Generating Situation-Based Motivational Feedback in a PTSD E-health System

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Abstract. Motivating users is an important task for virtual agents in behaviour chance support systems. In this study we present a system which generates motivational statements based on situation type, aimed at a virtual agent for Post-Traumatic Stress Disorder therapy. Using input from experts (n=13), we built a database containing what categories of motivation to use based on therapy progress and current user trust. A statistical analysis confirmed that we can significantly predict the category of statements to use. Using the database, we present a system that generates motivational statements. Because this system is based on expert data, it has the advantage of not needing large amounts of patient data. We envision that by basing the content directly on expert knowledge, the virtual agent can motivate users as a human expert would.

Keywords: e-health, virtual agent, PTSD, motivation, behavior change

1 Introduction

Virtual agents are often included in behaviour change support systems (BCSS) [3], and motivating users is on of their important functions. But given the diversity of situations it is not always exactly clear what this motivation should entail. However, human experts work in many domains of behaviour change, and they harbour a wealth of knowledge and experience in motivating people. In this paper we present a feedback system for a virtual agent operating in a Post-Traumatic Stress Disorder (PTSD) e-health system. This feedback system can generate motivational comments based on patient situation. It does this with the use of a database containing motivational statements with corresponding likelihood rates, which was developed using human expert knowledge.

Many e-health systems can be classified as BCSS, aiming to promote healthy behaviour and discourage habits detrimental to health. Systems exist for physical health[4], but many are also aimed at mental health disorders [3]. Motivation is important in such systems, but difficult to understand both in terms of construct and the question of how to improve it. Self-determination theory (SDT) separates the concepts intrinsic and extrinsic motivation, the former being more effective [1]. A sub-theory of SDT states that external motivation can be internalized though. For this the concept of *relatedness* is important, if a person feels related to the one offering the external motivation, it is more likely to be internalized.

The concept of relatedness might explain why a virtual agent can be more successful in changing behaviour than a purely text-based interface [8]. This

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implies that virtual agents successfully motivate people even by being present. However, they might be able to improve motivation even more. Interviews with therapists reveal that motivational statements are important for a virtual agent to use during therapy [5]. Although theoretical models exist on how to improve motivation [2], short motivational statements are commonly not included. One study into statements was done by studying human-human interactions and translating these into a motivating system [4]. However, a virtual agent does not always operate in the same real-life situation as a human, and will usually have more limited input from the user. Moreover, this method of studying real life interactions is very data-intensive. In this paper we therefore present a method wherein human therapists are presented with the same information a virtual agent would have. Using their input as a base, we developed a system that generates personalized motivational feedback based on situation.

2 Feedback system

The vision of our motivational feedback system is that it offers the right type of feedback depending on the situation of the patient at that point in time. The situation is described firstly by symptom progression, which can be indicated by the trend (up,stable,down) of scores on the PTSD-check-list (PCL), a short questionnaire measuring PTSD symptoms [7]. The second factor in a patients situation is their current trust in the outcome of therapy. We envision that in different situations, different motivational statement will be appropriate. To decide which statements will be used, the system uses the likelihood ratios of statement categories. The number of statements also depends on the situation, and the exact wording of the statement can be chosen from the database containing the different sentences used by experts. This full process is shown in Fig. 1.

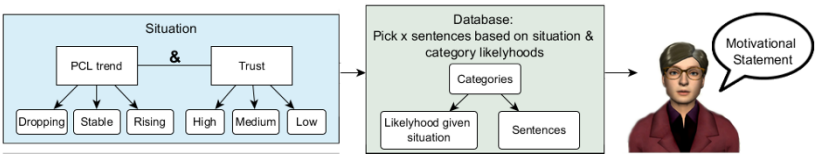

Fig. 1. Vision of the system, generationg motivational feedback based on situation.

Data collection

A survey was held among psychotherapists (n=13, 5 male, 8 female) from six different clinics to study what motivational feedback a virtual agent should give in what situation. They were presented with 18 situations describing the trust the patient had in the therapy at that point in text and a graph depicting PCL scores. Six different graphs were shown, either showing dropping scores, a stable score, or rising scores. The therapists were asked to write down what they would say to the patient in this situation to increase their trust in the therapy and their motivation to continue.

Results

For categorization all answers were split into different statements, divided based

on subject. This resulted in between 1 and 8 statements per feedback answer, 844 in total. All statements were categorized based on topic using categories that arose during this process. A random subset of 32 statements was coded by a second coder, interrater reliability was substantial (κ=0.73, p<.001). After categorization, all categories with less than 10 instances were removed and statements were either only analysed with their super-category, or left out entirely. This resulted in 97% of statements being included when taking the resulting 12 super-categories, and 91% when taking the total of 20 categories.

The data was analysed with R version 3.3. For every given answer in each situation, it was marked whether a category type was used in one of the statements or not. A multi-level analysis was done with participant as random intercept, and the variables of PCL, trust and category type, as well as their interaction effects as fixed effects. This analysis showed that category type (F(49,11238)=101.43, p<.001), as well as the interaction between this factor and both trust (F(98,11238)=3.68, p<.001), and PCL (F(98,11238)=16.03, p<.001) were significant predictors for whether a category was used or not. This confirms that the situation type as defined by trust and PCL is relevant for predicting category type. A second multi-level logistic regression was done per category, using participant as random intercept and the two-way interaction between PCL graph trend and trust as fixed effect. This resulted in the odds of a category occurring given the situation, which were then transformed into probabilities. These numbers, the mean number of statements per answer, and a further description of the categories, can be found in [6].

Motivational System

With the results from the expert survey, we can design a system which generates motivational feedback. This system is described in Figure 2. It picks categories up to the required amount for that situation (three or four), based on the probability of a category occurring, keeping in mind the sub-super category relationships. An example of feedback generated by this system for the situation with rising PCL scores and high trust in therapy outcome would be the following motivational statement. (translated from the original Dutch).

I see your scores have been rising. (note rising PCL) *It is normal if at first your scores do not go down, many people experience that.* (give perspective) *Your trust in the therapy is still high.* (note high trust) *Good job!* (compliment)

3 Discussion & Conclusion

In this paper we present a system which can generate motivational feedback during PTSD therapy based on the patients current situation, usable by a virtual agent. We show that the motivational statements given by experts can be categorized with a good fit, covering 97% of the utterances. Moreover, we can predict how likely it is that category of statement will occur in a situation, resulting in a system generating personalized motivational feedback.

One of the main strengths of the method used in this paper is that no patient dataset is necessary to train a virtual agent to make motivational statements. Especially with mental health disorders, such data can be confidential and difficult

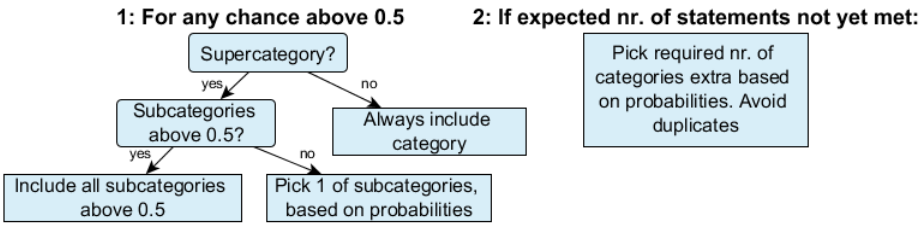

Fig. 2. Outline of the system generating motivational feedback.

to gather. Although the dataset presented in this paper is focused on motivation for during PTSD treatment, a similar type of system could applied to other domains as motivation is relevant for many health interventions. To appreciate the contribution of the system presented in this paper it is, however, also necessary to consider its limitations. The main limitation of this system is that it only considers two parameters for describing a situation. To study whether all important parameters are taken into account it would be necessary to study therapists in a more natural session with a patient, noting what factors they base their choice for statements on.

Despite these limitations, our system can be a valuable addition to a virtual agent as it enables the agent to give personalized situational motivation. Moreover, this method is extendable to more complex situations or different domains as it does not require large amounts of patient or observational detail. Given the importance of motivations in all areas of BCSS, this can be a valuable addition.

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