Increasing Psychological Well-being Through Human-Robot Interaction

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***Abstract*—Intelligent tutoring systems, electronic fitness bands, and assistive robots all contribute toward increasing the wellness of humans by providing different forms of support. As a class of machines focused on increasing the physical and psychological well-being of users emerges, new design considerations and questions arise. We are exploring the potential of prosocial machines via social robotic systems focused on enhancing a user's psychological well-being through positive interventions. This article briefly summarizes our initial approach to understanding prosocial machines via a positive psychology based intervention focused on comparing the ability of different systems to induce measurable increases in a human's level of hopefulness.**

I. Prosocial Machines

While Human-Robot Interaction (HRI) investigates a wide variety of fundamental usability concerns, a parallel interest in providing experiences which transcend the goal of usability and focuses on enhancing the lives of users has also emerged. As this effort progresses, a class of machines which users can attribute their own increases in psychological and physical well-being toward, has emerged earning the label of *prosocial machines*. For example, users of electronic fitness bands may be influenced to alter their behaviors as a result of the band's notification of an exercise goal accomplishment. Likewise, patients using a rehabilitation robot that verbally encourages them to progress with their physical therapy recognize the motivational nature of the system and experience increases in well-being as a result of using it [1].

While some prosocial machines act to treat an impairment (secondary prevention), the many are focused on enhancing the already *normal* life of a user (primary prevention). This sentiment has strong parallels with the field of positive psychology, which seeks to enhance the life of psychologically healthy individuals [2], [3]. In this respect, findings and techniques pioneered in the field of positive psychology have potential for application in human-machine interaction scenarios.

II. Current Work

Our current work explores the research question: *How can prosocial machines best leverage their capabilities to increase psychological well-being?*

Through a review of literature in the fields of human-computer interaction and HRI, we have identified four dimensions of prosocial machines which may influence their effectiveness. The study presented in this article focuses on *agency*, however we provide a brief description of each dimension here:

- *Agency* begins when a user perceives that a system transcends the boundary of being a tool and is recognized as its own entity. While complex machines are capable of demonstrating intentionality, forethought, self-reactiveness, and self-reflectiveness, users often instinctively react in a social manner to even simple machines.

- *Vigilance* describes the degree to which a prosocial machine monitors its environment and the behavior of its users in an autonomous fashion.

- *Propensity to intervene* characterizes how often and at what intensity the machine acts upon the world to enhance the well-being of the user. Systems may be entirely passive, acting only when called upon, or may be free to interrupt the user's activities as needed.

- *Presence* refers to the machine's availability to the user. A majority of social robotic systems, such as exercise motivation platforms and dieting coaches reside in a static location, like a rehabilitation facility or a user's home, but may also use common communication channels (e.g. text messaging) to stay in touch with users when they are away.

A. Experiment: Single Session Positive Intervention

In order to examine the effectiveness of social machines for increasing psychological well-being, we designed a single session positive intervention interaction modeled after a successful hope-inducing study from the field of positive psychology [4]. Most prior interventions have been administered by humans, however research into the use of self-guided interventions via traditional web applications has also been performed [5]. This provokes the question of how the delivery medium affects an intervention.

To study the effects of the system's perceived *agency* on the intervention's effectiveness, we developed two systems: one using only a desktop computer interface, and the other using a Nao humanoid robot in addition to the computer

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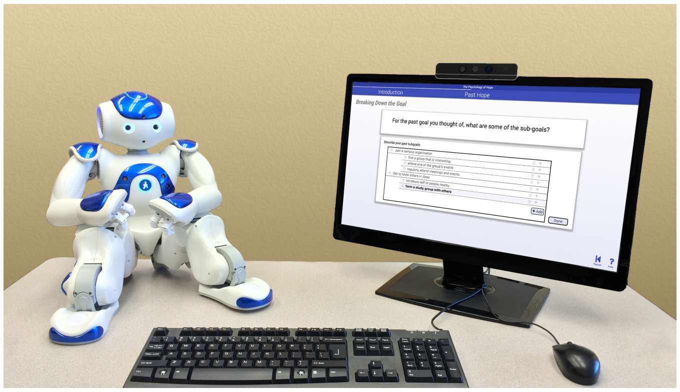

Fig. 1. The positive intervention environment in the robot condition.

interface. While our computer-based condition mirrors a self-guided intervention, we elected to include the same synthetic speaking voice to guide the exercise in both the computer and robot conditions. This allowed us to maintain consistent pacing and exposure between conditions.

The content of the intervention was derived from existing psychological theories of hope and includes three phases: learning hope theory, exploring past goals and pathways, and planning future goals and pathways. During the interactive session, the robot or computer engages in a dialogue with the participant, mirroring the behavior a human administering the same intervention. The exchange requires the participant to recall past events and structure future goals and pathways for achieving those goals.

Figure 1 shows the configuration of the study environment (in the non-robot condition the Nao robot is not present). The intention of this initial study is to determine (1) if a social robot can provide a positive intervention with similar effects to a human and (2) how a robotic platform compares to a computer-based administration.

Participants in the study complete standard self-report surveys validated in the field of positive psychology prior to the interactive session, following the session, and two to four weeks following the session (follow up administered via web survey) [6]. In addition to the computer and robot conditions, a no-intervention condition is also conducted in parallel to provide a baseline of hope level fluctuations for the population being sampled. Participants in the no-intervention condition complete an initial set of self-report surveys and a follow up set of surveys, but do not participate in any type of intervention.

Since prior studies have demonstrated successful administrations of similar hope intervention procedures among university students using a human to lead the intervention, we have opted to not conduct a human-based condition initially.

B. Results

At the time of writing, we have initiated an exploratory online only study to gather baseline information about the population we will sample from for in-person interactive positive interventions. This initial phase surveys approximately 50 participants (primarily university students) and will be used to provide insight into correlations between constructs of emotional intelligence, self-esteem, and sustained level of hopefulness. All data for this phase will be collected by the end of November 2015.

During the month of January 2016, we will conduct in-person interactive sessions with approximately 60 participants, while also gathering data from 30 participants in the no-intervention condition. We expect to conclude all data collection (including all two to four week follow-ups) by the end of February 2016.

Though we consider this study to be exploratory in nature, we have formed the following hypotheses:

H1: Participants in both the computer and robot condition experience greater increases in hope in comparison to those in the no-intervention condition.

H2: Participants in the robot condition will experience greater gains in hope in comparison to those in the computer-only condition.

We anticipate that the robot will provide a greater sense of agency in comparison to the computer-only interface, providing a more intriguing and captivating experience which will lead to a more pronounced effect. Following this study we plan to publish our results, data sets, and software architecture used for conducting the intervention.

III. Future Work

We hope to continue our exploration of the potential for prosocial robots with investigations into longer term interactions and increased abilities in the robot's capacity to be present, vigilant, and able to intervene into a user's daily life.

Achieving these goals requires conducting further studies which place a robot in the everyday life of users for several months, similar to that of the long-term interactions examined for Autom, a robotic weight loss coach [7].

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