Developing Digital Intervention Games for Mental Disorders: A Review

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Abstract

There is limited research on mental health interventions delivered in a digital game format and even less to guide developers on how to develop such games. This review focuses on understanding how to develop therapeutic digital games based primarily on mental health intervention games that have been empirically tested. The review was generated through database searches and backward search techniques for digital game-based interventions for specific mental disorders. We evaluated digital games that were based on validated psychological treatments. We located 24 studies and 18 games that met our search criteria. These games and their outcomes have been summarized. This review showed that these types of games have the potential to make an impact on mental health concerns but that there are currently few digital games available for the treatment or prevention of mental disorders. In addition, guidelines for digital mental health intervention game development have been presented. The consolidation of guidelines addressing multiple game development factors (e.g., time, cost, engagement) may help those interested in developing new therapeutic games that target a greater variety of disorders, thereby expanding access to larger populations.

Keywords: Review, Guidelines, Game development, Serious game, Mental health, Videogame

Introduction

DIGITAL GAMES HAVE gained mainstream appeal with the widespread availability of delivery platforms: computers, iPads, tablets, and smartphone gaming apps.¹ The videogame (VG) industry reports 150 million American users, with 44% being female and 27% being aged 50 or older.² Gamers play for the competition among friends, stress relief, and the challenge.³ The research focus on the negative impact of gaming⁴ (e.g., VG addiction in massive multiplayer online role playing games [MMORPGs], aggression in violent VGs such as first person shooter) has shifted to the positive impact of VGs over time.¹ Research points to cognitive, social, motivational, and emotional mechanisms through which gaming can be beneficial,⁵ contributing to a renewed interest in VGs as potential therapeutic games (TGs).

Research has emerged as TGs have become available.⁶ Many play VGs specifically for the purpose of mood repair/enhancement⁷ and certain commercial VGs may have the potential for mood repair.⁸ Some practitioners have investigated the

usefulness of commercial games or “casual games” for mental health intervention, such as “Lock-On: Modern Air Combat”⁸ for mood, “Tetris”^{9,10} for decreasing traumatic flashbacks, “The Sims Life Stories”¹¹ to engage adolescents in emotion regulation, “Left 4 Dead” (© 2008 Valve, USA)¹² for stress management, exergames (e.g., Nintendo® Wii™)^{13–15} for depression and attention deficit and hyperactivity disorder (ADHD), or MMORPGs (e.g., “World of Warcraft”)^{16–18} for depressive symptoms. Even simple puzzle games such as “Bookworm Adventure,” “Peggle,” and “Bejeweled” lead to improved mood and anxiety on self-report measures.^{19,20}

Granic et al.⁵ identify game types, reflecting the potential variety of games useful for mental health treatment. Depending on the skill and audience, games can be created on a continuum of complexity and social interaction. TGs can vary from simple puzzle-type games to more complex games involving additional components: fantasy, story genre, immersion into the game, level of interactivity, and story line development.⁵ Recent trends involve the creation and

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evaluation of “serious games” with a psychoeducational component designed to improve particular mental conditions.²¹

Serious games that are specifically designed as interventions or supplements to treatment have been delivered to people undergoing cognitive behavioral therapy (CBT),²² and experiencing depression, anxiety, stress, eating disorders, autism, driving phobia, or other conditions.^{13,23–30} Previously, VGs enhanced a relationship between therapists and adolescents.³¹

Methods

Search strategies

As the digital mental health intervention field is still in its infancy, we sought to review the literature on digital games based on validated traditional psychological interventions for mental disorders to generate a set of guidelines to aid game developers. Our search strategy is detailed in Figure 1, a flow diagram. In addition to database searches of articles published until December 2017, we examined the references of relevant review articles ($n=43$) and conducted Google searches. During database searches, the title and abstract were screened for eligibility. If the article could not be included or excluded based on this information, the full article was obtained and reviewed for inclusion. Two researchers reached a consensus on each study to determine inclusion.

Selection process

Inclusion criteria. We included articles that were (1) peer reviewed and (2) in the English language. The studies must have been empirical with a pre/postintervention statistical outcome on a psychological self-report measure. We included any digital game interventions (computer, mobile, tablet, Internet) developed for the purpose of intervening with a specific mental disorder.

Exclusion criteria. We excluded commercial videogames such as MMORPGs because we were more interested in games developed specifically for mental health diagnoses rather than for entertainment purposes. Likewise, exergames, many of which were commercially designed for the purpose of improving physical functioning and not on validated psychological interventions (see Li et al.³²), were excluded. We chose to exclude virtual reality (VR) games as they have a unique and complex game development process that is reviewed elsewhere.³³

Also, we excluded cognitive rehabilitation, educational, and social skills games because we were more interested in studying games targeting emotion management as opposed to cognitive processes such as executive functioning, attention, processing speed, memory, social cognition, language, or solely learning content. We also chose to exclude case studies.

Results

Over 100 studies were found (Fig. 1). Of these studies, $N=24$ were included and $N=18$ games located. See Table 1 for a summary of the studies.

Many of the currently reviewed TGs are based on biofeedback, CBT, and stimulus control for treating depression, anxiety, anger, ADHD, bulimia nervosa, and substance use. Certain mental disorders may be underrepresented in this review due to exclusions of cognitive rehabilitation (CR),

educational/social skills, and VR games. Many of the CR or educational games target disorders such as autism^{34,35} (see game development reviews^{36,37}), ADHD, dementia/neurocognitive impairment, schizophrenia,³⁸ and depression.³⁹ Similarly, VR games tended to treat anxiety disorders.^{40,41}

In other cases, we excluded games based on their descriptions. For example, “Think Feel Do,”⁴² noted in one TG review,⁴³ is attractive to children but the developers did not describe it as a game. The following is a brief discussion of the games and studies included in the review followed by game development guidelines based on these games.

Current games for mental disorders

Depression and mood. TGs have been developed to aid mood disorders and related conditions.⁴⁴ “SPARX,” a CBT game designed for adolescents with clinical depression, significantly improved depression, anxiety, and hopelessness with better remission rates than treatment as usual (TAU).^{45–48} “Rainbow SPARX” is a variant designed for diverse sexual orientations.⁴⁵ “SPARX” is a seven-level fantasy game with the goal of restoring balance by addressing the negative thoughts affecting the fantasy world. Another CBT fantasy game designed for adolescents with depressive symptoms is “The Journey,”⁴⁹ in which players travel through seven themed modules, earning points on completing each module. Rewards are simple mini-games. Compared to the attentional placebo, the intervention group had greater improvements in depression.

Unsurprisingly, many TGs, including those targeting depression, have focused on treatment for children. Several games that have been effective for depression use biofeedback. With this operant conditioning approach, the players’ physiology (heart rate, breathing, brain activity, and/or skin conductance measured through sensors attached to their body) controls or alters the gameplay. For example,²³ the biofeedback games “Freeze-Framer” and “Journey to the Wild Divine” are controlled by heart rate and skin conductance levels, which are monitored by sensors attached to the players’ fingers.

In “Journey to the Wild Divine,” players engage in meditation and breathing techniques to maintain lower physiological arousal levels, which manipulate music, imagery, and game goals such as building a fire, building a bridge, or shooting a bow and arrow.⁵⁰ “Freeze Framer” uses arousal levels to guide the activity of coloring a meadow or maneuvering a floating hot air balloon through a landscape.²³ These games significantly lowered posttest depression scores in the intervention group when compared with a control group.

Addiction and impulse control. TGs have been developed for controlling impulses in alcoholism, bulimia nervosa, and gambling disorder.

One intervention for treating alcoholism in military populations is the game “Guardian Angel.”²⁴ Functioning as an in-game practice environment, players hone skills such as managing cravings with feedback from a cravings meter, drink refusal in social settings, temptation avoidance through a driving-route planner, and individual resource development through “Go to therapy.” The player selects each of these through a series of mini-games. “Clean House,” a stimulus control mini-game, encourages the player to find and remove all alcohol-related items within 4 minutes. While players using the game showed lower scores on the Obsessive Compulsive

FIG. 1. Flowchart of inclusion/exclusion criteria and included/excluded studies.

TABLE 1. MENTAL HEALTH INTERVENTION GAMES WITH REPORTED OUTCOMES

<i>Author</i>	<i>Game</i>	<i>Sample</i>	<i>Outcome</i>
Amon and Campbell ⁵⁰	"Journey to the Wild Divine"	<i>N</i> = 36; with ADHD, <i>n</i> = 24; without ADHD <i>n</i> = 12 (9.5 mean age)	Significant improvement on ADHD questionnaire and strengths and difficulties questionnaire when compared to controls without ADHD.
Dennis-Tiwary and O'Toole ⁵⁶	"Personal Zen," app: ABMT and placebo	<i>N</i> = 78; no reported disorders; long training (45 minutes) ABMT <i>n</i> = 19; long training placebo <i>n</i> = 19; short training (25 minutes) ABMT <i>n</i> = 20; short training placebo <i>n</i> = 20 (21.28 mean age)	Long training ABMT reduced difficulty disengaging (TSST), state anxiety score (STAI), and stress reactivity compared to placebo; long training ABMT reduced threat bias but shorter version did not.
Dennis-Tiwary et al. ⁵⁷	"Personal Zen" (25 minutes), app: ABMT single session and placebo	<i>N</i> = 42; trait anxious; ABMT <i>n</i> = 19; placebo <i>n</i> = 23 (20.60 mean age)	A single session of ABMT improved the performance of females during an anxiety-related stress task and improved the neurocognitive response for males; no difference in self-reported anxiety (STAI).
Dillon et al. ⁵⁹	"Race and Relax," "The Loom," "Flow Free" (control)	<i>N</i> = 50; healthy adults with no significant anxiety; biofeedback-based intervention group <i>n</i> = 25; control group <i>n</i> = 25 (26.7 mean age)	Those in intervention group showed significantly reduced stress (VAS) and heart rate (wireless oximeter) when compared to the control group.
Fagundo et al. ⁵³	"PlayMancer/Islands"	<i>N</i> = 9 (all received treatment); all female with bulimia nervosa (CBT+PlayMancer); (30.6 mean age)	Binge eating, vomiting, and SCL-90 anxiety mean scores significantly decreased. EDI-2 subscales (bulimia and asceticism) improved.
Fernández-Aranda et al. ⁵²	"PlayMancer"	<i>N</i> = 38; bulimia nervosa patients; treatment (CBT+SVG) <i>n</i> = 20; control (CBT no SVG) <i>n</i> = 18 (29.5 mean age)	For patients with eating disorders, no statistical difference in outcomes (EDI-2, SCL-90 GSI, STAXI, STAI), although some reduced dropout rate in treatment group.
Fleming et al. ⁴⁸	"SPARX"	<i>N</i> = 32; depressed; treatment <i>n</i> = 20; wait-list control <i>n</i> = 12 (14.9 mean age)	Significant improvement in depressive scores (CDRS-R) and remission rates versus wait-list.
Kahn et al. ⁶⁵	"Rage Control"	<i>N</i> = 37; elevated level of anger and aggression; treatment <i>n</i> = 18; control (TAU) <i>n</i> = 19 (no mean age participants between 9 and 17)	Statistically significant differences in frequency of feeling angry (STAXI-CA) and greater heart rate improvements in intervention group over time.
Khanna and Kendall ⁶⁴	"Camp Cope-A-Lot"	<i>N</i> = 49; children with anxiety disorder; CCAL <i>n</i> = 16; ICBT <i>n</i> = 17; CESA <i>n</i> = 16 (10.1 mean age)	Significantly better results CSR and CGAS for children in ICBT or CCAL groups than for children in CESA.
Kassam-Adams et al. ⁶⁷	"Coping Coach"	<i>N</i> = 72; PTSS after the experience of an acute medical event; treatment <i>n</i> = 36; wait-list <i>n</i> = 36 (9.8 mean age)	Effect sizes showed potential for reducing post-traumatic stress; however, no significant differences between groups were found at posttest.
Knox et al. ²³	"Freeze-Framer"; "Journey to the Wild Divine"	<i>N</i> = 24; anxiety; intervention <i>n</i> = 12; control <i>n</i> = 12 (12.88 mean age)	According to STAI-C, MASC, and CDI, intervention group reduced anxiety and depression symptoms.
Lucassen et al. ⁴⁵	"SPARX-Rainbow"	<i>N</i> = 21; patients with depressive symptoms (16.5 mean age)	Significant improvement on depression (CDRS-R, RADS-II, and MFQ) from pretreatment to post-treatment.

(continued)

TABLE 1. (CONTINUED)

<i>Author</i>	<i>Game</i>	<i>Sample</i>	<i>Outcome</i>
Marsac et al. ⁷⁴	"Coping Coach"	<i>N</i> =42; PTSS prevention after an acute medical event; prototype I <i>n</i> =9; prototype II <i>n</i> =33 (9.89 mean age)	More Americans than Australians rated engagement and acceptability higher.
Merry et al. ⁴⁶	"SPARX"	<i>N</i> =143; clinical depression; TAU <i>n</i> =83; "SPARX" training <i>n</i> =69 (mean age unavailable)	For children's depression (CDRS-R), SPARX' reduction was greater by a marginally significant amount, while reductions in hopelessness, mood, anxiety, and remission rates were all significantly greater for the SPARX group than the TAU group.
Pham et al. ⁵⁸	"Flowy"	<i>N</i> =63; clinically anxious; intervention <i>n</i> =31; control <i>n</i> =32 (no mean age—ages ranged from 18 to 65+, majority of the sample was between 18 and 34)	Intervention participants showed statistically significant improvement in quality-of-life measures (Q-LES-Q-SF) and hyperventilation compared to control group but did not show significant differences in anxiety (GAD-7). However, panic (PDSS-R) did improve over time, but not in comparison to the control group.
Poppelaars et al. ⁴⁷	Computerized CBT program "SPARX"; school-based CBT program "Op Volle Kracht"	<i>N</i> =208; subclinical depression; CBT-OVK <i>n</i> =50, SPARX <i>n</i> =51; OVK and SPARX <i>n</i> =56; control <i>n</i> =51 (13.35 mean age)	According to RADS-II, depression symptoms for all conditions reduced but no significant difference between conditions.
Scholten et al. ⁶²	"Dojo"; "Rayman 2: The Great Escape" (control game)	<i>N</i> =138; above at-risk for anxiety; Dojo <i>n</i> =70; Rayman control <i>n</i> =68 (13.64 mean age)	On the SCAS, equal improvements in anxiety symptoms for both control and Dojo but no significant differences.
Schoneveld et al. ⁶⁰	"MindLight"	<i>N</i> =136; children with elevated anxiety; MindLight <i>n</i> =69; control game <i>n</i> =67 (9.95 mean age)	Significant reduction in anxiety (SCAS) reported by children and parents, but no difference in magnitude between conditions.
Shandley et al. ²⁷	"Reach Out Central"	<i>N</i> =266; no reported diagnosis (20.5 mean age)	Seeking social support (CSI-SS) and problem-solving (CSI-PS) improved for both males and females; however, females had significant increases. Resilience scores (RS) and satisfaction with life (SWLS) improved for females but worsened for males. AUDIT means were higher for males on alcohol use. Females reported higher psychological distress on the K10.
Stasiak et al. ⁴⁹	"The Journey"	<i>N</i> =34; patients with depressive symptoms; cCBT <i>n</i> =17; attention placebo <i>n</i> =17 (15.2 mean age)	Significant reductions on depressive symptoms (CDRS-R), but not on RAD-II, and problem-solving skills (ACS) significantly improved for a computer-based CBT program when compared with an attention placebo (CPE) program.

(continued)

TABLE 1. (CONTINUED)

<i>Author</i>	<i>Game</i>	<i>Sample</i>	<i>Outcome</i>
Tárrega et al. ⁵⁴	"PlayMancer"	<i>N</i> = 16; gambling disorder (34.8 mean age)	Significant improvements on many measures: SOGS, BIS (Cognitive impulsiveness, Unplanned impulsiveness, Total), I7: Impulsivity, STAI: Trait, SCL-90 (Hostility, Depression, Anxiety, General Severity Index, Positive symptom total), STAI-ST, TCI: Novelty Seeking.
Verduin et al. ⁵¹	"Guardian Angel"	<i>N</i> = 41; alcohol abuse or dependence; slides group <i>n</i> = 22; games group <i>n</i> = 19 (51.2 mean age)	Greater improvement on the OCDS and TSSE-RP but no differences in relapses.
Yahav and Cohen ⁶¹	Biofeedback-based, relaxation-training computer game; Plus in person CBT	<i>N</i> = 255; ninth grade students from Arab and Jewish high schools; Arab intervention group <i>n</i> = 68; Arab control group <i>n</i> = 56; Jewish intervention group <i>n</i> = 58; Jewish control group <i>n</i> = 73 (mean age for intervention groups = 14.6 Jewish and 14.7 Arab; mean age for control groups = 14.6 Jewish and 14.8 Arab)	Intervention groups demonstrated reduced state anxiety (STAI) and behavior symptoms, as well as increased self-esteem (Rosenberg Self-Esteem Scale), when compared with control groups. Both Arab and Jewish students improved in the intervention groups, but the Arab students had higher rates of improvement.
Zielhorst et al. ⁶⁶	"Dealing with Others"	<i>N</i> = 85; Burnout syndrome; GO <i>n</i> = 27; GT <i>n</i> = 17; Therapy Only <i>n</i> = 20; No Game or Therapy <i>n</i> = 21 (40 mean age)	Over time and by treatment there was improvement in combined disengagement and precursive symptoms. Precursive symptoms for GT, GO, TO conditions decreased, especially the GT, TO conditions. There was a significant improvement over time and condition for coping skills.

ABMT, attention bias modification training; ACS, Adolescent Coping Scale; ADHD, attention deficit/hyperactivity disorder; AUDIT, Alcohol Use Disorder Identification Test; BIS, Barratt Impulsiveness Scale; CBT, cognitive behavioral therapy; cCBT, computerized cognitive behavioral therapy; CCAL, "Camp Cope-A-Lot"; CDI, Children's Depression Inventory; CDRS-R, Children's Depression Rating Scale—Revised; CESA, computer-linked education, support, and attention; CGAS, Children's Global Assessment Scale; CPE, computer administered attention placebo program with psychoeducation; CSI-PS, Coping Strategy Indicator—Problem Solving; CSI-SS, Coping Strategy Indicator—Seeking Social Support; CSR, Clinician-Rated Severity; EDI-2, Eating Disorder Inventory-2; GAD-7, Generalized Anxiety Disorder-7; GO, Game Only; GSI, Global Severity Index; GT, Game+Therapy; I7: Impulsivity, I7 Impulsiveness Questionnaire; ICBT, individual CBT; K10, Kessler Psychological Distress Scale; MASC, Multidimensional Anxiety Scale for Children; MFQ, Mood and Feelings Questionnaire; OCDS, Obsessive Compulsive Drinking Scale; OVK, Op Volle Kracht; PDSS-R, Panic Disorder Severity Scale—Self-Report; PTSS, Post-Traumatic Stress Symptoms; Q-LES-Q-SF, Quality of Life Enjoyment and Satisfaction Questionnaire—Short Form; RADS-II, Reynolds Adolescent Depression Scale—Second Edition; RS, Resilience Scale—Short Form; SCAS, Spence Children Anxiety Survey; SCL-90, Symptom Checklist-90; SOGS, South Oaks Gambling Screen; STAI, State-Trait Anxiety Index; STAI-C, State-Trait Anxiety Inventory for Children; STAI-ST, State-Trait Anxiety Inventory—Spanish Translation; STAXI, State-Trait Anger Expression Inventory; STAXI-CA, State Trait Anger Expression Inventory—Child and Adolescent; SVG, serious videogame; SWLS, Satisfaction with Life Scale; TAU, Treatment as Usual; TCI, Temperament and Character Inventory—Revised; TO, Treatment Only; TSSE-RP, Task Specific Self-Efficacy for Relapse Prevention Questionnaire; TSST, Trier Social Stress Test; VAS, Visual Analogue Scale.

Drinking Scale (OCDS) and higher self-efficacy, relapse rates did not differ between game players and a control group who viewed educational slides.⁵¹

Researchers have also tested the effect of “Reach Out Central” on alcohol consumption.²⁷ The game involves playing a character who must navigate the challenges of being new in town. “Reach Out Central” helps younger adults identify and develop practical stress coping skills. While improvements occurred in areas such as problem-solving, seeking support, and resilience, researchers did not find significant differences in alcohol consumption across time.

Similarly, “PlayMancer,” a biofeedback game, was developed to treat impulse-related disorders.^{25,52} Physiological responses (heart rate, galvanic skin response, breathing frequency) determine obstacles and difficulty level as players tackle mini-games targeting problem-solving, impulse control, confrontation of frustrating situations, and negative emotion management.

When tested as a supplement to CBT for bulimia nervosa, use of “PlayMancer/Islands” led to improved emotion regulation and decreased impulsivity.⁵³ This consisted of three mini-games: “Face of Cronos” (obstacles appear based on arousal while climbing a cliff), “Treasures of the Sea” (collecting fish and artifacts while swimming and maintaining oxygen based on arousal), and “Sign of Magupta” (connecting stars in constellations based on breathing control). “PlayMancer” has also been used as an adjunct for CBT for gambling disorder with positive outcomes on a gambling self-report measure, the Symptom Check List-90, and subscales of an impulsivity and anxiety assessment.⁵⁴

Anxiety and stress. People use games for recovery to disengage from work, relax, and gain mastery and control.⁵⁵ “Personal Zen,” a game version of attentional bias modification, which implicitly trains participants to attend away from negative stimuli (in this case, angry faces), has significantly reduced state anxiety and stress reactivity.⁵⁶ The goal of this game was to trace the trail left by one of two sprites (the nonthreatening one) after both burrow into the grass. Different colored jewels are awarded depending on response speed and accuracy. Delivery as an app on a mobile device makes it highly accessible. A second study using this game⁵⁷ for 25 minutes (vs. 45 minutes in the previous study) found improved performance during a stressor for some but no changes in self-reported anxiety, suggesting the importance of length of play.

Another mobile app, “Flowy,”⁵⁸ is a breath-retraining game developed specifically for anxiety, panic attacks, and hyperventilation management. The game is operated (e.g., a sailboat moves down river or balloons fly into the sky through a series of mini-games and levels) where players press the mobile phone screen when inhaling and let go when exhaling. Perhaps attaching a breath-monitoring device to the phone would improve panic and hyperventilation overtime as these were not significantly different from the waiting list group.

“Loom” and “Relax and Race,” mobile phone game applications that used an electrodermal sensor to monitor skin conductance and heart rates, found significantly improved levels of stress and heart rate when compared with the control group “Free Flow.”⁵⁹

“MindLight,” a neurofeedback, CBT, and attentional bias modification training (ABMT)-based game approach, resulted

in improvements in anxiety over time but not when compared with “Max and the Magic Marker.”⁶⁰ In “MindLight,” players use a one-channel dry sensor headset that converts EEG waves into the amount of light coming from the avatar’s headset. Players create more or less light based on how relaxed they are navigating a dark haunted mansion and overcoming anxiety-inducing experiences to rescue the grandmother. The ABMT component encourages children to attend to the smiling faces over the negative faces.

Other biofeedback games, “Journey to the Wild Divine” and “Freeze-Framer,” lead to significantly lower self-report and trait anxiety scores compared to the waiting list group.²³ Improvements in state anxiety and self-esteem have also been noted with a combination intervention: in-person CBT plus a biofeedback game that used two electrodes on the fingers to measure electrodermal activity.⁶¹ Limited information was provided about this game.

Another game using biofeedback, “Dojo,” found that improvements in anxiety were not greater than those made by playing a non-TG, “Rayman 2”; the researchers did find, however, a steeper decline in personalized anxiety symptoms for adolescents who played “Dojo” rather than “Rayman 2.”⁶² In “Dojo,” after initial training in deep-breathing, progressive muscle relaxation, positive thinking, and guided imagery, the player engages in emotion-inciting puzzles that increase in difficulty based on heart rate variability monitored via sensors attached to the player’s fingers.⁶³

Other anxiety and anger management games have relied on CBT as the primary change mechanism. “Camp Cope A Lot,”⁶⁴ a multicomponent CBT game (relaxation, VGs, exposure) delivered with the therapist and at times the parent, resulted in improvements in anxiety. “Rage Control,”⁶⁵ with gameplay elements similar to the classic arcade game “Space Invaders,” relies on heart rate arousal levels via sensors on the players’ fingers to help children regulate emotions; higher arousal led to an inability to attack aliens. When paired with therapist-administered CBT, those treated had better anger and emotional control than TAU.

In addition to anxiety and anger, many TGs target general life stress. Using CBT, “Dealing with Others,” when combined with therapy, was found to improve coping skills for burnout syndrome more than therapy alone.⁶⁶ “Dealing with Others” trains individuals to assertively communicate with coworkers and offers positive thoughts about themselves or society. Difficulty levels increase as players gather points.

Another CBT game, “Coping Coach,” is a web-based game for children to prevent posttraumatic stress disorder (PTSD) after a medical event.^{67,68} “Coping Coach” directs children to create faces to match their feelings, to help game characters learn cognitive restructuring, and to understand why characters avoid situations. While effect sizes indicate the potential to reduce post-traumatic symptomology, there were no significant differences between the treatment and a wait-list control.⁶⁷

Attention deficit and hyperactivity disorder. “Journey of the Wild Divine” has also been evaluated with children diagnosed with ADHD.⁵⁰ The experimental group had reductions in ADHD behaviors. The game uses imagery and music based on biofeedback. Goals are accomplished if breathing is slow and deep. For example, one may build a bridge, which will disappear if breathing becomes too fast and reappear

when slow again. Most ADHD TGs target CR, particularly executive functioning, and are reviewed elsewhere.⁶⁹

Guidelines for therapeutic game development

Before embarking on TG development, one must account for three key issues. First, game designers need to possess a good understanding of the disorder, theoretical underpinnings of the intervention, and VGs.²⁴ Second, the cost is frequently substantial, with the cheapest reviewed game costing around \$25,000 to develop.²² Other reviews provide more technical information on developing games.^{70,71} Third, the technology platform (computer, smartphone, tablet, RGB-D) can make a substantial difference in treatment outcomes as seen in one emotion regulation study.⁷² In addition to these basic requirements, we consolidated a set of guidelines enumerated by researchers and reviewers as best practices of their experiences (refer to Table 2).

TABLE 2. GUIDELINES FOR DEVELOPING DIGITAL MENTAL HEALTH INTERVENTIONS

Engagement	
(1) Characters and gameplay should relate to the patient. ^{24,27}	
(2) Gameplay must be motivating, interesting, and engaging. ^{5,7,24,84,85}	
(3) Length of gameplay must be not too long or short. ⁸	
(4) Game must have immediate feedback. ⁵	
(5) Game must be easy to play. ²⁷	
(6) Game should have a large base of novel stimuli or situations. ²⁷	
(7) Use social media to improve motivation. ²⁷	
Accessibility	
(8) Game must be easily accessible. ^{5,27,30,31}	
(9) The game must work in the treatment environment. ^{22,24}	
(10) Game is more effective if accessible by phone. ³⁰	
Consistency with treatment	
(11) Develop with your patient in mind. ^{24,25}	
(12) Game design and play should be conceptually sound, in terms of best practices for both therapy and training. ²⁴	
(13) Game must have clearly defined and implemented learning goals. ^{24,60}	
Generalizability	
(14) Game must conform to a high degree of realism and immersion. ^{5,24}	
(15) Too much or too little input of the player can affect the usefulness of the intervention. ⁸	
(16) Game content has real-world problems. ^{23,27}	
Effective skill building	
(17) In order for true skill development to occur, a game-based environment must have the learner work through the three stages of skill acquisition: cognitive, associative, and autonomous. ²⁴	
(18) Gameplay must be frequent yet not excessive. ^{24,27}	
(19) Game has difficulty level that adjusts to the player. ⁵	
(20) Game must be interactive with moderate task demand. ^{7,84}	
General advice for developers	
(21) Plan for the cost of creating game, which can be as low as \$25,000. ²²	
(22) Game designers should be well versed in subject matter and videogames. ²⁴	

Games are useful supplements to therapy⁷³ as their activities may be more motivating for clients than traditional therapy.³¹ Well-designed TGs are based on the same principles as therapy, but also provide convenient and engaging treatment access, as seen with “Coping Coach.”⁷⁴ The most common recommendations for increasing the frequency of supplemental practice involve games being convenient, accessible, engaging, and soundly based.^{5,24,25,27} Games should be relatable to the individual, be immersive to accurately represent real-world challenges, and be able to scaffold ability by progressing through stages of skill development.^{5,23,24,27}

Engagement. People play games for competition, challenge, social interaction, diversion, fantasy, and arousal.⁷⁵ TGs using these criteria can successfully engage clients in skill practice. Games incorporate many strategies to enhance engagement, including immersive characters and stories (e.g., “Reach Out Central”), immediate goals such as level completion (e.g., “SPARX”), and points for successful activities (e.g., “Personal Zen”).^{25,27,56}

Accessibility. Another key characteristic of TGs is increased accessibility to users.^{5,27,31} The primary purpose of TGs is to practice skills without the presence of a therapist. Expensive, inaccessible games would not be nearly as effective in encouraging continued use as affordable, portable games.

Accessibility may actively encourage use through explicit reminders such as app-based push notifications or by more frequent encounters. Therefore, researchers^{56,58} may favor web-based games or smartphone applications, especially with the rise of smartphone users.⁷⁶ For example, “Virtual Hope Box,” a smartphone app with individualized coping tools, including casual games, was used more frequently than a conventional hope box method by patients at risk of suicide and self-harm.⁷⁷ In fact, the Veterans’ Administration is introducing mobile mental health interventions to improve accessibility to the military.⁷⁸ Promising new studies indicate the potential for biofeedback to occur via mobile devices.^{59,79}

Consistency with treatment. In addition, TGs must be founded on evidence-supported treatments. For example, the reviewed TGs are based on biofeedback, CBT, and stimulus

TABLE 3. PROMISING INTERVENTION GAMES NOT YET EMPIRICALLY TESTED

Game	Target problem
“Ricky the Spider” ⁸⁶	Pediatric obsessive compulsive disorder
“Treasure Hunt” ²²	Mental disorders
“Depression Quest” ⁸⁷	Depression
“The Cat Lady” ⁸⁸	Depression
“Headspace” ⁸⁹	Anxiety/stress
“gNats Island” ⁹⁰	Depression
“Maya” ⁹¹	Depression
“Walk in My Shoes” ⁹²	Post-traumatic stress disorder
“Personal Investigator” ⁹³	Distress
“Pogo’s Pledge” ⁹⁴	Psychosis recovery
“Plan It Commander” ⁹⁵	ADHD
“Crystals of Kaydor” ⁹⁶	Emotion regulation

control, which could potentially complement ongoing psychotherapy.⁵⁰ As in “MindLight,”⁶⁰ game designers must ensure that thought processes and behaviors stimulated by game play are compatible with therapy goals.

Generalizability. Beyond matching treatment rationale, games should also translate to real-world situations. A game that is highly realistic is likely to inspire high levels of immersion and cognitive states associated with emotions of virtual task.⁸⁰

Game designers have also noted the importance of realism to increase transfer-of-training to real-world scenarios. For example, the designers of “Guardian Angel” purposefully created characters that “almost identically” represented the clients for whom the game was designed.²⁴ They further note that the game should account for the client’s characteristics, as players may have different motivations, reading levels, and motor control. Game and scenario types may affect certain populations differently (e.g., females improving more in “Reach Out Central”²⁷). Another key for immersion is to incorporate real-world problems.^{23,27} As such, VR games are likely to be generalizable.

Effective skill building. TGs should promote successful skill building through practice to increase skill longevity. This involves creating a game that stays within players’ “zone of proximal development” through moderate task demand⁸ or through game difficulty levels adjusted to individual players.⁵ Bowers et al.²⁴ consider three different phases of learning as players proceduralize game techniques: cognitive, associative, and autonomous. Guiding players to generate automatic responses is integral to personal growth.

Aside from skill building, task demand affects how people choose what game to play,⁸ with moderate task demand increasing game play. In turn, increased game play likely leads to greater practice and gains. Moderate task demand also likely facilitates automatization of skills that, before play, are somewhat effortful and controlled.⁸

Time and cost. Based on our own experience and that of others,⁸¹ VG development may take 3 years, which may not include beta testing of the game. Game cost can vary based on complexity and graphic detail, with Baranowski and colleagues estimating millions of dollars for a high-end product. The challenge of TG development in academic settings includes gaining initial development funding and subsequent funding for evaluating efficacy. Unfortunately, research funding first requires feasibility data.

This lengthy research process becomes an impediment to technology-based research. The discrepancy between rapid technological change and the time needed to develop and evaluate TGs results in developers releasing games to the public before formal empirical testing (e.g., “Ricky the Spider” for pediatric obsessive compulsive disorder [OCD]²²). This seems to be a trend mirrored with behavioral health mobile apps.⁸²

Potential limitations for TGs. While research suggests the benefits of integrating TGs into clinical practice, some potential limitations exist. TGs may require an investment of time for the participants. Clinicians should consider diagnosis severity and social support availability when using TGs. For example, those with depression should be monitored and a clinician closely

involved to mitigate risk of suicide or self-harm. Currently, TGs do not have empirical support as stand-alone treatments for any mental health condition. Guidelines should be established on which games require the presence of a therapist, especially for biofeedback and neurofeedback games.

Conclusion

Many TGs are based on a limited number of psychological interventions (e.g., biofeedback, CBT) for a limited range of mental disorders. However, future games could be based on other psychotherapies such as exposure, acceptance and commitment therapy, or mindfulness and for other mental disorders. Several promising TGs are yet to be evaluated empirically for emotion management (Table 3). Future studies should include more diverse samples as many of the reviewed studies ($n=14$) evaluated adolescents and children. Game design can be adjusted for older demographics.⁸³ Few empirically validated TGs exist for mental disorders. The guidelines summarized through our review may simplify and strengthen future TG creation. Using TGs as treatments or treatment adjuncts may increase options for clients, decrease barriers to care, and overcome stigma.

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