Horizon: Resilience – Design of a Serious Game for Ecological Momentary Intervention for Depression

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ABSTRACT

Depression is the world's most prevalent mental disorder and the primary source of disability adjusted life years (DALY). While traditional face-to-face therapies have been shown to be effective, alternative delivery methods, e.g. internet-based therapies, have been investigated to overcome barriers to access, such as lack of availability of therapists and infrastructure. This article presents the design of a mobile serious game as a novel psychological momentary ecological intervention for depressive symptoms. We discuss how selected principles and techniques of common psychological frameworks used to tackle depression, namely Cognitive Behavioral Therapy (including Behavioral Activation) and Positive Psychotherapy, were integrated in the game concept, gameplay and game mechanics of "Horizon: Resilience", a City Building and Decision Making serious game. The selected techniques are put central in the game design by introducing "the Power R(esilience)", which groups the psychological principles of motivation for change, cognitive flexibility, activation and positivity. While identifying with game characters and maintaining high levels of the Power R, the players are introduced to and learn to use Cognitive Behavioral Therapy and Positive Psychotherapy strategies, which they can ultimately apply in their real-life depressive symptomatology.

CCS CONCEPTS

• **Human-centered computing → User centered design**; • **Applied computing → Psychology**.

KEYWORDS

Serious Game, Psychological Intervention, Game Design, Depression

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1 INTRODUCTION

Mental health problems are one of the most concerning diseases in modern times. According to the biannual report "Health at a Glance: Europe 2018", more than one out of six people in the EU had a mental health issue in 2016 (e.g., depression, substance use, psychoses, anxiety, eating disorders)[26], representing approximately 84 million Europeans. Other sources cite more than 50% of population in middle- and high-income countries suffering from at least one mental disorder at some point in their lives [35]. In the current health crisis due to COVID-19, these figures likely underestimate the scale of the problem, as the amount of mental disorders is expected to dramatically increase, particularly depression [24, 36].

Depression is the most prevalent mental disorder, with 4.4% of the world's population (over 300 million people) suffering it[23]. Despite the existence of effective psychological interventions [4], traditional face-to-face treatments suffer various barriers, such as fear of stigma, low perception of need, lack of financial means, and a shortage of staff or infrastructure [38]. As a result, over 50% of people with depressive symptomatology are not treated [37].

To alleviate barriers to access, technology-based psychological treatments, such as internet interventions, were developed [16] and shown to be effective [15] for depression. Nevertheless, with the rapid advance and proliferation of mobile technologies, new treatment methods and deliveries are possible, yet under-investigated. Particularly, a recent systematic review found that the use of embedded mobile phone sensors and alternative delivery methods, such as serious games, is scarce in literature, despite their huge potential [21].

In this article, we attempt to fill this gap, by presenting the design of a mobile serious game as a psychological intervention for patients suffering mild to moderate depression. We hereby address a known challenge in serious games [2], namely how to translate a learning objective (in our case, the psychological intervention) into the game concept, gameplay and game mechanics, while keeping the game engaging and fun to play.

2 RELATED WORK

Video games have multiple features which make them potentially effective as a learning and behavioral change tool. Among these features are: the ability to offer immersive experiences to such an extent that the flow state [22] can be reached, i.e. a state of total involvement with the action that is being carried out, the chance to be engaging and maintaining user adherence [7], immediate feedback [3][13], and the possibility to provide a rich and safe environment to train new skills in a reactive way [12]. For this reason, Video games are being investigated as a instrument in multiples fields such as medicine, psychology, training and education[1][20].

In the psychology field, systematic reviews reveal some studies towards the efficacy, acceptance and feasibility of video games for mental health [7][12][25]. We discern two categories: (i) serious games[33], which are video games designed and developed with the aim of learning and/or training while being entertaining, and (ii) casual games, which are commercial games aimed to entertainment only (i.e., there is no explicit therapeutic nor educational purpose) and are easy-to-use, easy-to-learn and do not require regular time commitment. Both types have obtained promising results in different studies, emphasizing their value as (part of) effective ways of treatment [13][25].

Plants vs Zombies and Bejeweled 2 are some of the more studied casual games, mainly for their effect of distracting the player/patient from their daily concerns[25]. A reduction of depressive and anxious symptoms in interventions that use these games is shown in research [10][28]. Regarding the use of serious games specifically for the treatment of depression, only eleven studies have been found between 2000 and 2018 based on several literature reviews[13][12][7][30][5][17], among which SPARX and some variants are the most evaluated [31][18] [32][19][11]. SPARX is a desktop-based serious game based on Cognitive Behavioural Therapy. It is designed to be used as a integral method in a (self-applied) intervention. The game includes 7 modules that align with the levels of the game. It is a third person game in which the player controls a custom character inside a fantasy world. The objective of the game is to reestablish the world's balance, to be accomplished by completing a variety of missions. Psychological content is introduced in the game through the narrative of these missions, and the player is able to help other characters, using techniques varying from solving problems to using a shooting-style game mechanics against negative thoughts[11]. The studies based on SPARX and the other evaluated game-based interventions are delivered on a desktop, and the use of smartphones as a platform for these games has not been considered in their design [17][6].

To the best of our knowledge, to date, there are no mobile serious games dedicated to provide an intervention for depression.

3 WEAVING A PSYCHOLOGICAL INTERVENTION INTO SERIOUS GAME DESIGN

When it comes to serious games, a major challenge is how to effectively integrate a learning objective (in our case, the psychological intervention) in gameplay and game mechanics, while keeping the game engaging and fun. In this section, we delve into this issue and explain our game concept, the psychological frameworks we intend to apply and finally, the mapping of therapeutic actions to game mechanics and gameplay.

3.1 Game Concept

Horizon: Resilience is a smartphone-based serious game which is specifically aimed at the treatment of mild to moderate depressive symptoms. To do so, the game is based on Cognitive Behavioral Therapy (see Section 3.2), whose underlying psychological principles, such as motivation for change, cognitive flexibility, behavioral activation, physical activity and some positive psychological strategies, are to be reflected in the game. The overall idea is that, by

learning, applying and practicing these coping strategies in the game and seeing their positive effect on the game characters – who suffer similar challenges and conflicts as depressed people – the player (i.e., the patient) will extrapolate to his/her own life and be able to better understand and manage his/her feelings, and thus achieve positive change. The game will also actively encourage the patient to translate and apply the used techniques in his own life.

The game concept is inspired by two well known game genres, namely city builder and decision making. Following the city builder genre, the main objective of the game is to progress and expand the town, by ensuring a steady inflow and the correct management of resources. Doing so, the town and its inhabitants can flourish. Decision making plays an important part in this process, as the player is continuously faced with inhabitants' difficulties and conflicts, which he/she needs to resolve. To do so, the player is presented with a set of predetermined options from which he/she needs to choose by means of a swiping mechanism.

The gameplay occurs in a virtual medieval town in which the player acts as the overall manager of the town. The game's story starts with an unstable situation, in which resources are becoming scarce and life is becoming increasingly difficult. The game follows the life of Emory and his nomadic family, who face a difficult dilemma in these complex circumstances: keep on living in the same place or move to a new one. The player's first task is to guide Emory's family through this decision, after which they start an adventure in a new town. Along the game, the player assists Emory and his family in this process of change, helps them to settle in their new life, and become party to the town's other inhabitants and their troubles. Even though this is a fantasy environment, the situations and difficulties Emory and the other town inhabitants face are recognizable for the player and designed so that he/she can identify with the game characters.

3.2 Psychological frameworks

Cognitive Behavioral Therapy (CBT) is a widely applied evidence-based psychotherapy intervention[14], commonly applied for depression. CBT is aimed at cognitive restructuring, i.e. evaluating and modifying a patient's dysfunctional beliefs, and applies behavioral activation (BA), i.e. promoting involvement in meaningful activities in the patient's life, such as pleasant activities or positive interactions with the patient's environment. Cognitive Behavioral Therapy has been shown to be more effective than other treatments for depression [34], while there is an increasing evidence base indicating that Behavioral Activation specifically is effective for depression [8]. In order to carry out CBT, therapists typically employ a psychoeducational approach and teach patients new ways of handling stressful situations in face-to-face or internet-based sessions, while homework assignments and outside-of-session activities form important support activities. Hereby, the typical techniques used are cognitive flexibility (i.e., understanding the influence of thought in feelings and learning adaptive ways to deal with stressful situations), motivation for change (i.e., learn to accept and evaluate ambivalent situations in order to achieve positive change) and as previously mentioned, behavioral activation.

Positive Psychotherapy (PP) focuses on the patient's strengths, positive emotions, engagement and meaning, rather than only on

the reduction of negative emotions, anxiety or depressive symptoms. It has been shown to be effective for patients with depression [29], also when delivered as Web-based exercises, even in case of severe depression. This makes it ideal to integrate in other digital platforms and delivery methods, such as serious games, to complement a CBT-based therapeutic approach.

As we will discuss in Section 3.3, Horizon: Resilience includes CBT techniques and exercises promoting cognitive flexibility and motivation for change, in combination with behavioral activation in the form of the promotion of physical activity – known to be beneficial from depressive symptoms [9]. Furthermore, we include positive psychotherapy strategies that focus directly on improving positive emotions, virtues and patient strengths [27], to enforce the CBT-based techniques reduce distress, depressive feelings, anxiety and related negative feelings.

3.3 Mapping psychological intervention actions to gameplay and game mechanics

Given the game concept (Section 3.1) and the selected psychological frameworks to apply, namely Cognitive Behavioral Therapy and Positive Psychotherapy (Section 3.2), we now focus on how to integrate techniques reflecting the psychological principles underlying these psychological frameworks within our serious game.

Fundamentally, the therapeutic frameworks were interwoven in the game design using two connected mechanisms: 1/ the introduction of psychological well-being, in the form of Resilience Power ("the Power R"), which consist of four elements that reflect the psychological principles originating from Cognitive Behavioral Therapy and Positive Psychotherapy: motivation for change, cognitive flexibility, activation, positivity; 2/ the use of psychological strategies as part of the underlying game narrative and decision mechanism.

The Power R is omnipresent in the game and a central aspect in gameplay. Important for the City Building principle, it acts as an enhancer for the collection of resources: the welfare of the population ensures a steady resource generation, which is fundamental to improve and expand the town, but a low mental well-being of the town's population results in a slower inflow or even a total stop. In other words, the player sees the concrete positive effects of mental well-being in daily life. The player can influence the Power R through various game mechanics.

First of all, the player is able to influence the different components of the Power R (motivation for change, cognitive flexibility, activation, positivity) through interaction with the locals. These interactions consist of distinct conversations, in which each character presents the player with an obstacle or problematic situation he/she faces in life, and which resembles daily issues or thoughts depressive patients typically have (e.g., feeling useless, negative thinking, stopping to enjoy pleasant activities, feeling not to be able to achieve objectives. etc.). As such, the player enters into a decision making process, which' underlying narrative is primarily based on CBT-based strategies, and secondary on positive psychotherapy strategies, each specifically working either on motivation for change, flexibility, activation, positivity. Hereby, the player learns and practices these strategies (such as listing and weighing costs and benefits of a choice, focusing on positive rather than negative

thoughts, recognizing and cutting negative feedback loops, etc.). Concretely, in each conversation, the player is presented with different options, some of which promote psychological resilience (e.g., adaptive thinking, detecting thought traps, decomposing goals in achievable tasks) and others lead to non-resilience (e.g., maintaining a status-quo, thought loops, negative thought traps). Throughout the conversation, the character gives feedback, telling the player how he/she feels following the decision of the player. Even though the narratives gently lead the player towards psychological resilience, he/she has a free choice, and gets an insight in the thought process and consequences of both positive and negative actions with respect to psychological resilience. At the end of the conversation, the player sees the consequence of his/her choices and actions reflected in (the different components of) the Power R, and thus ultimately, in the progress and well-being of the town.

Secondly, to emphasize Behavioral Activation, next to promoting positive activities in the daily life of the town's inhabitants (e.g. engaging in social interactions, performing personally enjoyable activities) as part of conversations with inhabitants, the game also promotes physical activity of the player in his/her daily life. To that aim, it is foreseen to use the phone's GPS coordinates and activity tracking API to determine the user's daily physical activity. The game incrementally rewards physical activity (e.g., walking, jogging, running) of at least half an hour a day sustained over a longer time period, consistent with scientific evidence of its positive effect on mental health [38], by increasing (the activation component of) the Power R. The player's real-life activity thus has an influence on the well-being of Emory, his family and the inhabitants of the town, giving him/her an incentive to increase his/her daily activity. The game allows players to keep track and visualize their coping ability and physical activity over time.

Thirdly, psycho-education is present throughout the game. The CBT components are visually represented by icons in the HUD which are highlighted while the player is conversing with the character and gives an answer. In this way, the game provides information about the strategy that the player is practicing and he/she mentalizes them. The more these strategies are practiced and worked on, the more resilient the inhabitants will be, and in consequence, the player. The Power R serves as a vehicle to achieve this process. In addition, taking advantage of the city builder paradigm, a library building is available, in which all psychological content and coping strategies, once worked on in the game, are available for reviewing by the player. Accessing the library also increases activation.

Finally, the gameplay and game mechanics are constructed in such a way that they gradually and sequentially introduce players to therapeutic content, consistent with the flow of content in traditional and internet-based therapies. Therefore, the progress in the game mimics therapeutic modules, which we can divide into four levels: working on motivation for change in level one, continuing with cognitive flexibility in level two and Behavioral Activation in level three. Finally, level four mixes all strategies and increases difficulty (e.g., more options to choose from, less outspoken "good" and "bad" answers). Also Positive Psychotherapy strategies are introduced in the last level.

(a) An isometric view of the town.

(b) The conversational decision-making game mechanic.

Figure 1: Horizon: Resilience Screenshots

3.4 Initial prototype

Figure 1 shows two screenshots of an initial prototype of "Horizon: Resilience". The general overview of the town in isometric view is displayed in 1a, while a sample of the conversational decision-making mechanic is shown in 1b. As discussed in Section 3.3, the Power R is present throughout the game and visualized through four icons representing it's four components (bottom Figure 1a, top Figure 1b). From left to right, the icons correspond with motivation for change, cognitive flexibility, activation and positivity. Each time the player solves a difficulty/conflict during a conversation, the icon of the corresponding component lights up, and consequently, the overall Power R is changed. This indicator modulates its color depending on whether the power R is weak, displaying it with a cold color, or strong, displaying it with a warmer color. As shown in Figure 1b, each constructed building generates an amount of

materials at a certain speed, modulated by the Power R. Each building has a maximum storage capacity for resources, and the player needs to collect the acquired material repeatedly over time, hereby promoting player engagement. Only the collected materials – indicated on the top of the screen – can be used to build new buildings and further expand the town. The maximum building capacity is also increased as the power R grows, implying a lesser need to frequently attend the game (and a decreasing therapy need) as the town's (and player's) mental well-being increases.

In the HUD, other options are available for the player such as Build ("Construir") or "Activate" (hidden in the figure - allows the player to record his physical activity). The "Build" option shows a list of all the expansion possibilities of the town. Only those that need less materials than those collected and require less Power R than the player has at the moment can be built. The characters,

now represented by white cubes, will be walking through the town. An exclamation mark above the character appears when he/she has an unresolved conflict and needs the player's help. Once the player touches the exclamation mark, a pop-up message appears, starting a conversation with the citizen. If the player decides to help the character, the view of 1b is displayed and a decision-making process is started. Hereby, the well-known left/right swiping interaction mechanism is used to reveal and select the various options.

4 CONCLUSION

In this article, we presented "Horizon: Resilience", a work in progress mobile-based serious game aimed as an alternative delivery of an ecological momentary intervention for depressive symptoms. In particular, we focused on the mapping of therapeutic strategies stemming from Cognitive Behavioral Therapy and Positive Psychotherapy to the gameplay and game mechanics of our game. In essence, "Horizon: Resilience" is a mix between a City Builder and Decision Making game, in which therapeutic actions are integrated in two ways: by making mental resilience and well-being an integral part of the city building mechanics and by integrating the different psychological strategies into the narrative and decision making game mechanics. The game has been designed using an iterative process, in which game developers and psychologists worked side-by-side to identify and select the therapeutic actions suitable to be used in the serious game, and game developers contemplated how to integrate them keeping their therapeutic value, while guarding the enjoyability, playability and user engagement in the game. We developed an initial functional prototype of the game, which includes the main game environment, game interaction and part of the narrative. We are currently in the process of expanding the game story with more conversations and corresponding therapeutic content, the library which provides psycho-educational content, the Behavioral Activation component based on the physical activity of the player, and generally a more pleasing visual design. Our immediate future work is to finish a complete prototype, and evaluate it using an n-of-1 study with a depressed patient, under supervision of a therapist. Based on this, we will assess the feedback, incorporate it in a next version, and perform a pilot randomized controlled trial to assess usability and effectiveness of this novel serious game-based ecological momentary intervention for depression.

ACKNOWLEDGMENTS

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