Personalized Tracking of Goals and Gains after Psychotherapy Using Behavioral Data

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Abstract
A multitude of stimuli can trigger anxiety or fear. If anxiety becomes pronounced and begins to impinge on a person's social functioning, psychologists speak of anxiety disorders. Most fears and anxieties are strongly tied to location: for example, fear of bridges, crowded places, or elevators. Even when fear is elicited by specific, animate stimuli such as dogs or spiders, there are often strong ties with certain locations (e.g. the dog park). As a consequence of this marked worry and anxiety, people with phobias often cease to approach these locations – they *avoid* them. Besides the tremendous deleterious impact on general wellbeing and personal life, the economic consequences of anxiety disorders also impacts society. Exposure therapy is the treatment of choice for anxiety disorders and involves deliberate, systematic confrontation of feared stimuli. Although highly effective, return of fear post-treatment remains a significant problem for many individuals. There is evidence to suggest that fears return due to a lack of regular self-exposure to feared situations. We outline a software tool that allows feared situations to be identified within psychotherapy sessions that can be later used to create dynamic "fear maps". These maps update as patients systematically confront these locations. In addition, we outline how

principles from gamification can be used to depict quantified gains, and performance generally. Our application collects GPS and self-report data collected by mobile phones. Tracking the location of patients allows i) identification of movement patterns and ii) tagging of user's emotional ratings at specific locations. This information helps the users to better quantify and understand the extent of their avoidance behavior, their progress and achievements, and importantly, provides an individualized measure of relapse potential.

Author Keywords
Quantified behavior; Anxiety; GPS; movement patterns; avoidance; situational exposure

ACM Classification Keywords
J.3 Life and Medical Sciences: Health; J.4 Social and Behavioral Sciences: Psychology; H.5.m Information Interfaces and Presentation (e.g., HCI): Miscellaneous.

General Terms
Design, Experimentation, Human Factors

Introduction

Anxiety disorders are high-prevalent and pose wide-reaching problems to society. The financial cost of Anxiety disorders in Europe in 2010 has been estimated at 74.4 billion Euros. The combined 12-month prevalence rate for all anxiety disorders is 14% for those aged 14 and above. Together, persistent worries about and avoidance of feared situations is associated with significant individual costs and a reduced quality of life [1] [2].

Exposure is a core component of evidence-based treatment for anxiety disorders [1]. It involves the systematic confrontation of feared stimuli and situations. Reductions in anxiety occur as individuals learn to tolerate their emotional responses (which over time habituate) and learn that the negative consequences they previously expected do not eventuate [4]. Although highly effective, one persistent reality is that following psychotherapy, many do not achieve complete fear reduction and experience a return of fear (ROF, sometimes called "relapse"). On an individual and economic level, this poses significant problems. Failure to continue practicing exposure is one explanation for ROF, with some researchers suggesting that continued confrontation of feared situations following treatment could help prevent relapse [5]. We argue that a personalized informatics tool has the potential to make a significant, and much needed, contribution to the field of relapse prevention.

We propose a software tool that tracks and rewards the approach of feared situations *after* therapy has ended. We describe how the core application features - movement tracking and the feedback and visualization of achievements – are guided by relevant theories.

Principles of Motivation and Rewards

In order to link achievements to motivation, we draw on principles from gamification. "Gamification" refers to the use of elements from game design in non-game contexts. It has spawned increased attention among various scholarly disciplines including education, marketing, and health [6]. A key principle of gamification is the use of fast feedback loops and instant gratification [7]. Prior research indicates [6] that fast feedback loops in combination with clear goals lead to a more intense and focused user engagement with the respective task. For example, the act of

gathering token rewards that are expressed as points or successfully solved challenges, satisfies the need for achievement [8]. In short, rewards make the defined goals and subsequent achievements more tangible.

Gamification compliments several of the ideas central to goal setting theory [3]. According to the theory, effective goals are specific, measurable, attainable, relevant and timely. Specifying task objectives in this way can help improve the quality of feedback on performance. These principles are regularly implemented across a variety of fields (e.g., management, behavior modification) and help guide the development of our application. Specifically, we support users and therapists with an application that: (i) uses a city map to collaboratively identify feared locations/situations, (ii) allows dynamic tracking of exposure attempts, and (iii) administers a token-based reward system (based on gamification principles).

The "Fear Map"

A central element of our application is a fear map, which is used to plan and later visualize the individual's movement behavior (see Figure 1). It allows users to set very specific exposure goals. Further, criteria for successful completion of these goals can be easily visualized on the device. Following an exposure attempt, users are provided with a depiction of previous movement paths. Hence, users receive objective, timely feedback on their performance. For example, when one feared area is successfully confronted, users can re-play their achievement, see that the color coding of the area has changed, and receive a token reward to help reinforce desirable behavior. Over time, users begin to learn that previously feared situations are no longer threatening.

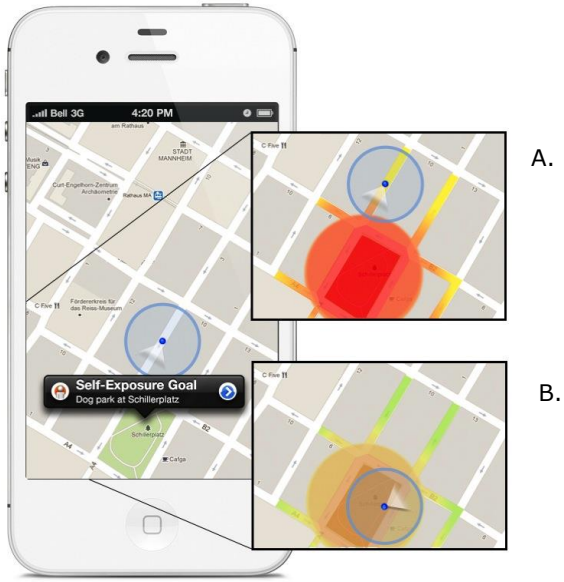

Figure 1: Goals are displayed on the fear map. This map originally consists of goals set at the end of therapy. When users click on a goal, the fear (represented as a color) associated with this area can be seen (see pop out box A). After confronting and providing self-reported anxiety ratings, the fear value associated with the area updates to reflect the most recent behavior of the user (see pop out box B). The degree to which color changes (and the size of the reward accrued) depends on how successfully the user confronts the feared situation. New goals are automatically created based on the time that has elapsed since a feared area was last confronted and current values assigned to feared areas.

Quantifying and Rewarding Behavior

A key feature of the fear map is the representation of differently feared areas with several colors. Color changes (e.g., from red to orange) are dependent on whether areas are successfully confronted, and on the self-report ratings provided as users confront a particular location. After remaining in the situation for 10 minutes, users are automatically promted to rate their anxiety. If, for example, a user remains in a feared situation for the specified time and indicates that they are "somewhat afraid" of the situation, then the color might change from red to orange.

The concept of a fear map allows accurate depiction of behavior. Since red zones represent higher levels of fear than orange zones, it follows that exposing oneself to a red zone is the greater achievement. The fear map hence encapsulates the location-to-fear mapping that is highly individual to each user. It is necessary that the mobile application recognizes successful self-exposition to feared locations, prompts the user for fear ratings, and updates the underlying color-coding of the map accordingly. How to reward desirable behavior with points is currently being considered.

Conclusion

Our mobile application has the potential to help millions of fear-affected people worldwide. Using a fear map allows users to set effective goals, and to visualize and learn from past behavior, thus promoting future confrontation of feared situations. Together, these features help to address the problem of relapse following treatment.

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