

Indexing Stories for Conversational Health Interventions

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Abstract

Personal stories encoding health information are an effective tool for promoting health behavior change. As millions of stories about health are accumulated daily in blogs and in social networks online there is an opportunity to harvest and index a large database of health stories for interventions. We envision such a database increasing user education, engagement, motivation and rapport in our conversational agent-based health intervention systems. In this paper we propose a model of indexing health stories based on health behavior change theory, enhanced demographics and quality metrics.

Introduction

Telling a simple story is a skill people acquire by the age of three [1]. Storytelling is used as a tool to make sense of the world and communicate; stories are an essential way we encode and share information with others. Each day we typically tell at least one casual story of what we've done, or what we believe. We are constantly making and remaking the story of our life by telling it to ourselves and to others over the course of a lifetime [2]. In the vast collection of stories we generate, there are reports of our health experiences. We tell stories to each other about whether we are sick or well, how we cope with illnesses, and what we do to achieve our best possible health.

In the domain of health communication, personal stories are recognized as a valuable source of information and inspiration for health promotion, and as tools to catalyze and sustain health behavior change. Health information that is grounded in the personal experience of members of a community is more likely to be engaging and less likely to be dismissed [3]. In a recent study, Houston, et al., videotaped narratives by individuals with hypertension and used these in a DVD-based intervention to help other individuals with hypertension maintain their chronic condition. In a randomized clinical trial with 299 participants, those receiving the story-based intervention had significantly lower blood pressure after 3 months, compared to a control group that received attention-control DVDs [30].

Informal methods of obtaining health information are gaining in popularity. A recent poll by the Pew Internet and American Life project reported that 43% of respondents preferred practical advice about day-to-day health situations from medical professionals while a surprising 46% preferred to get this advice from other informal sources and sources such as family, friends, and fellow patients [4]. Social networking platforms, blogs, and mobile applications support and have normalized the practice of informally reporting and sharing personal health data—diet, sleep habits, moods, exercise regimens, medications—sometimes in astonishing detail. Patients Like Me (patientslikeme.com) offers patients a platform for tracking and visualizing structured personal health data and sharing unstructured data—stories, journal entries and comments—in forums with other patients who share similar conditions [5]. One user amassed over 1000 peer-responses to a single health data entry. Peer responses provide stories of shared experiences such as, “I found that after I'd been taking hydrocodone for a while, it began to interfere with my sleep. I couldn't get to sleep in the first place, then once I got to sleep, I couldn't stay asleep for very long. I don't know if this could be happening for you or not.” [29] These platforms and practices are producing large, distributed corpora of useful health data that can serve as an adjunct support to formal health care.

Story indexing has its roots in early story understanding systems in which story indices were hand-coded for intelligent retrieval and inference [6,7]. More recently, researchers have employed statistical methods of text classification to collect and classify stories from large online data sets. Gordon et al., for example, created a classifier that was able to identify a million personal weblog entries from the Spinn3r dataset [8]. Features of counseling and persuasion have also been used to index stories. Domeshek et al. developed system that described social aspects of stories using 500 indices to enable retrieval of stories as social advice [9].

In this article we present our work in progress to develop methods for indexing unstructured health stories from existing repositories of online health information,

including blogs, support sites., and personal web pages. Our objective is to find the best possible story to tell an individual at a particular point in time, to help them through the next step of a long-term health behavior change program. Our story indices encompass constructs from health behavior change theories, expanded demographic information, and quality metrics. We seek to improve the utility of informal health stories by creating indexes that enable targeted, personalized delivery of story interventions to promote an individual's best possible health behavior change.

Previous Work

In our prior work on automated health behavior change interventions, we have used animated conversational agents to simulate counseling sessions with a health provider. We have explored the use of storytelling in several of these agent-based health interventions. Because storytelling can serve multiple conversational functions—including informing, motivating, and engaging—as well as relational functions, such as establishing trust and rapport among interlocutors [10], there are many roles stories can play in dialogue-based health interventions. Here, we briefly review a few of these prior systems and studies.

Storytelling to Increase Engagement and Retention

One of the most basic functions of conversational storytelling is to engage and entertain listeners, by relating interesting or humorous events. We have explored the use of such stories in engaging users in order to increase adherence to health intervention protocols and retention in longitudinal health behavior change interventions.

In the “RAISE” project (Relational Agent Intervention for Sun and Exercise) a conversational agent delivered a year-long, daily contact intervention for exercise promotion and ultraviolet (sunlight) avoidance, in order to reduce cancer risk. The agents in this intervention use unique daily stories—including humorous anecdotes, serial story segments, and stories containing health trivia—doled out in a pre-specified sequence, in addition to other relational behavior, to maintain user adherence and retention over the year. A randomized trial compared a state-of-the-art web-based behavior change intervention with the same website augmented with this agent. A national sample of 914 participants were randomized to the two conditions, with those in the agent group completing significantly more interactions per week over the year (0.142 vs. 0.048) [11].

We have also used conversational storytelling by an agent as a mechanism to provide companionship and social support to users. The goal of the Hospital Buddy project is

to develop a hospital bedside companion agent to provide information and support to patients throughout their hospital stay. The Hospital Buddy is an animated conversational agent to which the patient responds using a touch screen attached to a flexible articulated arm at the bedside. The agent chats with patients about their hospital experience - providing empathetic feedback and emotional support - in addition to discussing a range of medical topics. The agent can also tell the patient stories to provide emotional support and companionship. We conducted a preliminary pilot study to gauge acceptance and use of the system by three hospital patients when left in their rooms for 24 hours each. All patients used the storytelling function (in addition to the other functions), scored the agent highly on a standardized measure of therapeutic alliance, and indicated that the agent was effective at providing companionship during their hospital stay (“The best thing about the system, like, you know, when you don’t have anyone here with you...it was actually nice to have her. I mean it kept me company.”) [12].

Finally, we conducted a study to determine if the type of conversational stories used by agent—first vs. third person biographical—had an impact on user engagement. We investigated the use of autobiographical stories told by a conversational exercise promotion agent as if it were a person, for example, talking about its childhood. In this system, conversational stories were dynamically generated from autobiographical story fragments transcribed from interviews with a human exercise trainer. In the study, half of the 26 participants were randomized to hear the stories told in first-person (as if the agent were talking about its own personal history) while the other half heard the same stories told in third-person (as if the agent were talking about the history of another user it had), in order to control for the content of the stories. We found that users reported significantly greater satisfaction when the stories were told in first person compared to third person. More importantly, users in the first person condition were observed to log in more frequently over the 37 days of the study, compared to those in the third person group [13].

Storytelling to Promote Health Behavior Change

We have also used conversational storytelling as a mechanism to provide motivation and information to users attempting to change their health behavior, and have built systems in which these stories are elicited from other users as a means of bootstrapping the development of relevant and culturally tailored story content. In the Preconception Care system, an agent screens women on 120 health risks related to low infant birth weight and infant mortality, then counsels them on addressing these risks using techniques based on the transtheoretical model of behavior change, motivational interviewing, shared decision making, and

other techniques (Figure 1) [14]. In addition to scripted counseling dialogue, the agent elicits stories of successful change from users once they have reported addressing a health risk, and re-tells these stories to other users who are struggling with the same risks. We developed an authoring system to let users write their stories and specify the nonverbal and prosodic behavior the agent would use in re-telling their story, without having to program [15]. Pilot studies of the system are promising. A first study involving 24 users indicated that it was effective at screening for risks: users reported an average of 23 preconception risks to the system. In a longitudinal follow up pilot with 6 women, participants agreed to work on 64% of their identified risks, and successfully addressed 83% of the risks they agreed to work on [16].

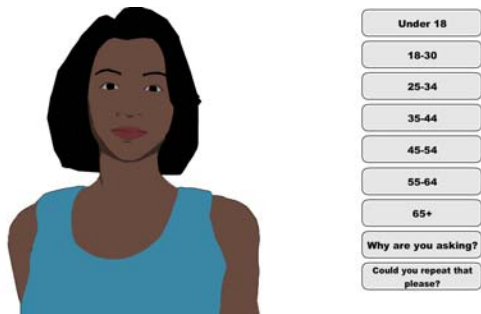


Figure 1: Conversational Agent used for the study.

Current Work: Automatic Story Indexing

Our current research is focused on leveraging existing stories of health behavior change that have been posted on Internet blogs, social networks, support sites, and personal web pages by individuals, by having a counseling agent tell selected stories to other users to inform and motivate their health behavior change. Our current challenge is to determine the indices to use to find the optimal story to tell (of the thousands potentially available) that will be the most effective at helping the listener through the next step of their behavior change program. We are exploring indexing parameters which can be either manually specified by story authors or automatically computed based on the text of a story.

Health behavior Change Theory Indices

Table 1 shows the current list of indexing parameters we are considering using for content matching stories to individuals. One of the more important indexing variables is based on the Transtheoretical Model (TTM) of health behavior change. The TTM considers health behavior change as a continuum wherein an individual moves from not considering an action or health behavior to maintaining adoption of the behavior [18]. In the TTM, change is a process involving progress through a series of discrete

stages. The five stages of change are Precontemplation (people are not intending to take action in the foreseeable future), Contemplation (people are intending to change soon), Preparation (people are intending to take action in the immediate future), Action (stage in which people have made specific modifications in their lifestyles) and Maintenance (people are working to prevent relapse).

INDEX	Description
THEORETICAL MODEL	
Processes of change (Transtheoretical model of change)	Processes of change used. (Please refer table 2)
Pros	Pros of changing the behavior
Cons	Cons of changing the behavior
Source of emotional support	People providing the support
Cues to Action	Motivational events to proceed from precontemplation/contemplation to action
Health Condition	Prior health condition the storyteller is suffering from
TAILORING VARIABLES	
Race/culture	Race and Culture of the storyteller
Gender	Male Female
Age	Age of the storyteller
Education level	Education level of the storyteller
Geography	Country
Profession	Enumeration of professions.
Cues to Action	Motivational events to proceed from precontemplation/ contemplation to action
Celebrity Status	Yes No
Stigmatized group	Groups stigmatized by the society like gays, lesbians etc.
Failed Actions	All the actions which failed to produce result
Successful Actions	All the actions which successfully produced results
QUALITY METRICS	
Coherence of the story	coh-matrix score
Emotions	Emotions conveyed in the story

Table 1: Indexing variables used to match the story to the users

The specific actions or techniques that people can use to change their behavior are categorized into 11 “processes of change” (Table 2), and the processes that are most helpful

to an individual at a given point in time are determined by the stage of change the individual is in. In the initial stages of change the most effective processes tend to involve cognitive, affective and evaluative techniques, and as individuals progress through later stages, commitments, contingencies, environment controls and social support tend to be more effective [18,19]. Thus, the TTM processes of change reflected in a story is one of the primary indices we will use to match the story to an individual, given their stage of change (assessed through standard questionnaire [27] or dialogue equivalent). Matching the stage of change of the individual to the processes of change in the story will help deliver more relevant content. The relation between the processes of change and stages of change for weight loss is shown in Figure 2 (this association is empirically determined, and is different for each behavior) [28].

- “Dramatic Relief” will contain more high emotion keywords etc.



Figure 2: Relation between stages and processes of change for weight loss

Processes of change	Description
1. Consciousness Raising	attempt to seek out information concerning their problem behavior
2. Dramatic Relief	increased emotional experiences followed by reduced affect if appropriate action can be taken
3. Substance Use	Use of Medication
4. Social Liberation	increase in social opportunities
5. Self Reevaluation	cognitive and affective assessments of one's self-image
6. Stimulus Control	removes cues for unhealthy habits and adds prompts for healthier alternatives
7. Helping Relationship	combine caring, trust, openness and acceptance as well as support for the healthy behavior change
8. Counter Conditioning	learning of healthier behaviors that can substitute for problem behaviors
9. Reinforcement Management	consequences for taking steps in a particular direction
10. Self Liberation	belief that one can change and the commitment and recommitment to act on that belief
11. Environmental Reevaluation	affective and cognitive assessments of how the presence or absence of a personal habit affects one's social environment

Table 2: Processes of change used

We will automatically compute the processes of change for a story using text classifiers. Example features include:

- “Helping relationship” contains reference to proper nouns around supportive words (helped, advice, supported, trigger, tips, motivated etc.).

Tailoring Theory Indices

Tailoring a health communication message by matching the user by age, gender, race, culture, country, education levels, etc., helps deliver a more personalized message [20]. Previous work has focused on using these variables for message tailoring. These indices can be automatically computed by using keyword identification from the stories and the storyteller’s profile.

Additional Story Metrics

In addition to indices that are used to match stories to user characteristics, we also plan to compute metrics that evaluate stories on an absolute scale. The quality of a story can be estimated by a Cohesion metric. Cohesion is an objective property of the explicit language and text, such as words, phrases, or sentences that guide the reader in interpreting the substantive ideas in the text, in connecting ideas with other ideas, and in connecting ideas to higher level global units (e.g., topics and themes). Coh-Metrix is a computer program that analyzes various text features relevant to text comprehension by incorporating techniques informed by theories of text processing, cognitive psychology, and computational linguistics [23, 24].

Another story feature we plan to compute is the degree of positive emotion reflected in a story, under the assumption that stories with positive emotions create more optimism in listeners [25]. Emotions can be calculated using the positive and negative scores provided by the SentiWordNet database [26].

Finally, we plan to compute the number of “pros” and “cons” as a feature of stories. TTM says “Changing or initiating a health action involves a gradual change in decisional balance between the pros and cons” [19]. Pros are the advantages associated with behavior change and the cons are the perceived disadvantages of behavior change.

Helping individuals identifying the pros help them take effective actions and hence make these pros and cons an important parameter to use to rank the overall effectiveness of a story. Highlighting the pros could help create a positive effect in motivating the health behavior change.

Future Work

We are developing a system that can automatically compute the above indices and metrics given the text of personal health stories gathered from the Internet. We plan to conduct an evaluation study to test which of these parameters are important for health behavior change, and whether stories retrieved by utilizing these parameters are more effective than stories retrieved randomly from a given corpus. Our ultimate goal is to integrate this capability into a counseling agent that provides an automated longitudinal health behavior change intervention based on storytelling, and conduct a randomized trial to determine if the overall system is effective at promoting and maintaining long term health behavior change.

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