

The Effectiveness of Serious Video Games on Mental Health Related Outcomes: Systematic Review

Oleksandra (Sasha) Danilina

University College London
London, UK, WC1E 6BT

oleksandra.danilina.15@ucl.ac.uk

Andres Fonseca

University College London
London, UK, WC1E 6BT

a.fonseca@ucl.ac.uk

Anna L. Cox

University College London
London, UK, WC1E 6BT

anna.cox@ucl.ac.uk

Sonia Johnson

University College London
London, UK, WC1E 6BT

s.johnson@ucl.ac.uk

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Abstract

Therapeutic serious video games are advancing rapidly in the field of mental health, targeting a number of psychiatric conditions. However, little is known about the impact of these games on mental health symptoms. We conducted a systematic review of papers reporting studies of the effectiveness of serious video games on mental health related outcomes. Results suggest that serious video games for intellectual disabilities and psychotic disorders, targeting cognitive symptoms seem to have the most potential, while serious video games for anxiety tend to show less impact, especially in randomised control trials. There are as yet unrealized opportunities for designers to create serious game mental health interventions for a wider range of audiences and delivery platforms.

Author Keywords

Mental health; systematic review; serious video games; work in progress.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

1. Introduction

According to the Adult Psychiatric Morbidity Survey (APMS) 17.5% of working-age adults (16–64 years old) had symptoms of mental health problems in 2007 [42].

Furthermore, every week, one in six adults experiences symptoms of a common mental health problem, such as anxiety or depression. Although a number of psychosocial interventions like Cognitive Behavioural Therapy (CBT) have been shown to be effective in alleviating symptoms of mental health problems, there is a still noticeable gap in treatment provision [31]. This limitation of the traditional model for the delivery of care has been tackled via the introduction of an online version of CBT (known as cCBT) and other low intensity e-mental health interventions. However, although the effectiveness of computerized interventions has been demonstrated in a controlled environment, there is a significant problem in translating these results into a real-life practice. The main issue has been attrition and high levels of disengagement among patients [33;35].

In order to address the problems above, research has turned towards serious video games and gamification as potential ways of engaging patients in cCBT, while being equally as effective as traditional treatment delivery methods) [48; 20]. Over the past 5 years the number of serious video games for mental health has been on the rise, with more games emerging every year. Despite being feasible and acceptable, there is a lack of evidence of the effectiveness of these games as to date, few serious games for mental health have been tested and studied in a systematic way. An exception is a meta-analysis by Lau et al [25] that identified 8 different games that were used in 10 randomised controlled trial (RCT) studies. They found a mean moderate effect size of these serious video games for reducing psychiatric disorder-related symptoms. Their findings were consistent with previously conducted systematic research into depression [17;26] and cognitive training, that included ADHD, ASD and dementia-focused serious video games [28]. Unfortunately, there are no

other systematic reviews or meta-analyses that look at the effectiveness of serious video games on common and serious mental health conditions.

The contribution of this paper is a systematic evaluation of the evidence that serious video games are effective in engaging patients in treatment protocols and in improving mental health related outcomes (including symptoms associated with a particular mental health disorder, measures of quality of life, or measures of functioning). Our findings demonstrate that serious video games seem to be as effective as treatment as usual (TAU) in improving cognitive symptoms of various disorders including ADHD, ASD and psychotic disorders like schizophrenia. Disorder-specific symptoms are more likely to be improved in games that aim to tackle depression, suggesting that serious video games like *SPARX* are as effective as TAU. However, serious video games have only a limited effect on anxiety related disorders. We present this contribution by outlining existing quality of the evidence and providing a descriptive summary of the level of effectiveness of serious video games on mental-health related outcomes.

2. Research Method

2.1 Aims

Our principal aims are to determine:

1. which mental health conditions are being treated by serious games
2. which audiences are being targeted
3. which platforms are being used for delivery of serious games for mental health
4. whether there is evidence that serious games for mental health are effective in engaging patients in their treatment protocol

5. whether there is evidence that games are effective in treating mental health conditions

2.2 Review Protocol

The following section describes the data databases, the search strategy, and finally the requirements for data inclusion and exclusion. The full protocol is available at https://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42017058074

2.2.1 DATABASES

The following databases were searched: MEDLINE (Ovid interface); PsychINFO (Ovid interface); CINHALL (Ebsco interface); CMCH; EMBASE (Ovid interface); Web of Science; and ACM digital library.

2.2.2 SEARCH TERMS

Our search can be broken down into three parts: search terms that define “serious video games”, “mental health related outcomes” and “effectiveness”. Search terms above from the three categories were linked together via **AND** boolean.

2.2.3 STUDY SELECTION

The following inclusion and exclusion criteria were applied to the search:

Inclusion Criteria

- The intervention described is a serious video game
- The serious video game is designed to treat mental health disorders, including co-morbid conditions that include both physical conditions and mental health conditions.
- The paper must report the outcome of the study (effectiveness of intervention) for the treatment of a mental health condition.

- There is a sufficient description of the game that allows us to extract a description of the key features of the serious game.

Exclusion Criteria

- Not a serious video game i.e. paper describes gamified intervention. (Researchers define “gamification” as the use of game design elements in a non-game context in order to motivate and engage. This means that a gamified intervention uses elements of the game however it is not a game itself.)
- Participants do not have a psychiatric diagnosis or subclinical symptoms, or the study is designed to treat physical conditions, there is no co-morbid mental health condition

2.2.4 QUALITY ASSESSMENT

Studies included in the systematic review vary in terms of study design, methodology and quality of evidence. For example, RCT’s tend to have the least biases that could potentially underinflate or overinflate the result due to rigorous methodical guidelines and therefore the quality of evidence from these trials is the highest. We have used a modified Downs and Black rating scale for the quality assessment. The modified checklist consists of 27 items with “yes-or-no” answers, distributed between 5 subscales – reporting, external validity, bias, confounding, power. Items can score either 0 (no/unable to determine) or 1 (yes). The maximum score is 28. Each paper was assigned a grade of “excellent” (24–28 points), “good” (19–23 points), “fair” (14–18 points) or “poor” (<14 points).

3. Results

Our search identified 13,369 papers. After removing duplicates 6,018 papers remained. Of these 5,971 were removed based on screening of title and abstract. The remaining 47 articles were considered and assessed as full texts. Of them 20 did not pass the inclusion and exclusion criteria. 27 eligible studies remained and were individually

assessed for this review. The study selection process is reported as recommended by the PRISMA group [36]. Systematic review identified 20 unique serious video games.

3.1 Engagement

Engagement was measured by attrition and dropout reports. Dropout rate was reported clearly in 14 studies out of 27. On average, the dropout rate was higher in quasi-experiments and multiple case control studies (mean dropout rate is 21%). RCTs tended to have lower rates of dropout post treatment (3.86%) and on subsequent follow ups (10.32%).

The highest dropout rate was reported in study on serious video game *Flowy* (42%). The lowest dropout rates were reported in study on game *BrainGame Brian* (post-treatment 3.4%, follow up 9%, [10]) and *SPARX* (post treatment 3.9%, follow up 7.9 %, [42]).

3.2 Quality Assessment Data

Out of 27 papers, 13 papers (46%) were categorized as providing a "Fair" amount of evidence, it is worth noting that the majority of papers scored 18 points, meaning that their quality assessment score was on the brink of being labelled as "Good". Furthermore, 7 papers (27%) were categorized as providing a "Good" amount of evidence and 5 papers (20%) were categorized as providing an "Excellent" quality of evidence. Only 2 papers (7%) were categorized as providing "Poor" quality of evidence. According to O'Connor [39], in quality assessment tool by Downs and Black, if a paper scored "Fair" then it does not meet all criteria stated in the tool but is judged to have no serious flaw that may compromise results.

3.3 Effectiveness Data

This section reports the effectiveness of games designed to treat particular mental health disorders.

3.3.1 BULIMIA NERVOSA

The game *Playmancer* was used for training in bulimia nervosa patients [13]. An initial multiple case study found that using the game as an adjacent tool to CBT resulted in a decrease in the number of binges, vomiting and anxiety. However, a larger quasi-experiment compared *Playmancer* with a typical treatment for patients with eating disorder (CBT) and only found significant improvements on general psychopathology scale (SCL-90-PST) [16]. However, the risk of dropout was higher for CBT alone, suggesting that serious video game use increased adherence.

3.3.2 ANXIETY

Mindlight was compared to a commercial videogame in an RCT with the aim of reducing anxiety symptoms in a subclinical population of children and adolescents [46] The results showed that both video games significantly reduced levels of anxiety in participants, however there was no statistical difference between two conditions.

Similarly, *Dojo* was compared to another commercial video game [45]. Outcome data suggests that anxiety symptoms significantly decreased at follow-up in both conditions, however no statistical difference was observed between the two video games.

The third serious video game *Flowy* was tested in a pilot RCT [40]. It aimed to reduce anxiety, hyperventilation and panic symptoms. Overall, results showed no significant difference for psychopathology measures between *Flowy* condition and wait-list control, although quality-of-life was

rated significantly higher for Flowy participants than the control.

Lastly, a small quasi-experiment compared the effectiveness of the serious video game *Journey of the Wild Divine* to a control waitlist group on measures of anxiety and depression [24]. Results showed significant improvement in serious video game condition on both scales comparing to the control group.

3.3.3 DEPRESSION:

There are 3 RCTs that looked at one serious video game (*SPARX*) which is aimed at reduction of depressive symptoms in adolescents.

First RCT [18] compared *SPARX* to a waitlist and found significantly greater reductions in depression for those using *SPARX* on both depression scales. In addition, remission rates were also significantly higher in the *SPARX* group (78.9%) compared to the control (36.4%). Measures on quality of life, suicidality and locus of control were statistically insignificant.

The second and biggest RCT [34] compared *SPARX* to TAU (face to face therapy). Results showed that both conditions produced significant reduction in the number and severity of depressive symptoms, suggesting that *SPARX* is as effective as TAU in reducing depressive symptoms. However, remission rates were significantly higher in the *SPARX* group (43.7%) compared to TAU (26.4%).

The third RCT, with the biggest number of participants, [42] contained 4 conditions, including (1) Dutch CBT-based program only, (2) *SPARX*, (3) Dutch CBT-based program and *SPARX* and (4) monitoring condition. Results showed

that depressive symptoms decreased significantly in all conditions during the study period with a medium effect size. The analyses showed no difference in depressive symptoms across conditions, including the monitoring control condition indicating that all conditions were equally effective in reducing depressive symptoms.

A RCT on another serious video game *The Journey* found that significantly greater reductions in depression for those using *The Journey* than in a control psycho-educational program [49]. At the end of treatment 88.2% of those who had received an active intervention had a higher response rate compared to control. At the 1-month follow-up there was still a difference between groups.

Lastly, a small, multiple-case control study looked at the serious videogame *gNats* [6]. Narrative discussion stated that there were minor improvements in depressive symptoms, while results from other scale were inconclusive.

3.3.4 PSYCHOTIC DISORDERS

A serious video game-based program *SocialVille* was designed to reduce cognitive symptoms of schizophrenia and improve social cognition [37]. Results showed significant improvements on proximal measures of social cognition (prosody identification and facial memory); and significant improvements on social functioning, motivation and reward sensitivity.

Next, the serious video game *X-Cog* was tested in two quasi experimental studies. The aim of the game is to reduce cognitive and negative symptoms. In the first study, *X-Cog* was compared to TAU [44], participants were diagnosed with first episode of psychosis. Results showed that post-treatment there were significant differences

found in the domain of executive function between the X-Cog and control groups. In addition, there was a significant difference in negative symptoms, with the X-Cog group scoring significantly lower than the control group.

In the second, bigger study, *X-Cog* was compared to an occupational therapy. Here participants were diagnosed with schizophrenia or schizoaffective disorder [52]. This time serious video game was tested on several domains. Results suggested that *X-Cog* produced independent, general effects on participant's memory, attention and executive functioning. There also was a significant improvement in positive symptomatology, mainly a decrease in the number of delusions. Contrary to previous findings, there was no significant effect on negative symptoms. Subsequent analysis also revealed that there was no difference in time until first relapse between *X-Cog* and control, although data suggests that relapse was shorter for serious video game condition.

The last serious video game *Navigation Game* [1] was aimed at schizophrenia patients. Outcome data suggests that patients clinically significantly improved at the end of week 12 compared with the baseline. There were also considerable improvements on the measures for quality of life, self-esteem and level of insight.

3.3.5 ADHD

A serious video game *BrainGame Brian* was tested in two studies. Firstly, is a quasi-experiment [54], where *BrainGame Brian* was tested against the waitlist. Results showed that children in the training game condition showed a greater reduction in ADHD symptom behaviours (inattentive and hyperactive/impulsive behaviours) as reported by the parent compared with children in the control condition. In addition, executive functioning and

motivational behaviour scores showed more improvement in game condition than children in the wait-list group, although some subscales did not show significant effects.

The second study is a double-blind RCT [10]. There were 3 conditions: full-active condition (complete version of the *BrianGame Brian*), partially active condition (some of the tasks are in a placebo mode), lastly a placebo condition (all training tasks within the game were in a placebo mode). Outcome data revealed a significant decrease in ADHD symptoms at the post-test and at the follow-up for all three conditions and there was no statistically significant difference between treatment conditions. The only statistical difference was found in the measures of visuospatial STM and WM, with significant improvements for full-active condition. In addition, inhibitory performance and interference control only improved in the full-active condition and the partially-active condition.

Next is a multiple-case control study on a serious video game *CogoLand* [27]. In this study, results showed that an 8-week intervention significantly improved inattentive symptoms of ADHD, based on a behavioural rating scale by parents. Compared to the baseline score, there was significant improvement in parent-rated inattentive and hyperactive-impulsive symptoms. The behavioural improvements were sustained but did not improve further after training sessions. This study also looked at EEG data and attempted to map results from neuroimaging onto other scales' measures.

Lastly, Prins et al [41] looked at the effectiveness of a serious video game *Supermecha* on the working memory capacity and motivation in children with ADHD. Game condition was compared against control working memory training that contained no game elements. From this quasi-

experimental study, researchers concluded that memory span in the game training condition significantly increased from pre- to post-test, while no significant increase was found in the control training condition. Game condition also performed more training sequences within the game comparing to control. In addition, children who trained on the game version of a visuospatial working memory task were more strongly motivated to do the training and completed more trials correctly within the game.

3.3.6 ASD

There are 5 serious video games that were designed to improve ASD symptomatology, the main target was to improve recognition of facial expressions and emotions.

First serious video game is *Let's Face It!* [50]. The main aim of the game is to reduce poor facial recognition skills, which is a common feature of ASD patients. In this RCT, *Let's Face It!* was compared against waitlist control condition. The outcome data suggests that there was no significant difference between two conditions for the ability to discriminate between face dimensions, immediate memory for faces, masked features and expression. However, relative to the control group, children in the *Let's Face it!* condition demonstrated reliable improvements in their analytic recognition of mouth features and holistic recognition of a face based on its eyes features.

Another serious video game that targeted facial recognition was *FaceMaze* [22]. In study two groups of children. who were either normally developing or with ASD, completed the game. Results showed that by the end of training, children with ASD were significantly better in recognizing happy and angry facial expressions. In fact, their performance was comparable to the performance of a normally developed control group.

The serious video game *Poki Poki* is a prosocial CBT-based game, which was compared to an offline CBT [4]. The results showed that the ability to identify emotional words and emoticons were significantly improved in both groups. However, there was no significant difference in the degree of improvement between the two groups. In a post hoc test, the game-CBT group showed greater improvements in social interactions scores compared to the offline-CBT group, while the offline-CBT group showed greater improvements in restricted, stereotyped behaviour score.

The cognition-training serious video game *BrainGame Brian* was also used to reduce executive functioning deficits in children diagnosed with ASD [8]. Similarly, to study by [10] had three conditions: WM(working memory) -training condition, including five training-tasks with increasing difficulty; flexibility-training condition, consists of a switch task that increases in difficulty and mock-training condition (all tasks performed at a low level of difficulty). The outcome data suggests that children from all 3 conditions improved in working memory, flexibility, attention, and parent-rated executive functioning, social behaviour, ADHD-behaviour, and quality of life. However, the working memory and flexibility trainings did not result in a larger improvement than the mock-training. Although, in the WM intervention-condition parent rated ADHD-behaviour decreased more than children in the other intervention-conditions, and after the post-training this improvement continued only in the WM intervention-condition.

The last serious video game that aimed to address ASD deficits is *Junior Detective Training Program* [2]. The aim of the game is to improve social skills in children diagnosed with ASD through a series of problem-solving game tasks. In the quasi-experimental study, *Junior Detective Training Program* was compared to a waitlist control condition. The

outcome data showed that there was a significant improvement in social skill training for the game condition but not for the control group. A similar pattern of results was found for emotion regulation but not emotion recognition. Furthermore, results showed that for both intervention groups, parent-reported improvements in social skills were maintained at 6-week follow-up and 5-month follow up.

3.3.7 GAMBLING DISORDER

The serious video game *Playmancer* was initially designed for treatment support in patients with eating disorders. However, since one of the key components is impulse control, it was subsequently tested on patients with gambling disorder [51]. This multiple-case study looked at the number of measures and outcomes. Results showed that *Playmancer* was successful in significantly decreasing gambling behaviour, cognitive and unplanned impulsiveness. In addition, there was a significant decrease in trait anxiety score and novelty seeking behaviours. However, results were insignificant for motor impulsiveness and state anxiety.

3.3.8 ALCOHOL USE DISORDER

One study looked at the effectiveness of a serious video game on the symptoms of alcohol use disorder [55]. Serious video game *Guardian Angel* is based on the CBT principles and was compared to educational slides that participants viewed in a control condition. The results showed that there were no significant differences between the conditions with respect to the probability of relapse. However, participants in the game condition reported to have fewer obsessive thoughts about alcohol, also post training measure of self-efficacy has increased significantly in a game condition. Alcohol craving rating reduced in both

conditions, reaching statistical significance. However, there was no difference between two conditions after treatment.

3.3.9 MCI AND ALZHEIMER'S DISEASE

Cognitive impairments in MCI and Alzheimer's Disease was of interest to one study: a study [30] looked at the effectiveness of serious video game *Kitchen and Cooking* in improving cognitive symptoms in patients with MCI and Alzheimer's Disease. Findings revealed that after 1 week of practicing on a game scenario, participants became faster in both executive functions activity and praxis activity. In addition, MCI participants improved significantly more in the executive functions activity compared to AD participants.

4. Discussion

In this systematic review, we have reviewed 27 studies in order to evaluate the evidence for serious games as effective treatment of mental health disorders.

4.1 Which mental health conditions are being treated by serious games?

We identified serious videogames for the treatment of a wide range of mental health disorders including depression, anxiety, ADHD, ASD, eating disorders, schizophrenia and first episode of psychosis, alcohol use disorder, gambling disorder, mild cognitive impairments and Alzheimer's disease.

4.2 Which audiences are being targeted?

16 out of 27 games were aimed at adolescents and children with either depression, ADHD and ASD symptoms. This can be explained by the fact games might appear to be a more natural and acceptable medium for children and

adolescents rather than for adults. However, it is worth noting that currently games are played within a variety of age groups. In fact, according to an ESA report [12], the average gamer player age is 35, with 30% of players being 18-35 years old and 27% being 50+ years old. The only games that were aimed at adults seem to be used for training of cognitive abilities (*Kitchen and Cooking, SocialVille, X-Cog, Navigation Game*). There is therefore an opportunity for the designers of e-mental health interventions to consider serious videogames as a potential deliver opportunity for adult treatment.

4.3 Which platforms are being used for the delivery of serious games for mental health?

Many of the identified games were delivered via PC. This would appear to be a good choice of platform for games tackling depression as [29] demonstrated an increased prevalence of desktop-only play for people with depression. The ESA report from 2016 [11] further suggests that the majority (56%) of people who play videogames use a PC to do so. However, there is now an almost equal number of people who use a dedicated game console (53%) and an increasing number using smartphones for gaming (36%).

Over half of the population of the United States owns a smartphone and 83% of these users do not leave their homes without it [13]. As a consequence of this ubiquity, an increasing number of apps for mental health are now available via smartphones and other mobile devices (e.g. [3]). In our study, both *Flowy* and *Kitchen and Cooking* were delivered via mobile devices and user experience feedback suggested that participants liked the game and platform of delivery. Further work is therefore required to understand how gaming platform preferences might influence rates of acceptability and adherence of treatments for various mental health illnesses.

4.3 What evidence is there that serious games for mental health are effective in engaging patients in their treatment protocol?

Serious games for mental health are effective in engaging patients in treatment protocols. The rates of dropouts were lower (mean drop-out rate was 21%) compared to those from traditional CBT (26.2%, from meta-analysis by Fernandez et al, 2015). However, drop-out and attrition rates were only reported in half of the studies, meaning that information can be over or under-represented.

4.4 What evidence is there that games are effective in treating mental health conditions?

Overall, the quality of the research has improved over the recent years, with more RCTs emerging over the past couple of years (10 out of 27 studies). Only 2 papers scored "Poor" in our quality review, with the rest of papers falling within "Fair" and "Good".

The results of this systematic review indicate that serious videogames may have a positive impact on certain mental health conditions but not others. Games that were aiming to treat cognitive symptoms were the most likely to produce positive outcome. For examples games that were aimed at ADHD symptoms (*BrainGame Brian, Cogoland, Supermecha*) were more effective than control conditions, producing improvements in working memory and motivational behaviour. Effects on executive function and ADHD symptoms were mixed: whilst *Cogoland* and *BrainGame Brian* [54] produced significant improvements in ADHD symptomology and problematic behaviours it is important to note that the RCT on *BrianGame Brian* found reductions in ADHD symptoms in all 3 conditions of a game, including the placebo version of the game. Other classes of games that were effective in promoting mental health outcomes were games that tackled psychotic

disorder symptoms (*SocialVille*, *X-Cog*, *Navigation Game*) and games aimed at children with ASD targeting facial and emotion recognition (*Let's Face It!*, *Face Maze*) and social skills (*Junior detective Training Program*, *Poki-Poki and BrainGame Brian*).

Games for depression had the strongest evidence base though revealed mixed results. The RCT of *The Journey* [49] found a substantial effect on reduction of depressive symptoms. In addition, [18] and [34] produced positive results suggesting that *SPARX* is as effective as TAU. However [42] failed to replicate their findings.

Lastly, serious videogames on anxiety symptoms demonstrated that although specifically designed games like *Mindlight* and *Dojo* can produce a significant reduction in anxiety symptoms, they are no more effective than commercial videogames. There are two possible explanations: 1) Commercial games may train some of the same skills that serious video games target. Even though commercial video games are not specifically designed for anxiety reduction, they may incorporate some of the more general game mechanisms that have benefits for emotional wellbeing. Indeed, previous research has demonstrated a positive correlation between playing videogames and wellbeing measures such as post-work recovery [5] 2) Failure to account for non-specific factors like motivation to change. Studies [14;46] suggest that for children one of the main motivations to play video games is to reduce stress and increase feelings of autonomy. These motivations for playing games seem particularly pronounced for children with clinically elevated mental health symptoms [14]. Indeed, children in both studies may have been motivated to play both games because they believed they would feel better as a result. The only serious videogame that produced promising results for

anxiety treatment was *The Journey of the Wild Divine*, however this was a small trial where the control group was on a wait-list.

In summary, serious video games seem to be as effective as TAU in improving cognitive symptoms of various disorders including ADHD, ASD and psychotic disorders like schizophrenia and in treating depression but have no additional effect on anxiety related disorders above those of resulting from playing commercial videogames.

6. CONCLUSION

Serious videogames are an effective medium for improving mental health related outcomes as they support engagement and delivery of treatment. However this is only true for serious video games that tackle cognitive and depressive symptoms rather anxiety symptoms. This review suggests that in the future, developers of e-mental-health interventions should explore the opportunities for designing serious videogames for adults, using smartphone-based and console-based platforms of delivery in addition to pc games, and researchers should ensure that they report attrition rates so that this can be properly evaluated.

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