

**REWIND: CBT-BASED SERIOUS GAME TO
IMPROVE COGNITIVE EMOTION
REGULATIONS AND ANXIETY DISORDERS**

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**REWIND: CBT-BASED SERIOUS GAME TO
IMPROVE COGNITIVE EMOTION
REGULATIONS AND ANXIETY DISORDERS**

by

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LIST OF ABBREVIATIONS

GAD	Generalized anxiety disorder
PTSD	Post-traumatic stress disorder
SAD	Social anxiety disorder
FEP	First episode psychosis
CCT	Computerized cognitive training
CBT	Cognitive behavioural therapy
PPT	Positive psychotherapy
VRET	Virtual reality exposure therapy
YLD	Years lived with disability
DALY	Disability-adjusted life years
CERS	Cognitive emotion regulation strategies
GWAP	Game with a purpose
DHI	Digital health intervention
RCT	Randomized control trial
3D	Three dimensional
NPC	Non-player character
PC	Personal computer
ABM	Attention bias modification
EEG	Electroencephalogram
AI	Artificial intelligence

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**REWIND: PERMAINAN SERIUS BERASASKAN TERAPI TINGKAH LAKU
KOGNITIF UNTUK MENAMBAH BAIK REGULASI EMOSI KOGNITIF
DAN KECELARUAN KERESAHAN**

ABSTRAK

ReWIND merupakan permainan serius berasaskan tingkah laku kognitif (CBT) yang direka khusus untuk menambah baik regulasi emosi kognitif dan kecelaruan keresahan pesakit. Objektif utama kajian ini adalah untuk mereka bentuk permainan berasaskan cerita untuk memudahkan terapi tingkah laku kognitif dan menilai keberkesannya dalam rawatan kecelaruan keresahan. Jalan ceritanya bertumpu pada tiga strategi regulasi emosi kognitif: malapetaka, ruminasi, dan kekurangan fokus dalam perancangan. Setiap strategi terdiri daripada dua senario berdasarkan pada kejadian benar dalam kehidupan dan diubahsuaikan mengikut model CBT Ellis (peristiwa, kepercayaan, akibat, pertikaian, dan kesan). Metodologi kajian ini menjelaskan pengembangan jalan cerita, pengembangan permainan, dan eksperimen secara terperinci. Analisis ANOVA (mixed-design) digunakan untuk menilai prestasi keseluruhan ReWIND dan mengesahkan hipotesis mengenai keupayaannya dalam mengurangkan tanda-tanda kecelaruan keresahan dan meningkatkan regulasi emosi kognitif. Hasil kajian ini adalah memuaskan kerana ReWIND mampu mengurangkan keterukan gejala kebimbangan dan tahap kebimbangan sifat sambil meningkatkan persepsi kawalan kebimbangan lebih baik daripada tugas bukan interaktif. Kajian ini menyumbang kepada pengembangan solusi permainan terapeutik dengan kandungan yang lebih bermakna dan berkaitan dengan kecelaruan keresahan. Penemuan kajian ini akan menerangkan bagaimana elemen CBT boleh dinyatakan melalui mekanik permainan untuk menambah baik regulasi emosi kognitif dan kecelaruan keresahan.

REWIND: CBT-BASED SERIOUS GAME TO IMPROVE COGNITIVE EMOTION REGULATIONS AND ANXIETY DISORDERS

ABSTRACT

ReWIND is a CBT-based serious game designed specifically to improve cognitive emotion regulations and anxiety disorders of patients. The main objective of the study is to design a story-driven serious game to facilitate cognitive behavioural therapy (CBT) and measure its efficacy to complement the treatment for anxiety disorders. The foundation of the game storylines focuses on three cognitive emotion regulation strategies common in anxiety disorders: catastrophizing, rumination, and lack of refocus on planning. Each strategy consists of two scenarios remodelled from real-life incidents following Ellis' ABCDE-model (activating event, belief, consequence, disputation, and effect). A three-phase methodology is presented in this study covering the storyline development, game development, and experimental design in detail. The mixed-design ANOVA model is used to assess the overall performance of ReWIND and test the hypotheses regarding its capability to reduce participants' anxiety symptoms and improve cognitive emotion regulations. The outcome of this study is satisfactory as ReWIND is capable of reducing the severity level of anxiety symptoms and trait anxiety levels while increasing perceived control of anxiety better than the non-interactive task. This study makes an important contribution in the development of a complementary and non-intrusive therapeutic solution that takes the form of a game with more meaningful and anxiety-relevant content. Specifically, the findings will shine light on how CBT elements can be manifested through game mechanics to improve cognitive emotion regulations and anxiety disorders in patients.

CHAPTER 1

INTRODUCTION

1.1 Background

Anxiety disorder is a common mental disorder with the highest prevalence among mental diseases and inflicts a significant burden on patients (Bandelow et al., 2017). Anxiety disorders can be caused by a variety of psychosocial variables, including early adversity, stress, trauma, and genetic vulnerability, which manifest themselves in neurobiological and cognitive dysfunctions. With the prevalence of digital technologies, such as computerized therapies, online learning, and remote communication, it is plausible to investigate how game intervention facilitates therapeutic process in tackling anxiety related issues and affect decision making, behaviours, and quality of life. Although we have observed several studies about game solutions for a particular anxiety disorder such as agoraphobia (Christoforou et al., 2017), SAD (Miloff et al., 2015), PTSD (Walshe et al., 2005), and specific phobia (Sharmili & Kanagaraj, 2020), the absence of a dedicated serious game intervention that works on improving cognitive emotion regulations and anxiety disorders is the underlying motivation to carry out this study. We aim to evaluate, through a well-planned experimental study, a CBT-based serious game designed for anxiety disorders in general. This study introduces a state-of-the-art solution that implements a CBT-game framework to design scenarios with therapeutic content and coordinate well with role-playing game (RPG) style storytelling, which brings forth a complementary and non-intrusive therapeutic solution that can improve cognitive emotion regulations and anxiety disorders.

1.2 Motivation

Game has the potential for expansion in various fields, including healthcare. In fact, one of the game genres which is role-playing game (RPG) comes with decision-making elements for the purpose of developing behavioural, social, and even language skills. This research aims to provide a solution that can guide individuals with anxiety disorders to change the way they perceive their surroundings using functional and rational means. By having more positive thought patterns towards the issues faced under negative stimuli, both cognitive emotion regulations and anxiety disorders can be improved. Through the game structural flow and storyline, we attempt to simulate real-life situations and lead them to think more clearly and thoroughly whenever they encounter similar occurrences in real life. Patients can also unlock different achievements with incentive rewards such as acquiring new character skins as they explore the game. This works to incentivize participation in the game to prevent loss of interest when the therapy is ongoing. Also, we can introduce the therapeutic session in a more relaxing environment that can reduce their defensiveness and subsequently increase the acceptance rate.

A systematic review on gamification in apps and technologies for improving mental health and well-being (Cheng et al., 2019) revealed that existing gamified treatments lack of explicit connection between the theory and gamification implementation. While gamification can invoke motivational reasons for patients to take part in the treatment, motivation alone is not enough to drive health behavioural changes. The novelty of this study lies in the solution itself that introduces motivation, capability, and opportunity from the behaviour change wheel (Michie et al., 2011) to improve cognitive emotion regulations and anxiety disorders. With the current technological advancement in video game development, we can expect a better

integration between game and healthcare treatment to yield positive results. Findings from Lau et al. (2017) suggest that serious game-based mental health interventions are promising, bolstering the feasibility of developing a serious game for therapeutic purposes. Meanwhile, Abd-alrazaq et al. (2022) also conclude that serious games can potentially reduce anxiety levels. It is essential to come up with non-invasive strategies to treat people suffering from mental illnesses. Otherwise, the strategies may be perceived as coercive and cause opposite effects during the therapy sessions. Hence, a better understanding of the efficacy of game intervention leveraging CBT is important to introduce a better way to tackle anxiety disorders in the mental health domain.

1.3 Problem Statement

Anxiety is becoming the most common mental disorder worldwide (Zsido et al., 2020), and if people with anxiety disorders are left untreated, the disorders and symptoms could persist for decades. They are also more likely to experience a relapse again following a period of remission. Given the limitations of anxiety measures (Spitzer et al., 2006), more research is needed to improve the screening process, diagnosis, as well as treatment of anxiety disorders. According to Our World in Data (2021), the prevalence of anxiety disorders of all ages in Malaysia has reached 5.02% globally. The current situation urges the need for more attention to adults with a prevalence of 5.57% for the age of 20 to 24 and 5.61% for the age of 21 to 29, as compared to children and adolescents with a prevalence of 3.17% for the age of 5 to 14 and 5.41% for the age of 15 to 19.

Currently, anxiety disorders are commonly treated by consulting a psychotherapist. However, the cost for the treatment is expensive, ranging from RM 200 to RM 500 per session in Malaysia. The pricing is reasonable but not affordable for most of the people, especially those from the middle and lower social classes. This

limits the accessibility of getting treatments particularly those who are not able to afford long-term care. Moreover, while anxiety disorders are highly prevalent in the community, people generally are still reluctant to seek professional help, forming barriers between themselves and health facilitators. Studies have shown that some common barriers include public, perceived, and self-stigmatizing attitudes to mental illness, confidentiality and trust, fear of seeking help or source of help itself, shame, and poor mental health literacy (Gulliver et al., 2010; Saporito et al., 2011; Rüscher et al., 2014). Social support and encouragement from others may reduce the help-seeking stigma, while the provision of relevant materials can potentially increase mental health literacy. With that in mind, games can provide a therapeutic solution as a self-help tool with entertaining elements, whereby a greater acceptance rate can be achieved. Games can provide a more relaxing and comfortable environment as opposed to a professional setting, which can help reduce the reluctance to get treatment.

Next, eHealth interventions such as gamification and serious games have been introduced in treating mental health illnesses. However, existing gamification and serious game solutions are all task-driven, in which therapeutic content is not delivered in an adequate manner to keep players engaged and enhance treatment adherence. This aligns with the findings by Cheng et al. (2019) who suggested that the current application of gamification does not align with the positive reinforcement of mental health and well-being due to the a lack of comprehensive implementation. De Freitas (2018) claimed that game-based approaches require considerable efforts to obtain a balance between game playability, fun, and design that aligns learning outcomes with assessments. Therefore, it is important to come up with a comprehensive design that incorporates game elements with a meaningful purpose in an ethical fashion. Moreover, most game solutions are either targeting more specific anxiety disorders

like panic disorder, which indirectly limits the number of people benefiting from the outcome, or they are oriented particularly towards younger populations between the age of 7 to 19 years old, which may not appeal to adults who are not in the age range. For that, we need a game solution dedicated to anxiety disorders in general that works better on adults.

1.4 Research Objectives

The main objective of this research is to introduce a serious game implementing CBT to improve cognitive emotion regulations and anxiety disorders. To be more specific, we seek to address the following research objectives:

- 1) To design anxiety-relatable scenarios based on real-life incidents following the CBT model for a story-based serious game to complement the treatment for anxiety disorders.
- 2) To explore the incorporation of game mechanics that can facilitate CBT's effect into a serious game for anxiety psychoeducation.
- 3) To measure the performance of a CBT-based serious game targeted to improve cognitive emotion regulations and anxiety disorders in adults.

1.5 Research Questions

This study aims to address the following research questions:

- **R1:** How to implement CBT principles to create realistic, anxiety-relevant game storyline encompassing a multitude of possible anxiety symptoms?
- **R2:** What game mechanics can be used to facilitate CBT's effect in helping players learn to cope with negative emotional states and anxiety?

- **R3:** How well does a CBT-based serious game perform in improving cognitive emotion regulations and anxiety disorders in adults?

To address the three research questions, the proposed methodology consists of three phases: 1) storyline development, 2) game development, and 3) experimental study. R1 is addressed in Phase 1 which focuses on gathering relevant content that can be remodelled into different scenarios in the game and analysing them for further classification. In Phase 2, designs of the game mechanics are explained in detail to address R2. To answer R3, an experimental study is conducted to evaluate the efficacy and usability of the game.

1.6 Thesis Proposal Outline

Chapter 1 introduces the background of the research topic, motivation, problem statement, as well as the research objectives. Chapter 2 surveys related work on various game interventions for different mental health problems and reviews mental health concepts relevant to the study. In Chapter 3, we present our three-phase methodology used to develop and evaluate ReWIND, a CBT-based serious game to improve cognitive emotion regulations and anxiety disorders. Phase 1 focuses on the storyline development, Phase 2 on the game development, and Phase 3 on the experimental study for ReWIND and the non-interactive task (i.e., control).

Chapter 4 presents the outcomes of our experimental study by reporting the overall performance of ReWIND compared to the non-interactive task. We use the mixed-design ANOVA model for hypothesis testing and analyse the main effect of the between-subjects and within-subjects variables. Finally, Chapter 5 ends with closing remarks, research contributions, and theme discussion for future work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Mental health has always been a topic of interest among researchers over the years, as mental illnesses account for 32.4% of years lived with disability (YLDs) and 13% of disability-adjusted life years (DALYs), thus indicating the highest global burden yet among all health problems (Samartzis & Talias, 2019). Therefore, quality mental health service plays an important role in preventing and treating mental illness to sustain the quality of life, economy as well as society.

Through this literature review, we aim to identify the gaps in related literature and present a viable integration of existing work on game intervention for mental health treatment. Hence, a discussion in psychology and human-computer interaction (HCI) domains provides a more comprehensive background of this research. This literature review explores anxiety disorders in detail, followed by the definition of cognitive emotion regulation and introduction to different game interventions in mental health treatment.

2.2 Anxiety Disorders

According to DSM-V (American Psychiatric Association, 2013), anxiety disorders are characterized by excessive fear and anxiety, as well as accompanying behavioural problems. Anxiety is described as the emotional response to a future threat, whereas fear is the emotional response to an actual or imagined imminent threat. Fear is more typically connected with surges of autonomic arousal essential for fight or flight, thoughts of immediate danger, and escape behaviours. Anxiety, on the other hand, relates more to muscle tension and vigilance in preparation for future danger, as

well as cautious or avoidant behaviours. In this regard, pervasive avoidance habits can sometimes reduce the level of dread or anxiety.

Anxiety disorder is the most common mental disorders in the general population and inflict a significant burden on patients (Bandelow et al., 2017). Anxiety disorders can be caused by a variety of psychosocial variables, including early adversity, stress, trauma, and hereditary predisposition, which manifests itself in neurobiological and cognitive dysfunctions. According to Chand and Marwaha (2022), specific phobia has the highest prevalence among different types of anxiety disorders, with a rate of 12.1% over a 12-month period. The next most frequent anxiety condition is social anxiety disorder, which has a prevalence rate of 7.4 percent over a 12-month period. With a 12-month incidence rate of 2.5 percent, agoraphobia is the least common anxiety illness. Females are more likely to be associated with higher intensity of symptoms and recurrent anxiety disorder than males with an approximate 2:1 ratio (Ohannessian et al., 2017; Narmandakh et al., 2021; Chand & Marwaha, 2022).

As a precursor to understanding how games can be a viable solution that targets anxiety disorders, different types of anxiety disorders are discussed, followed by a review of current treatment options.

2.2.1 DSM-V Perspective of Anxiety Disorders

Anxiety disorders as defined in Diagnostic and Statistical Manual of Mental Disorders 5th Edition - DSM-V (American Psychiatric Association, 2013) include separation anxiety disorder, selective mutism, specific phobia, social anxiety disorder, panic disorder, agoraphobia, generalized anxiety disorder, and substance/medication-induced anxiety disorder. Formerly in DSM-IV, we also have obsessive-compulsive

disorder (OCD) and post-traumatic stress disorder (PTSD), but they have been removed and made into separate categories in DSM-V. Table 2.1 shows a list of anxiety disorders along with the description (Chand & Marwaha, 2022).

Table 2.1 List of anxiety disorders

Anxiety Disorders	Description
Separation anxiety disorder	Individuals with separation anxiety disorder exhibit anxiety and fear that are out of character for their age and stage of development when separated from attachment figures. There is a continuous and excessive fear or anxiety about attachment figures being harmed, lost, or separated. The symptoms include nightmares and physical symptoms. The symptoms might persist throughout adulthood even though they are developed in childhood.
Selective mutism	This disorder is defined by a persistent failure to speak in social contexts where speaking is expected, despite the fact that the person speaks in other situations, can speak, and understands the spoken language. Young children are more likely to develop the disease than teenagers and adults.
Specific phobia	Individuals with specific phobias are terrified of or anxious about specific things or circumstances, which they avoid or endure with great fear or anxiety. The fear, anxiety, and avoidance are almost always instantaneous and tend to be persistently out of proportion to the real threat posed by the specific object or circumstance. There are several types of phobias: animal, blood-injection-injury, and situational.
Social anxiety disorder	This disorder is characterized by a strong or persistent fear or anxiety of being scrutinized in social circumstances. Individuals with this disorder are concerned that they will be negatively evaluated in such circumstances. They also fears being embarrassed, rejected, humiliated, or offended by others. These events can cause fear or anxiety and they are avoided or endured with great trepidation.

Table 2.1 List of anxiety disorders (continued)

Anxiety Disorders	Description
Panic disorder	Individuals with this disorder experience recurrent, unexpected panic attacks and are constantly concerned about having another panic attack. They also have maladaptive changes in their behaviour associated to panic attacks, such as avoiding activities and situations to prevent panic attacks from happening. Panic attacks are abrupt surges of intense fear or extreme discomfort that reach a peak within minutes, accompanied by physical and cognitive symptoms such as palpitations, sweating, shortness of breath, fear of going crazy, or fear of dying. Panic attacks can strike without warning and with no obvious trigger, or they might strike when you least expect them, such as in response to a feared object or circumstance.
Agoraphobia	Individuals with this disorder experience fear and anxiety in two or more of the following circumstances: taking public transit, being in open spaces, being in confined spaces such as shops and theatres, standing in line or in a crowd, or being alone outside of the home. They fear and avoid these situations because they are worried that escape may be difficult or help may not be available if panic-like symptoms or other incapacitating or embarrassing symptoms occur (e.g., falling or incontinence).
Generalized anxiety disorder	Individuals with this disorder have trouble controlling the persistent and excessive worry about various domains, including work and school performance. They may also experience feeling restless, keyed up or on edge, being easily fatigued, difficulty concentrating or mind going blank, irritability, muscle tension, and sleep disturbance.
Substance/medication-Induced anxiety disorder	This disorder involves anxiety symptoms caused by substance intoxication or withdrawal, or medical treatment.

2.2.2 Current Anxiety Disorder Treatments

Fortunately, anxiety disorders can be treated with pharmacotherapy and psychotherapy following appropriate treatment regimens and conforming to clinical practice guidelines (Bandelow et al., 2017). Pharmacotherapy is a type of therapy that treats disorders or diseases with pharmaceutical drugs. Profound knowledge and experience in biomedical, pharmaceutical, and clinical sciences are required to ensure medications are administered correctly while taking patients' circumstances and needs into consideration. The optimal dose for complete range coverage, the adequate duration for the trial period, and the correct diagnosis for the patient contribute to patient adherence to a treatment regimen. Meanwhile, substantial research has produced effective anxiolytic drugs, even though no novel therapeutic agent has emerged in the market for the last two decades (Murrough et al., 2015).

Problems arise when anxiety disorders are often misdiagnosed and result in treatment failures. Patients may also be unresponsive to treatment or fail to adhere to a complete course of drug treatment due to inappropriate prescriptions. Hence, researchers began to focus on psychotherapy as a treatment option. Psychotherapists assist patients in identifying and resolving their troublesome emotions, thoughts, or behaviours. Psychotherapy can work individually as an alternative to medication or work along with medication to address a patient's symptoms. Patients with anxiety may find psychotherapy useful as they usually require supportive talk and attention to the emotional problems that they are facing (Bandelow et al., 2017). Different kinds of psychotherapies exist for anxiety disorders, such as acceptance and commitment therapy (ACT), interpersonal therapy, and cognitive behavioural therapy (CBT). CBT is a popular psychotherapy treatment for anxiety disorders, as evidenced by several

controlled studies (Foreman & Pollard, 2016; Carpenter et al., 2018). As CBT is the most extensively studied of all psychotherapies and found to be effective in the treatment of anxiety disorders, we focused only on CBT in this research study.

2.3 Cognitive Behavioural Therapy

CBT is a time-limited, goal-oriented psychotherapy that attempts to regulate dysfunctional patterns of thinking and maladaptive behaviours through hands-on and practical approach (Høifødt et al., 2011; Hofmann et al., 2012). It is used to prevent the development of and maintain emotional distress for mental health problems, including depression and various anxiety disorders (Foreman & Pollard, 2016). CBT aims to help patients develop the ability to recognize, eliminate, and correct dysfunctional thoughts to cope better with different scenarios and reduce symptoms, thus improving daily functioning and remission of the disorder (Hofmann et al., 2012). CBT emphasizes three different aspects of cognition (Chand et al., 2022) that share common relationships with emotion and behaviour:

- 1) **Automatic thoughts:** Immediate and unpremeditated interpretations of events that shape an individual's present emotions and reactions. CBT studies unrealistic or exaggerated dysfunctional automatic thoughts modelled after the observations.
- 2) **Cognitive distortions:** Irrational thoughts that lead to erroneous conclusion in response to adverse events. Table 2.2 explains several cognitive distortions that have been identified along with the description (Chand et al., 2022).
- 3) **Underlying beliefs or schemas:** Core and intermediate beliefs for information processing about oneself or others, thus shaping the perception and interpretation of events.

Table 2.2 List of cognitive distortions and their description

Cognitive Distortion	Description
Dichotomous thinking	Viewing things in absolute terms and regarded as two mutually exclusive categories with no intersection in between.
Overgeneralization	Taking a single event or experience as an invariable rule to make wide generalization.
Selective abstraction	Focusing exclusively on a certain event that is usually negative while filtering out everything else.
Disqualifying the positive	Ignoring or invalidating positive experiences that conflict with the individual's negative perspectives.
Mind reading	Assuming the beliefs, thoughts, or intentions of others without asking for clarification.
Fortune telling	Predicting how things will unfold in a particular way before they happen.
Minimization	Minimizing positive experiences and accepting them as insignificant.
Catastrophizing	Exaggerating the situation to be the worst possible outcome, thinking that it is unbearable or impossible as opposed to the actual situation.
Emotion reasoning	Judging events or circumstances based on how one feels rather than the objective reality.
“Should” statements	Focusing on the “should”, “ought to be” or unattainable standards rather than the actual situation that one is facing.
Personalization, blame, or attribution	Assuming oneself or others to be entirely or directly responsible for a negative outcome.

2.4 Ellis' ABCDE Model

Ellis' ABCDE model outlines the importance of helping the patient to accept the rational beliefs and dispute the irrational beliefs (David et al., 2010). When it comes to the application of ABCDE model, Malkinson and Brask-Rustad (2013) explained that helping the patient to relate irrational evaluations on a trigger event and repercussions that may lead to emotional distress or conflict is the key to resolving

difficulties through proper disputation and achieving a more positive outcome. The principles behind the model include:

- 1) **Activating event (A):** Occurrence that leads to an emotional reaction
- 2) **Belief (B):** Interpretation or evaluation on the event
- 3) **Consequence (C):** Negative outcomes due to irrational beliefs
- 4) **Disputation (D):** Restructure the irrational beliefs
- 5) **Effect (E):** Assimilation of more rational beliefs

According to Foreman and Pollard (2016), events, beliefs, and outcomes interact with one another because the way we interpret a situation influences how we feel and react to it. In fact, people frequently allow their belief (B) about certain antecedences or activating events (A) to overly affect their emotional and behavioural responses, which subsequently lead to negative consequences (C). On that basis, such belief "B" represents the proximal source of dysfunctional emotions and maladaptive behaviours, which aligns with the underlying beliefs or schemas emphasized in CBT. A faulty belief caused by dysfunctional automatic thoughts will eventually lead to cognitive distortion that is harmful to both the individual and his/her surroundings. Hence, it is important to dispute (D) irrational beliefs and substitute them with effective rational beliefs to bring forth positive behavioural changes. As such, Ellis' ABCDE model correlates well with the cognitive aspects emphasized in CBT.

Traditional CBT is usually conducted in a limited number of sessions with the patient in the presence of the psychotherapist. Psychotherapists will attempt to assist patients in challenging their negative thoughts while providing advice during the sessions so that they can think in a more balanced and functional manner and subsequently overcome the self-defeating patterns. However, it is impossible for psychotherapists to constantly monitor each patient's progress or condition. They have

no control over a patient's situations outside of the CBT sessions, especially during an unanticipated anxiety attack. Patients with anxiety disorders become confused more easily compared to a normal person in unforeseen circumstances, and this further accentuates the importance of self-emotion regulation.

2.5 Cognitive Emotion Regulation

Emotion is a continuum of conscious and unconscious processes involving experiential, behavioral, and/or physiological changes that may also entail changes in subjective experience of emotion (Gross, 1999). Meanwhile, Thomson defined emotion regulation as:

“Emotion regulation consists of the extrinsic and intrinsic processes responsible for monitoring, evaluating, and modifying emotional reactions, especially their intensive and temporal features, to accomplish one's goal.”

(Thompson, 1994, p. 27)

We will focus on cognitive emotion regulation, which refers to the cognitive approach of handling emotionally arousing information. Cognitive emotion regulation is part of the broader concept of emotion regulation (Garnefski & Kraaij, 2007), in which nine conceptually distinct cognitive emotion regulation strategies (CERS) have been introduced, including self-blame, acceptance, rumination, positive refocusing, refocus on planning, positive reappraisal, putting into perspective, catastrophizing and blaming others. Table 2.3 shows all nine CERS and their description as defined in Garnefski et al. (2001).

Table 2.3 List of CERS and their description

CERS	Description
Self-blame	Thoughts of blaming yourself for what you have experienced.
Acceptance	Thoughts of accepting what you have experienced and resigning yourself to what has happened.
Rumination	Thinking about the feelings and thoughts associated with the negative event.
Positive refocusing	Thinking about joyful and pleasant issues instead of thinking about the actual event.
Refocus on planning	Thinking about what steps to take and how to handle the negative event.
Positive reappraisal	Thoughts of attaching a positive meaning to the event in terms of personal growth.
Putting into perspective	Thoughts of playing down the seriousness of the event or emphasizing its relativity when compared to other events.
Catastrophizing	Thoughts of explicitly emphasizing the terror of an experience.
Other-blame	Thoughts of putting the blame of what you have experienced on others.

Emotion regulation is intrinsically connected to human life and aids people in maintaining emotional control during or after the experience of threatening or stressful events. For example, we tend to blame ourselves or others when we experience a negative life event, or we may trap ourselves in an endless loop of negative thoughts by ruminating over the situation. The capability to regulate emotions through cognitions differs for everyone. Therefore, people are subject to emotion dysregulation in certain or multiple cognitive aspects.

2.5.1 Emotion Dysregulation in Cognitive Aspects for Anxiety

The definition of emotion dysregulation varies based on the scope of discussion. Several versions have been presented and discussed by Jazaieri et al. (2018). In this context, emotion dysregulation is operationalized as the inability of an individual to employ regulatory strategies involving cognitive processes to deal with emotionally arousing information. Emotion dysregulation can cause physical and mental symptoms that interfere with a person's daily functioning. As a result, it is critical to dispute negative emotions since acting on irrational impulses can cause harm to oneself and possibly others, whether through aggressive behaviour, hasty decisions, or deceitful liaisons. For example, the consequence of emotion dysregulation is apparent when people have arguments with one another, such as couples, due to conflicts like distrust and disagreement¹².

According to Mowrer (1947), people with anxiety disorders are more prone to experience heightened emotion intensity and are more vulnerable to the impacts of poor emotional responsiveness. As a result, people with anxiety disorders tend to divert their attention away from their anxiety when circumstances demand it, repressing their emotional experiences through avoidance mechanisms such as those described in Mowrer's two-factor theory (Mowrer, 1960a, 1960b; Feather, 1963), which exacerbates their ruminative worry distress (Wells & Papageorgiou, 1995). This situation fits the CERS criteria of rumination, and psychoeducation on effective emotion management is necessary to help people overcome the challenge and improve their cognitive emotion regulations. Although rumination has been studied more

¹ Source: <https://patient.info/forums/discuss/relationship-anxiety-ocd--753823>

² Source: <https://patient.info/forums/discuss/i-m-at-my-wits-end-385385>

commonly in relation to depression, Fresco et al. (2002) stated that rumination is associated with anxiety as well. In fact, emotion dysregulation in emotional understanding, dysregulated expression of sadness and anger, and ruminative responses to distress increase the risk for anxiety symptoms (McLaughlin et al., 2011), hence showing a clear relationship between rumination and emotion dysregulation in anxiety disorders.

Chan et al. (2015) showed that catastrophizing was a positive predictor of anxiety among male adolescents with high anxiety, and it mediated the effects of everyday hassles on anxiety. The same study also stated that both rumination and catastrophizing were positive predictors of anxiety among female adolescents. However, only catastrophizing but not rumination mediated the effects of everyday hassles on anxiety. Although gender differences do affect the result of the prediction, catastrophizing has persisted in both male and female adolescents that have severe anxiety. The study explained that people with catastrophic thoughts get fixated with the question "what if?" not to mention that they have the tendency to focus on the worst possible outcomes. Their overestimation of negative outcomes caused anxiety and made it difficult for them to manage future events. Meanwhile, Garnefski and Kraaij (2018) also claimed anxiety to be defined by thoughts about overestimating threats and harm. The findings in both studies conform to the idea of catastrophizing as an important factor of emotion dysregulation in anxiety disorders.

According to Suveg et al. (2010), an individual's capacity to respond adaptively in an emotionally evocative scenario may be impeded when the arousal level exceeds a certain threshold. This can potentially cause the individual to react in a maladaptive manner when exposed to high levels of negative emotional arousal for an extended period of time. Constant involvement in maladaptive emotion regulation will also lead

to ineffective emotion management and subsequently promote anxiety. The limited ability to manage, soothe, or temper oneself when exposed to negative emotional arousal hints at the lack of refocusing on planning. Indeed, Legerstee et al. (2011) reported that anxiety-disordered adolescents tend to use refocus on planning more often to cope with negative events. A recent study by Sacchi and Dan-Glauser (2021) found out that perceived unchanged use of planning led to an increase of negative emotions and anxiety symptoms. Conversely, anxiety symptoms had a reduction when more planning was adopted, even though the symptoms were not associated with the overall level of planning. In addition, the heightened use of planning was seen to have an effect on promoting positive emotions. As such, efficient coping in the form of refocusing on planning is of utmost importance to help keep the anxiety level at bay. This also shows that the lack of refocusing on planning is a core factor influencing emotion dysregulation in anxiety disorders.

Martin and Dahlen (2005) have also presented additional empirical evidence that individuals with anxiety symptoms scored significantly higher in CERS on self-blame, rumination, catastrophizing, and low positive appraisal in comparison to the healthy control group. The result is consistent with the research findings by Wells and Papageorgiou (1995) and McLaughlin et al. (2011) about rumination, and Chan et al. (2015) about catastrophizing. Table 2.4 summarizes all the findings from different research studies corresponding to CERS and offers a synthesis of knowledge in the psychology domain regarding anxiety disorders and emotion dysregulation. As prior studies have critically identified rumination, catastrophizing, and lack of refocus on planning to be particularly influential in anxiety disorders, it would be beneficial for a game intervention to focus on these three CERS.

Table 2.4 Emotion dysregulation and corresponding elaborations

CERS	Elaboration	Scholars
Rumination	Divert their attention away from their anxiety when circumstances demand it; repressing their emotional experiences through avoidance mechanisms which exacerbates their ruminative worry distress.	Mowrer (1947); Wells and Papageorgiou (1995)
	Rumination is among emotion dysregulations that increases the risk of anxiety symptoms.	McLaughlin et al. (2011)
Catastrophizing	Fixated on the "what if?" question and have the tendency to focus on the worst possible outcomes. Overestimation of bad outcomes causes anxiety and make it difficult to manage future events.	Chan et al. (2015)
	Anxiety is characterized by thoughts about overestimating threats and harm.	Garnefski and Kraaij (2018)
Refocus on planning (negative)	Individuals might react maladaptively when exposed to high levels of negative emotional arousal for a prolonged time. Ineffective emotion management promotes anxiety and limits the ability to manage, soothe, or temper oneself when exposed to negative emotional arousal.	Suveg et al. (2010)
	Perceived unchanged use of planning leads to an increase of negative emotions and anxiety symptoms.	Sacchi and Dan-Glauser (2021)

2.6 Game Intervention in Mental Health Treatments

As the world transitions to a more digital environment, health researchers have been paying close attention to digital health interventions (DHIs) such as eHealth and mHealth in replacing traditional treatment methods to explore innovations that can benefit the community. DHIs have potential to improve outcomes, widen access and meet the increasing demand on mental health services (Hollis et al., 2017). Moreover, multiple studies show that eHealth DHIs such as games, artificial intelligence (AI), and virtual reality have high feasibility and acceptability of remote technologies, potential to improve intentions to use services, improved accessibility, cost-

effectiveness in the long term, flexibility in terms of standardization and personalization, interactivity as well as plausible public engagements (Lal & Adair, 2014; Naslund et al., 2015; Apolinário-Hagen et al., 2017; Ferrari et al., 2020).

In addition, games are suitable for mental health interventions and can be leveraged for non-intrusive assessment of mental health, such as population screening or prevalence estimations (Mandryk & Birk, 2017, 2019). Ferrari et al. (2020) conclude that game interventions and solutions employ unique and experiential features that facilitate learning processes, coping strategies and skills while delivering more interactive and youth-friendly treatments. In the context of this study, Bevan Jones et al. (2022) suggest that digital technologies such as gamification and serious game can support young people with depression and anxiety, despite being challenging to do so. Therapeutic games can also provide CBT delivery support in real-world settings, which further strengthen the practicality and validity of game interventions in the mental health domain (van der Meulen et al., 2019). Moreover, game interventions are complementary to CBT sessions as it offers a form of psychoeducation that can be delivered for long-term care and recovery even without constant physical presence of a therapist.

2.6.1 Gamification

Gamification is defined as “the use of game design elements in non-game contexts” (Deterding et al., 2011). It focuses on game elements and characteristics such as narrative context, feedback, rule enforcements and parallel communication systems rather than the gameplay or playfulness. Gamification has emerged as a new trend in eHealth and mHealth and are gaining global popularity due to its cost-effectiveness,

accessibility, and flexibility. Cheng et al. (2019) categorized the reasons for applying gamification into two main themes: promotion of engagement with the intervention and the enhancement of the intervention's intended effects. A gamified solution can reduce barriers between target users and the app or technology to promote engagement, which subsequently increases the motivation to complete the treatment with less distress. A gamified solution is also more interesting and enjoyable than traditional treatment, as target users can gain a sense of achievement upon reaching the end goal. In terms of the intended effect enhancement, a gamified solution can promote attitude and behavioural changes more effectively and at a lower cost. In addition, target users can learn better in a stress-free setting, allowing them to sustain the behavioural change over time due to a stronger impression made by a gamified solution compared to the more rigid traditional treatment plans. These findings aligned with studies by Johnson et al. (2016) and Sardi et al. (2017) that gamification has the potential to improve motivation, communication, health behavioural changes, and well-being. In addition, Suleiman-Martos et al. (2022) showed that gamification can effectively reduce anxiety in children. Applications or programs implementing gamification include SuperBetter, SmartCAT2.0, Alcor, Agoraphobia Free, and Challenger App.

SuperBetter (SB) is a gamification program leveraging CBT and positive psychotherapy (PPT) targeting depressed people (Roepke et al., 2015). SB is also expected to reduce anxiety symptoms as the secondary outcome, which is reasonable given the high comorbidity of anxiety and depression. At the same time, both anxiety and depression also share some commonalities in treatment approaches. SB users interact with the program by gaining points and "levelled up" (see Figure 2.1) as they progress through the following activities: describe a goal (epic win), take recommended steps toward this goal (quest), complete recommended mood-boosting

activities (power-ups), directly address specific obstacles (battle bad guys), and enlist social support if desired (invite allies). There is also an optional feature of using the forum and recruiting Facebook social support (allies) during the intervention process. This explicitly provide a rationale for the importance of seeking help when they are in trouble. The program is user-oriented and increases resilience by improving protective factors while reducing obstacles to resilience. Instead of implementing traditional clinical therapeutic models (e.g., fixed number of sessions in each period), SB users engage in the intervention in a self-directed manner whereby they have the flexibility to manage their time and location. SB has been tested in a randomized controlled trial (RCT) and achieved its purpose by demonstrating significant improvements in user depression and anxiety symptoms after following the program.

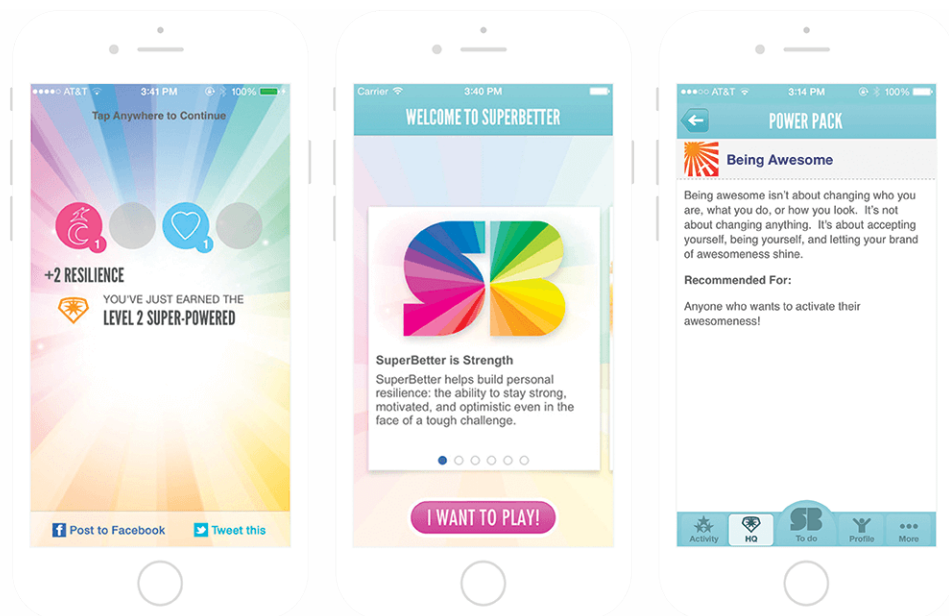


Figure 2.1 App view in SuperBetter

Source: <https://www.superbetter.com/>

Pramana et al. (2018) introduced SmartCAT2.0, a gamified version of an existing mHealth system called Smartphone-enhanced Child Anxiety Treatment (SmartCAT) for intervention in child anxiety treatment. SmartCAT2.0 is used as an

adjunctive component to CBT treatment in an open trial for childhood anxiety disorder (Silk et al., 2020). It consists of several interactive Skillbuilder Activities (see Figure 2.2) which reward users with digital points upon completion. Apart from that, users can also earn additional points by voluntarily completing additional activities. The points can then be used to redeem various rewards such as pens, accessories, and certificates. Users are also rewarded with digital trophies after finishing all required activities for each session. This reward system acts as an incentive to encourage participation. In addition, SmartCAT2.0 incorporate a messaging system that allows children to send messages to their therapist and ask therapy questions. This feature aims to support therapist-patient interaction beyond office visits and facilitate treatments through communication. SmartCAT2.0 has been evaluated in an open trial on the remission of anxiety diagnosis and reduction in anxiety symptomatology. The result is positive, whereby significant reduction has been observed in anxiety severity as well as child- and parent-reported symptom severity from pre-to-post-treatment.

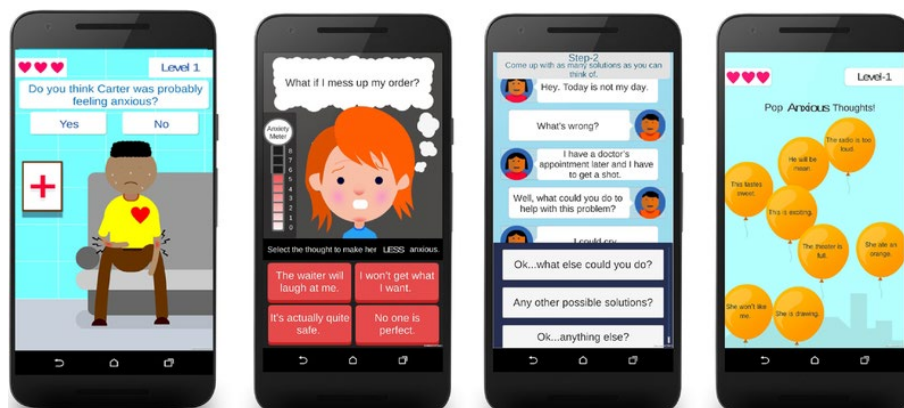


Figure 2.2 Interactive Skillbuilder games in SmartCAT2.0

Source: <https://pubmed.ncbi.nlm.nih.gov/32005341/>

Alvarez et al. (2008) introduced a gamified cognitive training program named **Alcor** for treating major depression and cognitive impairment among university students. The program consists of two parts: “Juego de las Series” (Series Game) for