

Motivating Health Behavior Change with a Storytelling Virtual Agent

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ABSTRACT

Storytelling can increase the impact of persuasive messages and can thus be used to motivate people to change their health behavior. This suggests that virtual agents can use storytelling to improve the effectiveness of health counseling sessions with users. To explore this idea, we developed a virtual agent that motivates users to change their health behavior by telling existing cultural narratives that have high relevance with the counseling topic in an engaging way. We propose a system that indexes a story based on relevance to the counseling topic, automatically generates relevance statements that tie the story to the health topic, and has the agent tell the story and the relevance statements in an engaging way. To evaluate the effectiveness of this approach, we developed a prototype health intervention for church-going communities that attempts to increase fruit and vegetable consumption with a virtual agent telling relevant, motivational Bible stories. We evaluated this prototype 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.

CCS CONCEPTS

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

KEYWORDS

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. In conversation, they can be used for multiple purposes, including conveyance of instrumental information [42], establishing expertise [47], and building rapport [31]. They not only comprise a significant part of “small talk” but can be used in task-oriented dialogue for both relational and instrumental purposes [3].

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. By telling stories to a client of successful change in others, a counselor can provide a model of the change process, promote self-reflection for cognitive restructuring, and improve client memory of information. In Cognitive Behavioral Therapy, storytelling can play a role in the fundamental processes of reflecting on antecedents, beliefs, and emotional consequences, through the conveyance of examples of maladaptive thoughts and examples of people who successfully changed their thoughts or behavior. Storytelling of how others have changed allows instructions to be given in a less threatening way than direct imperatives [9].

Cultures accrue stories — factual or mythological — that provide common ground [7] for solidarity and understanding. These shared stories can be told in conversation in the same way that personal narratives are, and for many of the same purposes. However, given their status on common ground, they can be referenced much more efficiently, and referencing these stories also serves the goal of signaling group solidarity. Since these stories are often complex, a single story 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. Many cultural stories — such as religious stories — can carry additional spiritual or religious meaning that can also be drawn on by the storyteller.

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 [35]. Tailoring works by increasing attention to messages, increasing personal involvement, increasing both “central route” (effortful processing) and “peripheral route” (via affiliation or emotion elicitation) persuasion, and encouraging self-referential thinking [18].

In this work, we are interested in developing virtual agents that provide health and wellness counseling to members of a particular culture that have a well-developed set of accrued stories. The virtual agent will be able to incorporate these stories to improve the efficacy of its counseling, by automatically selecting appropriate stories to tell in counseling conversations and delivering them 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 and information about the user and past counseling conversations with them.
- (2) **Generating Relevance Statements:** Generating utterances for the agent that clarify the relevance of the story to the counseling goals, highlighting the most relevant parts of the story, and providing actions the user should take that promote their health, taking into account the lessons from the story. Although people are very good at generating their own relevance relationships between narratives [21], making these ties explicit reinforces the counseling goals of the agent.
- (3) **Generating Prosody for Engaging Storytelling:** Telling the story in an engaging and impactful manner, appropriate for the culture and the story genre.

In our current work, we are developing a health counseling agent for a network of historically Black churches in our city. Religious communities generally have an accrued set of stories that are codified in their foundational texts, such as the Christian Bible, the Jewish Torah, or the Islamic Koran. We are grounding our approach in the selection, contextualization, and delivery of Bible stories, told as part of health counseling conversations with a virtual agent.

After reviewing related work, we describe our general approach to incorporating stories into counseling conversations, followed by a description of our initial prototype and the results of a preliminary evaluation study.

2 RELATED WORK

Our work draws on previous research on virtual agent-driven health counseling systems, storytelling agent systems, the use of storytelling in healthcare settings, story indexing, and generating relevance statements.

2.1 Conversational Agents for Health Counseling

Many studies have now demonstrated that embodied conversational agents can successfully provide automated health counseling and interventions [4, 23, 32].

One study evaluated the efficacy of a virtual health coach in improving physical activity, Mediterranean-style diet adherence, and health risk factors in middle-aged and older adults [27]. In this investigation, participants interacted with a virtual health coach that provided advice on diet and physical activity. Results showed that the intervention led to improvements in participants' diet and physical activity. However, there was no significant change in participants' risk factors.

Another investigation evaluated the extent to which a virtual agent could modify the lifestyle health behavior of women [12]. The intervention provided techniques for stress management, physical activity, and healthy eating. Participants accessed this information either by interacting with a virtual agent or through standard material (patient education sheets and informational audio). Results demonstrated that the group of women who interacted with the

agent decreased stress-related alcohol consumption and increased daily fruit intake in comparison to the control group.

2.2 Storytelling in Healthcare

Storytelling is a powerful tool used as a vehicle for communication, entertainment, education, or health promotion. Depending on the goal, stories can be delivered using different narratives or structures [1]. In the case of health education and counseling, storytelling can be used to provide meaningful anecdotal advice to patients on what to do and to avoid. For example, health professionals often use different methods to make their storytelling more effective, namely use of stories that demonstrate good and bad interventions and illustrate concepts; use of scenarios, case studies, and vignettes for analysis; and use of reflective analysis [10].

Storytelling provides healthcare practitioners with an alternative strategy for helping patients make better decisions [8]. One study investigated knowledge, behaviors, and health belief outcomes regarding skin cancer comparing emotional (narrative) and informational (statistical) audiovisual conditions [8]. Overall results demonstrated that both methods were equally influential in decreasing the intention to tan and increasing the intention to use sun protection. However, the emotional narrative method was more persuasive on a long-term basis.

In addition, a study compared whether narrative storytelling was more effective at conveying health-related knowledge, attitudes, and behavioral intention than delivering the identical information in a more traditional, nonfiction, non-narrative format [34]. Participants watched an informational film about cervical cancer presented either in narrative storytelling or non-narrative format. Results showed that the narrative condition was more influential in improving cervical cancer-related knowledge and attitudes. Furthermore, similar results were revealed in a study focused on motivating participants to adopt a healthier diet and physical activity [24]. This study compared the use of culturally-tailored storytelling to a standard non-narrative method of instruction, and showed that participants in the storytelling condition reported greater intent to consume more servings of vegetables and perform more minutes of exercise [24]. In addition, an intervention that involved culturally appropriate patient stories demonstrated significant improvements in blood pressure for African-American patients [19].

2.3 Bible Scriptures in Healthcare

Studies have shown that scriptural and Bible elements in health intervention messages for church communities can help create more culturally-sensitive messaging, framing health as an important aspect of faith [11, 22, 49].

Koenig et al., [20] found evidence that spirituality was strongly associated with superior health outcomes. Furthermore, Tyron [46] promotes the use of the Biblical narratives as a foundation for healthier lifestyle changes. Specifically, this author encourages medical personnel to use the promise of Restoration, "*I will restore you to health and heal your wounds*" (Jeremiah 30:17), to help patients see a connection between this concept to making healthy lifestyle choices.

Using storytelling with religious content has been used for delivering healthcare information and coping strategies for patients [17].

A study examined the effect of religious stories included in songs to aid patients to cope with stressful events. Participants listened to songs with religious content during stressful events in their personal lives. After the intervention, participants reported feelings of being comforted, strengthened, able to endure, uplifted, and able to find peace. These results provide evidence for how supportive messages communicated via religious songs and biblical text are robust resources for enhancing optimism and perseverance during stressful situations [17].

2.4 Conversational Agents for Storytelling

Embodied conversational agents have the ability to produce compelling oral narratives. Ryokai et al. [40] created an interactive embodied agent that tells stories to teach literacy skills to children. During the narration, the agent engages with children using mutual gaze and uses verbal and non-verbal conversational behavior. The children who played with the agent and listened to its stories incorporated its storytelling techniques into their own narratives.

Another study found that virtual human storytellers resulted in higher attention and involvement, and resulted in higher learning outcomes, in a virtual simulator of a visit to an art museum. The study included three conditions for informational aid about the museum artwork, namely, traditional text, a narrating voice, or a virtual human narrator. Interacting with the virtual human enabled understanding the information much easier than learning the information through just the text and voice narrations [5].

Additionally, there has been research in generating more engaging storytelling speech styles for agents by manipulating the prosodic elements of their speech [14, 33, 41, 45]. For example, prosodic elements such as pause, tempo, pitch, intensity, and duration have been analyzed for generating more engaging speech styles for children’s stories [33, 41, 45].

2.5 Indexing Stories

Given the explosive growth of available text online, there is a growing need for language processing techniques that are able to index and classify narrative content [28]. Riloff et al. [38] describes different information extraction techniques such as partial parsing, discourse analysis, and automated knowledge acquisition. Nevertheless, these superficial techniques differ from “Story Understanding Systems”, used for deep semantic understanding of complete stories. One study applied statistical text classification on stories in public blog entries to identify personal stories [16]. Additionally, Manuvinakurike et al. [28] developed an indexing algorithm that combined text classification and machine learning techniques to extract and select personal stories that could be used in an automated health behavior change intervention delivered by a virtual agent.

3 DESIGNING STORYTELLING MOTIVATIONAL AGENT

In this work, we are designing a virtual agent that motivates users to change health behavior through health counseling augmented with existing cultural stories told in an engaging way. This section describes the three main aspects of designing our storytelling motivational agent: indexing the best story from all possible cultural

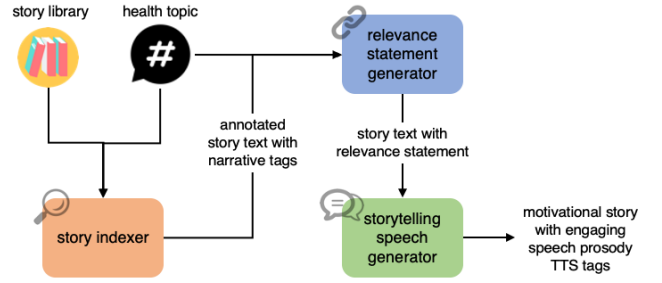


Figure 1: A diagram of proposed system for storytelling motivational agent.

stories, generating utterances for the agent that clarify the relevance of the story to the counseling goals, and lastly, generating engaging storytelling style of speech for the agent.

3.1 Indexing Stories

In an exploratory study, we investigated how we can best select stories for health behavior change tailored to a very specific community, namely, a faith-based community. We conducted a study using an online crowdsourced research platform (www.prolific.co), to gain a better understanding of what Bible stories can lead to greater motivation for health behavior change. We randomly assigned users to have a counseling conversation with a virtual agent on either increasing fruit and vegetable consumption (healthy eating) or exercise. Within each conversation, one story from a library of 42 Bible stories was randomly chosen to be told to the user by the agent. Based on the participants’ decisional balance [26], self-efficacy [2, 26], motivation, confidence, and stage of change before and after their interaction with the agent, we found that a story’s relevance to the health topic was an important factor in increasing motivation for change.

Based on the results from our exploratory study, a system can automatically select a story from a 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. In a basic version of the system, we can rank stories based on the number of occurrences of words or phrases from a given topic’s lexicon and present those with higher ranking to the user. In a more complex system, 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 [15, 43, 48].

3.2 Generating Relevance Statements

Providing a connection to how the main characters of a story can teach users about healthy behaviors and presenting key takeaway



(a) A scene from “Daniel and his friends refusing to eat the king’s food” story.

(b) A scene from “Jesus feeding the 5000” story.

(c) A scene from “The Prodigal Son” parable in the New Testament.

Figure 2: A sample of screenshots of the agent waiting for the user to respond in the middle of telling a Bible story, with the dialogue response options displayed at the bottom of the screen.

messages that align with the user’s cultural beliefs can be important when presenting stories for motivational change. In our system, the agent first states the main purpose of presenting a story. Then, the indexed story is told by the agent. Following the end of the story, 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.” Furthermore, the agent provides some generic 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” when discussing making good food choices. Finally, there is a closing statement for every story based on the topic that reiterates the moral of the story.

The generation of plain, linking language can be semi-automated by using annotated narrative tags within the story’s text and corresponding templates. For example, the system can generate the language for the recap and generic moral for healthy eating by using the following tags:

```
<FOOD-ACTION ACTOR="DANIEL" ACTION="MINDFUL EATING"/>
<FOOD-MORAL OUTCOME="POSITIVE"/>
```

3.3 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, pitch, speech rate, and volume. In addition, we incorporated repetition of clauses and noun phrases as a way to emphasize important concepts to users.

We used the following ruleset based on existing literature to create a more engaging storytelling TTS speech tags.

3.3.1 Pause. According to Theune et al. [45], speech in storytelling tends to have longer pauses than other types of speech, such as newsreading. People often use pauses to indicate narrative structure [13, 36] and reported speech within a story [25, 37, 44]. To generate a more storytelling style of speech, we included two second pauses after each section of the story [36], one second pauses after introducing new information such as the main characters [13], and one second pauses around the reported speech of characters in the story [25, 37, 44]. Furthermore, we added a long pause of 1.5 seconds before the climax of the story to increase suspense [33, 39].

3.3.2 Speech Rate. Speech rate or tempo was slowed down by 10% from the neutral baseline, as stories are generally told in a slower rate [45]. In addition, we slowed down the reported speech parts of the story further to draw the user’s attention and allow them to follow all the information [33]. Lastly, slower tempo was used to emphasize key takeaways and morals from the story, which is often done in sermons [39].

3.3.3 Pitch & Volume. Differences in pitch have been incorporated into reported speech to generate a voice that tries to mimic a character in the story [33]. For example, the pitch of the agent is lowered for a male character for reported speech. Based on the given genders of the characters in the story, the baseline pitch of each character is altered for reported speech. In addition, we increased the pitch and volume when introducing climactic events [45]. The increased pitch and volume is intended to capture the attention of the user as the climax of the story is introduced.

3.3.4 Repetition. Lastly, we incorporated the concept of repeating important words or phrases in the story to highlight important aspects of the story based on the health counseling topic. This style of speech is often used in sermons and has been incorporated to highlight the target behavior we want to promote through the story [39].

The prosodic manipulations are automated by applying the above rules to story text that has been annotated with the narrative tags

that provide information such as characters’ names and gender, sections of story, and location and type of climax.

4 PROTOTYPE IMPLEMENTATION

In order to assess the potential effect of storytelling on people’s attitudes towards health behavior change, we created a proof-of-concept motivational storytelling agent specifically for church-going communities based on the proposed system described in section 3. For the prototype, we focused on one health behavior and a specific cultural group. Our agent, named Sam, uses a counseling approach called Motivational Interviewing (MI) [29] and three pre-indexed Bible stories to motivate users towards increasing fruit and vegetable consumption (healthy eating).

4.1 Agent Implementation & Design

Our agent system incorporates a 3D animated character who converses with users using synthetic speech, conversational behavior, and multiple-choice menu inputs for user responses (Figure 2). The agent’s synchronized nonverbal conversational behavior, such as hand gestures, head nods, eyebrow raises, and posture shifts, is automatically generated using the Behavior Expression Animation Toolkit [6]. Agent utterances are generated using template-based text generation. The agent’s dialogue is driven by a hierarchical task network-based dialogue engine. We developed a web-based application using the Unity3D game engine and CereProc for speech synthesis.

To create an agent tailored to church communities, we present Sam as a member of a church who is involved in her church’s health ministry within the health counseling conversation. Throughout the counseling conversation, Sam provides spiritual support and encouragement by sharing content that relates to the user’s faith and presents a culturally informed, holistic picture of health that honors the users’ belief system.

4.2 Bible Story Implementation

Based on our formative work and consulting a pastor within the church network we are working with, we indexed three Bible stories that are considered to be highly relevant to the topic of healthy eating for our evaluation study. The three Bible stories are “Daniel and His Friends Refusing to Eat the King’s Food” (Daniel 1), “Jesus Feeding Five Thousand People” (Matthew 14:13–21), and “The Prodigal Son” (Luke 15:11–16). Figure 2 shows the virtual agent and sample user responses for each of the three Bible stories. The relevance statements of the Bible story with the topic were scripted using a template.

5 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. The experiment was a between-subjects design where a user was randomly assigned to one of the 7 configurations. The participants had a conversation with our agent Sam during the study. There were three main conditions shown in table 1. In one condition, Sam provides a counseling session without any Bible story (NOSTORY). In the second condition, the agent provides the same counseling session but with a neutral delivery (NEUTRAL) of

Table 1: Study Conditions. NEUTRAL and ENGAGING are each conducted with one of three Bible stories at random: “Daniel and his friends refusing to eat the king’s food” (Daniel), “Jesus feeds the 5000” (Jesus), and “The Prodigal Son” (Prodigal Son).

Condition	Story	Relevance	Text-to-Speech
NOSTORY	No	No	No
NEUTRAL	Daniel	No	NEUTRAL
NEUTRAL	Jesus	No	NEUTRAL
NEUTRAL	Prodigal Son	No	NEUTRAL
ENGAGING	Daniel	Yes	ENGAGING
ENGAGING	Jesus	Yes	ENGAGING
ENGAGING	Prodigal Son	Yes	ENGAGING

a Bible story. The last condition involves the agent providing the counseling session with a Bible story delivered in a style described in section 3.3 with the relevance statements (ENGAGING). We randomized the Bible stories across the NEUTRAL and ENGAGING conditions, so the effects of any differences among stories would be eliminated.

5.1 Participants, Measures, & Procedure

Participants of the study were recruited via an online research platform (www.prolific.co). They were required to be 18 years old or older, able to read and write English, located in the USA, publicly and/or privately participate in regular Christian activities such as attending a Christian church, and have a working audio for their computer. The study was approved by our institution’s IRB and participants were compensated for their time (\$4.75 for 30 minute study).

Each participant 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 and His Friends Refusing to Eat the King’s Food,” “Jesus Feeding Five Thousand People,” “The Prodigal Son”).

Prior to interacting with the counseling agent, we collected the following measures: socio-demographics, subset of Brief Multidimensional Measure of Religiousness/Spirituality (private religious practices, self-reported religiosity and spirituality) [30], and self-reported Bible stories knowledge. In addition, we collected the following measures related to healthy eating before and after interacting with the agent: decisional balance [26], self-efficacy [2, 26], motivation, confidence, and stage of change. The final set of measures we collected following the conversation with the agent were general ratings of the agent and its religiosity and the appropriateness of the Bible story if one was presented in the conversation.

6 RESULTS

A total of 108 participants successfully completed the study. Participants were on average 43.13 ($M=43.5$, $\text{Range}=18\sim74$) years old. The gender breakdown was 49.07% identifying as man, 48.14% as woman, 1.85% unknown, and 0.93% as genderqueer or non-binary. Participants were 70.37% white, 12.96% Black or African-American, 8.33% multi-ethnic, 4.63% Hispanic or Latinx, 2.78% Asian or Asian

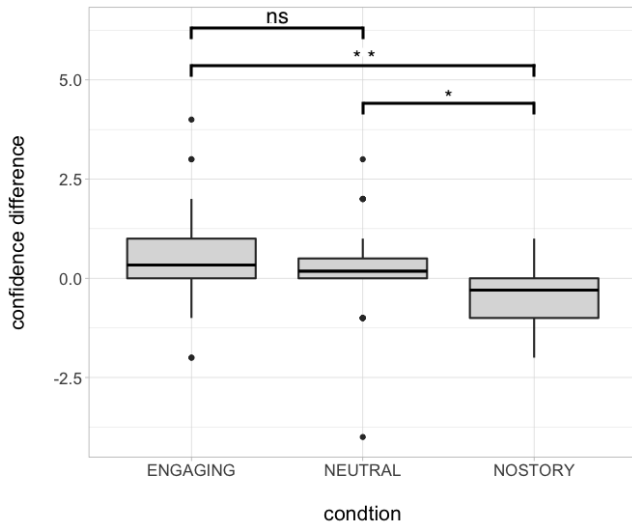


Figure 3: Participants had a significantly greater change in confidence following the conversation with both types of storytelling agent. (ns $p>0.05$, * $p<0.05$, ** $p<0.01$)

American, and 0.93% American Indian or Alaska Native. More than 95% of participants had either a high school degree or equivalent. In terms of religious preference, about 33% of participants were Catholic while 50% were Protestant. Participants indicated that they have been in their current church for a mean of 17.84 years ($M=11$, Range=0~65).

6.1 Health Behavior Change

Across all conditions, there was 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. A Mann-Whitney U test showed that there was a significant difference ($U=376$, $p<.001$) between the the NOSTORY group ($Median=0$, $IQR=0.5$, $Mean=0.18$) compared to the ENGAGING group ($Median=0$, $IQR=1$, $Mean=-0.30$) shown in Figure 3. 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, $Median=0$ ($IQR=1$, $Mean=-0.30$) vs. $Median=0$ ($IQR=1$, $Mean=0.33$) ($U=383$, $p<0.05$) shown in Figure 3. However, we did not see any significant differences between the NEUTRAL and ENGAGING conditions.

The stage of change difference of participants between NOSTORY and NEUTRAL conditions and between NOSTORY and ENGAGING conditions were found to be trending. Participants in the NEUTRAL condition had a greater difference in stage of change to eat healthier compared to the NOSTORY condition, $Median=0$ ($IQR=0$, $Mean=0.05$) vs. $Median=0$ ($IQR=0$, $Mean=-0.19$) ($U=449$, $p=0.13$). Meanwhile, participants in the ENGAGING condition had a greater difference in stage of change to eat healthier compared

to the NOSTORY condition, $Median=0$ ($IQR=0$, $Mean=0.14$) vs. $Median=0$ ($IQR=0$, $Mean=-0.19$) ($U=486$, $p=0.14$). None of the other health behavior change measures collected were significantly different among the treatment groups.

6.2 Satisfaction

Based on the analysis of our results, participants were generally satisfied with the agent. They indicated that the agent used religious language and scripture appropriately. These measures were significantly greater than neutral (Table 2). We found that participants who had a story presented to them during the conversation had significantly greater than neutral for how much they trust and like the agent.

Measures of whether they would like to continue working with the agent, characterization of their relationship with the agent, and their perceptions of the agent's care and understanding were only significantly greater than neutral for participants in the ENGAGING condition.

We found significant correlations between a users' religiosity and their perceptions of the agent and the presented Bible story. A user's private religious practices score ($r=0.38$, $p<0.001$), self-reported religiosity ($r=0.35$, $p<0.05$), and self-reported knowledge of Bible stories ($r=0.40$, $p<0.001$) each were positively correlated with how appropriate the agent's use of scriptures was in the conversation. Furthermore, the private religious practices score was positively correlated with how relevant the Bible story was to the context ($r=0.39$, $p<0.001$) and personal life ($r=0.51$, $p<0.001$) as well as the degree of enjoyment ($r=0.36$, $p<0.05$) and familiarity ($r=0.35$, $p<0.05$).

7 DISCUSSION

Our preliminary evaluation study has demonstrated that the use of storytelling can improve counseling outcomes. We found that the presence of stories can have a positive effect on the change in confidence to engage in a target healthy eating behavior. In addition, the presence of religious stories generally had a positive effect on trust, likability, caring, and understanding of the agent. This shows that the presence of stories can help with motivating religious users toward eating healthier or maintaining to eat healthy.

Participants in all three study conditions indicated higher than neutral overall satisfaction and appropriate use of religious language and scriptures. This can indicate that our design for the agent worked for our priority community. We found that participants who scored higher on the religiosity measures found the agent's use of scriptures to be more appropriate than those who scored lower. This result is supported by how participants who scored higher on the religiosity measures found the Bible story that were presented to them to be more enjoyable, familiar, and relevant to the context of healthy eating as well as their personal life. This can show that religious tailoring using Bible stories for the context of healthy eating can appeal to religious users.

However, we were not able to find significant results between the NEUTRAL condition and ENGAGING condition. Our study showed that presenting Bible stories in the context of a health counseling conversation can be an effective way to motivate religious users to change their diet behavior, but the additional presence of explicit

Table 2: Single items participants were asked regarding the agent, Sam. The last column shows which items for each condition were significantly greater than a neutral score of 4.

Item	Anchors (1...7)	Condition	Median (IQR)	Wilcoxon S-R Test
How likely are you to recommend talking to Sam to other members of your church?	not at all likely - very likely	NOSTORY: 5 (4) NEUTRAL: 4.5 (3.75) ENGAGING: 5 (2)		n.s. n.s. n.s.
How satisfied are you with Sam?	not at all satisfied - very satisfied	NOSTORY: 5 (1.75) NEUTRAL: 5 (3) ENGAGING: 5 (3)		$W=249.5$ $p<0.05$ $W=404$ $p<0.001$ $W=482$ $p<0.001$
How much would you like to continue working with Sam?	not at all - very much	NOSTORY: 4 (4) NEUTRAL: 5 (3) ENGAGING: 5 (2)		n.s. n.s. $W=428$ $p<0.05$
How much do you trust Sam?	not at all - very much	NOSTORY: 5 (3) NEUTRAL: 5 (2.75) ENGAGING: 5.5 (2.5)		n.s. $W=344$ $p<0.05$ $W=586$ $p<0.0001$
How much do you like Sam?	not at all - very much	NOSTORY: 5 (2.5) NEUTRAL: 6 (3) ENGAGING: 5 (3)		n.s. $W=417$ $p<0.001$ $W=531$ $p<0.0001$
How would you characterize your relationship with Sam?	complete stranger - close friend	NOSTORY: 3 (3) NEUTRAL: 4 (3) ENGAGING: 4 (1.75)		n.s. n.s. n.s.
How much do you feel that Sam cares about you?	not at all - very much	NOSTORY: 5 (3) NEUTRAL: 4 (3) ENGAGING: 5 (2)		n.s. n.s. $W=312.5$ $p<0.05$
How much do you feel that you and Sam understand each other?	not at all - very much	NOSTORY: 4 (2.75) NEUTRAL: 4 (2) ENGAGING: 5 (2)		n.s. n.s. $W=440.5$ $p<0.05$
How appropriate was Sam's religious language?	not at all - very appropriate	NOSTORY: 6 (2.5) NEUTRAL: 6 (2) ENGAGING: 6 (2)		$W=263$ $p<0.01$ $W=457$ $p<0.0001$ $W=804.5$ $p<0.0001$
How appropriate was Sam's use of scripture?	not at all - very appropriate	NOSTORY: 6 (2) NEUTRAL: 6 (2) ENGAGING: 6 (2)		$W=305$ $p<0.001$ $W=460.5$ $p<0.0001$ $W=753$ $p<0.0001$

linking of a story to the health topic or the use of engaging speech prosody were not found to lead to further significant improvements.

8 CONCLUSION

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 Sam 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).

There are several limitations to our study beyond the small convenience sample used. We conducted our evaluation using only one health behavior (diet), so it is unclear whether our results hold for

other health behaviors. Future work should evaluate the system using additional health topics such as exercise and also other counseling topics that go beyond health as our proposed system can be applied to broader domains. Most importantly, health behavior change can take weeks or months to achieve, and our single session evaluation did not test effects of longitudinal sessions or behavior change.

For future work, we plan to further automate our system that can index stories, generate relevance statements, and generate engaging storytelling speech for broader counseling topics. Our findings demonstrate that a user's cultural background, such as their religiosity, can be used to create more personalized health interventions. Exploring ways to adjust the level of an agent's use of cultural language and storytelling can be important when developing interventions for people with different levels of acculturation.

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