Motivating Health Behavior Change with a Storytelling Virtual Agent

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ABSTRACT

We developed a virtual agent that motivates church-going users to change their health behavior by telling existing cultural narratives that have high relevance with the counseling topic in an engaging way. We evaluated this agent in a between-subjects experiment where participants interacted with an agent that counseled them on nutrition either without a story, with a story but told in a neutral speech style, or with a story using dramatic delivery inspired by church sermons. We found that interaction with either one of the storytelling agents leads to a significantly greater change in confidence to engage in the target behavior of healthy eating than interacting with a non-storytelling agent, demonstrating the efficacy of stories in health counseling by virtual agents.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in HCI**; • **Computing methodologies** → **Intelligent agents**.

KEYWORDS

virtual agent, embodied conversational agent, persuasive technology, storytelling, health, bible stories, faith-based communities

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1 INTRODUCTION

Stories are central to the human experience. Cultures accrue stories — factual or mythological — that provide common ground [3] for solidarity and understanding. In the context of counseling or psychotherapy conversations, stories can be used for many purposes when told by the counselor, including instruction, self-disclosure, motivation, and confidence building. Due to their complexity, cultural stories can be used in a wide variety of ways in conversation to support different goals or arguments by highlighting different events or characters, or through different interpretations. Cultural stories also leverage the power of tailoring theory to increase the impact of health counseling, by relating health messages to stories the user already knows. Tailoring — adapting messages for particular recipients — has been shown to lead to significant improvements in health interventions compared to interventions that are generic [10].

Figure 1: Virtual counseling agent with the dialogue response options displayed at the bottom of the screen.

We are developing a virtual agent that provides health counseling to members of a network of churches that have a well-developed set of accrued stories. The agent incorporates these stories to improve the efficacy of its counseling, by automatically selecting appropriate stories to tell in counseling conversations and delivering them in in a way that improves health behavior change motivation and self-efficacy in users. This general problem has three components:

(1) **Indexing Stories**: Selecting the best story to tell from all possible cultural stories, given the goals of the current counseling conversation.
(2) **Generating Relevance Statements**: Generating utterances for the agent that clarify the relevance of the story to the counseling goals.
(3) **Generating Prosody for Engaging Storytelling**: Telling the story in an engaging manner, appropriate for the culture and the story genre.

2 PROTOTYPE STORYTELLING MOTIVATIONAL AGENT

2.1 Indexing Stories

A story's relevance to the health topic is an important factor in increasing motivation for change. Based on the results of an exploratory study, a system can automatically select a story from a

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library of cultural stories given the goals of the counseling conversation and information about the user and past counseling conversations with them. Lexicons of words or phrases related to various topics can be stored in the system and be used to determine stories with the highest relevance for a given topic at hand. For example, words such as *food*, *eat*, *bread*, and *fruit* can be included in the lexicon for the topic of healthy eating. We can utilize existing natural language processing algorithms for semantic text matching or corpus-based text similarity between the lexicon of a given topic (query) and stories (documents) to rank the stories [5, 14, 17].

2.2 Generating Relevance Statements

Our agent first states the main purpose of presenting a story, then the indexed story is told by the agent. Next, the agent gives a brief one-sentence recap describing the actions of the protagonist relative to the health counseling topic. For example, the agent shares how the story of "Daniel" is linked to healthy eating by saying, "In this story, Daniel was mindful about his eating." Finally, the agent provides a moral relative to the topic. For example, the agent can share "This story is a good reminder that making good food choices can lead to good things in our lives".

2.3 Generating Prosody for Engaging Storytelling

Our virtual health counseling agent uses synthetic speech for flexibility. To enable our agent to deliver more engaging stories, we used a set of rules to convert a neutral text-to-speech (TTS) speech style to a speech style more conducive to storytelling, such as that delivered in church sermons. We manipulated the prosody of the agent's speech, especially the length of pauses between sentences [4, 6, 9, 11–13, 15], speech rate [9, 13, 16], and pitch & volume [9, 16]. In addition, we incorporated repetition of clauses and noun phrases as a way to emphasize important concepts to users [13].

2.4 Prototype Implementation

We created a proof-of-concept motivational storytelling agent specifically for church-going communities. Our agent uses a counseling approach called Motivational Interviewing (MI) [8] and three pre-indexed Bible stories to motivate users towards increasing fruit and vegetable consumption (healthy eating). Our system incorporates a 3D animated character who converses with users using synthetic speech, conversational behavior, and multiple-choice menu inputs for user responses (Figure 1). The agent's synchronized nonverbal conversational behavior, such as hand gestures, head nods, eyebrow raises, and posture shifts, is automatically generated using BEAT [2].

3 EVALUATION STUDY

We conducted a user evaluation study to evaluate the effect of Bible storytelling on religious people's attitudes to change their health behavior using our prototype storytelling agent. The experiment was a between-subjects design where a user was randomly assigned to one of the 7 configurations. Each participant, recruited via an online research platform (www.prolific.co), was randomly assigned to one of the three study conditions (NOSTORY, NEUTRAL, ENGAGING), with those in NEUTRAL and ENGAGING randomly assigned one of the three Bible stories ("Daniel Refusing to Eat the King's Food," "Jesus Feeding the 5000," "The Prodigal Son").

We collected the following measures related to healthy eating before and after interacting with the agent: decisional balance [7], self-efficacy [1, 7], motivation, confidence, and stage of change.

4 RESULTS

Participants (N=108) across all conditions showed a significant increase in motivation to improve healthy eating (Wilcoxon signed rank, Z=4.21, p<.001), decisional balance for healthy eating (Z=3.95, p<.001), and self-efficacy for healthy eating (Z=3.59, p<.001). Participants in the ENGAGING condition had a significantly greater change in their confidence to engage in healthy eating behaviors, compared to the NOSTORY condition (Figure 2). In addition, participants in the NEUTRAL condition had a significantly greater change in their confidence to engage in healthy eating behavior, compared to the NOSTORY condition (Figure 2).

Our results show that a Bible storytelling agent can help with increasing confidence to engage in positive healthy eating behavior. The agent was overall well-received by the participants of the evaluation study. Especially, participants who scored higher in the religiosity measures found our agent to be trustworthy, likable, caring, and understanding. They also found the presented Bible story to be relevant to the context, enjoyable, and familiar. However, we were not able to find any significant differences between the two STORY conditions (NEUTRAL vs ENGAGING).

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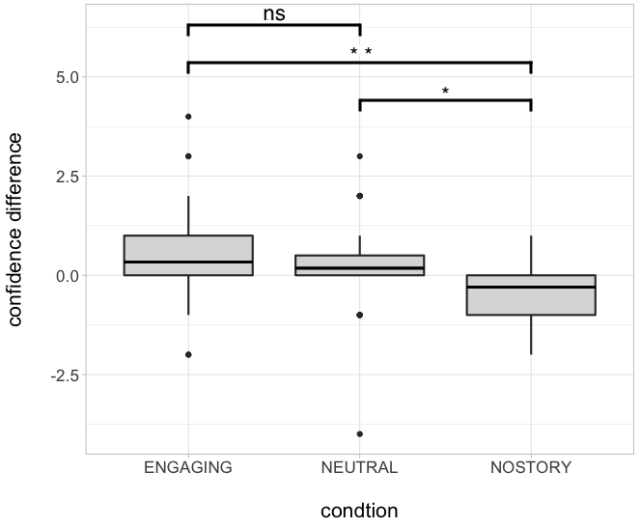

Figure 2: Participants had a significantly greater change in confidence with both types of storytelling agent. (* p<0.05, ** p<0.01)

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