blackjack-playing agents that were empathetic about subjects' performance during the game (e.g. "I'm happy that you won") were perceived as more likeable,

supportive, trustworthy and caring than agents which expressed self-oriented empathy (e.g. "I'm sad that I lost"). Various other studies have reported similar findings, but it is still unclear whether these enhanced positive perceptions over short interactions also persist over longer interactions and whether such agents can effectively influence the attitudes and behavior of users.

3. Experiences in Designing/Evaluating Supple Interfaces

To learn more about how agents can build and maintain long-term relationships with users, we have built an embodied agent that simulates the role of a human health professional and attempts to help users improve poor dietary habits (Fig. 1). We are particularly interested in learning more about the importance of simulated emotion in human-computer relationship building and the influence it has on users' perceptions and behavior.



Fig 1. Screenshot of experimental system

Experimental Progress

To date, we have completed an initial experiment to confirm that subjects can recognize the emotional expressions of our agent. We are currently running another experiment which is investigating how subjects respond to the agent over a single interaction lasting around 10-15 minutes. Students from Birmingham University have been invited to enlist as subjects and randomly assigned to one of two different conditions: emotion and no emotion. In the emotion condition, the agent's voice varies widely in pitch, tempo and loudness and its facial expressions match the emotion it is expressing. In the no emotion condition, the voice varies little in pitch, tempo and loudness and the same neutral facial expression is used throughout the interaction. The dialogue and type of (human) voice used in both conditions is the same. Subjects start by having an interaction with the agent and can respond to the agent's questions by selecting from a list of pre-scripted responses. After completing the interaction, they are informed that they can view educational pages about maintaining a healthy lifestyle for as long as they desire. Subjects are then asked to complete an online questionnaire adapted from Brave et al. (2005) and to answer open-ended questions about the agent and system. After completing this experiment and analyzing the results, we plan to run a longitudinal study over a period of 4-8 weeks (the exact time is still undecided). In this experiment, we will again compare an emotional and unemotional agent and will ask subjects to interact with it on multiple occasions over the duration of the experiment. This experiment will help us to understand more about how users' perceptions of such agents change with time and whether affective agents have the potential to influence user motivation and habitual behavior.

Design and Evaluation Considerations

In building the agent and system, we have taken into consideration a number of important factors. It is not possible to cover all of these factors in detail here, so we provide an overview of some of the most important and relevant issues. Initially, we had to consider the appearance of the agent and how it would communicate emotions effectively to subjects. The age, appearance and gender of the agent were also important and required careful consideration. With regard to the dialogue, we had to construct it in such a way that it enabled the agent to build a relationship with users – this involved, for example, asking questions such as how can we best develop initial rapport with users? It was also important to consider which interventions the agent would use and how and when the agent should use them. In addition to this, we had to think about how we could accurately measure the quality of the relationship between the agent and user, as well as how we could determine whether the interaction had a positive influence on user behavior.

To help address many of these issues, we used a behavior change model called the Transtheoretical Model (TTM). This is a model that many human health professionals use to help people change problematic behavior (Prochaska et al., 1994) and works on the premise that behavior change involves moving through a number of stages before change is achieved. The model also defines other constructs including change processes (activities that are used to help progress through the stages), decisional balance (weighing the pros and cons of changing a behavior), and self-efficacy (the confidence felt about performing an activity). The model suggests that linking the correct process with the right stage increases the likelihood that people will successfully move through the different stages.

Making use of such a model enables us to determine which stage of change a person is in both at the start and end of the experiment, which is useful when examining whether a subject's motivation to change behavior has been influenced during the course of the experiment. Also, the model provides guidance about the types of interventions that are best to use for subjects in each stage of change. For example, the model suggests that for people who are in the "contemplation" stage of change (i.e. people who have an intention to change a problematic behavior within the next six months) it is best to focus on building confidence for change and to achieve a commitment to change through the use of a number of different techniques.

With regard to the age, gender and general appearance of the agent, we decided to build a physically attractive female agent that was of a similar age to prospective subjects (mid to late twenties). This was because a number of research studies have suggested that therapy is often more successful when interacting with female therapists that are of a similar age to subjects (e.g. Bickmore (2003)). Our reasoning behind making the agent physically attractive was related to the *halo effect* – people who are physically attractive are often perceived to be more intelligent, persuasive and sensitive than less attractive people (Cialdini, 2003). The voice of the agent was recorded by a twenty-five year old female to ensure that it matched the appearance of the agent.

Numerous studies have investigated the emotional expressions of therapists in sessions with clients with expressions of happiness, warmth and concern (empathy), along with a more neutral facial expression, being frequently displayed. Therefore, we designed our agent and the interaction so that these emotions were expressed at appropriate times. To ensure a degree of control over the interaction, we decided that it was best to provide subjects with a variety of pre-scripted responses when responding to the agent's utterances – using free textual or speech input, for example, would likely result in subjects having very different interaction experiences that could strongly influence the validity of any effects found.

To assess the quality of the relationship between the agent and subject over the longitudinal study, we have decided to use a measure called the Working Alliance Inventory (WAI) (Horvath and Greenburg, 1994). This is often used to measure the quality of a (human) therapist-client relationship and can easily be adapted for our purposes. Success of the interaction in the longitudinal study will primarily be measured through whether or not a subject's stage of behavior change (according to the TTM) has been influenced – if it has remained the same or has fallen to a previous stage, then the interaction will have failed to have a positive influence on subject behavior, while if the stage of change has moved up at least a level, this would be deemed as a successful and beneficial interaction.

4. Contribution to Workshop and Primary Goals in Attending

Our main contribution to the workshop will be to share with other workshop participants how we designed the agent and interface, along with a detailed description of the varied design and evaluation issues we encountered. We would also like to demonstrate the system in use. At the time of the workshop, we will have completed the experiment we are currently running and will be able to share our findings from the study. This should provide some interesting and useful insights into how users respond to affective agents and the influence they can potentially have on user motivation to change problematic behavior. Our primary goal in attending the workshop is to learn more about techniques for designing and evaluating affective interfaces – in particular, we are interested in how such systems can autonomously adapt themselves according to different types of user input. As our agent only adapts its affective responses based on the pre-scripted responses selected by subjects, we would like to learn more about how the system can autonomously use other cues (e.g. physiological input, face tracking, emotive content in speech) to adapt its own affective responses. This type of functionality in our system would be particularly useful, for example, when attempting to effectively mirror the facial and vocal emotional expressions made by subjects, to ensure that empathy is effectively expressed by the agent. As we plan to run the longitudinal study after the workshop, we will still be in a position to incorporate new techniques into the design and evaluation of our experiment.

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Embodied cognitive science encompasses a loose-knit family of research programs in the cognitive sciences that often share a commitment to critiquing and even replacing traditional approaches to cognition and cognitive processing. Empirical research on embodied cognition has exploded in the past 10 years. Believable agents designed for long-term interaction with human users need to adapt to them in a way which appears emotionally plausible while maintaining a consistent personality. For short-term interactions in restricted environments, scripting and state machine techniques can create agents with emotion and personality, but these methods are labor intensive, hard to extend, and brittle in new environments. Fortunately, research in memory, emotion and personality in humans and animals points to a solution to this problem.Â Our tests of this model on robot pets and embodied characters show that emotional adaptation can extend the range and increase the behavioral sophistication of an agent without the need for authoring additional hand-crafted behaviors. Introduction. Creating a platform for dynamic and expressive social-emotional play Kirsten Boehner, Phoebe Sengers, Simeon Warner: Interfaces with the Ineffable: Designing and Evaluating for Sympathetic Awareness Silvia Lindtner: Playful Spaces between Fantasy and Real Chris Creed, Russell Beale: Building Affective Embodied Agents to Assist Long-Term Behavior Change: Design and Evaluation Considerations.Â Different team composition? â€œHow and when we know that weâ€™ve succeeded. Are evaluation criteria different from other areas of HCI? What sorts of measures are appropriate? What does rigor mean in this type of design? â€œGrounding in theory.