



SERIOUS GAMES FOR THE TREATMENT OR PREVENTION OF DEPRESSION: A SYSTEMATIC REVIEW

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Abstract: Serious games (computerised interventions which utilise gaming for serious purposes) have been shown to support improved outcomes in several health conditions. We aimed to review evidence regarding serious games for depression. We undertook electronic searches of PsycInfo, EMBASE and Medline, using terms relevant to computer games and depression. We included full-text articles published in English in peer-reviewed literature since 2000, where the intervention was designed to treat or prevent depression and which included pre-and post-intervention measurement of depression. Nine studies relating to a total of six interventions met inclusion criteria. Most studies were small and were carried out by the developers of the programs. All were tested with young people (ages between 9 and 25 years). Most reported promising results with some positive impact on depression although one universal program had mixed results. Serious gaming interventions show promise for depression, however evidence is currently very limited.

Keywords: Depression; adolescents; computerised CBT; serious gaming; e-therapy.

Juegos serios para el tratamiento o la prevención de la depresión: una revisión sistemática

Resumen: Se ha demostrado que los juegos serios (intervenciones computarizadas que utilizan juegos) mejoran los resultados en diferentes problemas de salud. Pretendemos examinar las evidencias de estos juegos para la depresión. Se realizaron búsquedas electrónicas en PsycINFO, EMBASE y Medline usando términos relacionados con juegos de ordenador y depresión. Se incluyeron artículos publicados desde el año 2000, donde se diseñó la intervención para tratar o prevenir la depresión incluyendo medidas pre- y post-intervención. Nueve estudios sobre un total de seis intervenciones cumplieron los criterios de inclusión. La mayoría de estos fueron pequeños y los llevaron a cabo los desarrolladores de los programas. Todos incluían población joven (9 - 25 años). La mayoría presentan resultados prometedores con un impacto positivo sobre la depresión aunque un programa universal tuvo resultados mixtos. Se concluye que las intervenciones basadas en juegos serios son prometedoras para la depresión, aunque la evidencia es todavía muy limitada.

Palabras clave: Depresión; adolescentes; TCC informatizada; juegos serios; e-terapia.

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Disclosures: The intellectual property for SPARX is held by UniServices. UniServices has licensed SPARX to a third party for the territories of the USA, Canada and Mexico and, as the result of a revenue-sharing agreement between UniServices and S. Merry, K. Stasiak, T. Fleming, M. Shepherd and M. Lucassen stand to gain financially from any revenue received from this license. K. Stasiak developed The Journey and S. Merry was PhD supervisor on this project.

INTRODUCTION

Depression and sub-threshold depression cause serious harm and are leading causes of disability (Ustun, Ayuso-Mateos, Chatterji, Mathers, & Murray, 2004). Although evidence-based treatments exist, most people do not receive treatment and expanding clinical services to address these unmet needs would require substantial funding (Wittchen, & Jacobi, 2005). In addition, available services may be inconvenient, costly, or not appealing to some of those who might benefit from them (Fleming, Dixon, & Merry, 2012). Partly in response to these issues, computerised therapies, mainly computerised cognitive behavioural therapies (CCBT), have been developed.

There are some computerised therapies for depression that are widely available such as MoodGYM (Christensen, Griffiths, & Jorm, 2004), and Beating the Blues (Proudfoot et al., 2003). Systematic reviews have found CCBT programs to be promising or effective for the treatment of depression (Hedman, Ljotsson, & Lindfors, 2012; Newman, Szkodny, Llera, & Przeworski, 2011; Richards, & Richardson, 2012) and acceptable to the adult population (Gun, Titov, & Andrews, 2011). While less research has focused on children and adolescents, growing evidence suggests that CCBT programs can be effective at reducing symptoms of depression and anxiety for young people (Calear, & Christensen, 2010; Richardson, Stallard, & Velleman, 2010). The National Institute for Clinical Excellence (NICE) guidelines currently recommend the use of CCBT for anxiety and depression as part of a stepped-care approach (NICE, 2009).

Maximising the impact of computerised therapies is challenging. It has been proposed that computerised therapies may help to address unmet needs for large numbers of people; however dramatic uptake rates which might reduce population rates of depression have not been reported. Attrition (non-completion) rates have been shown to range from 2 to 83% (Melville, Casey, & Kavanagh, 2010; Richards et al., 2012; So et al., 2013). Such rates may not be dissimilar to face-to-face therapy, and concepts of dose may require reassessment

(Donkin et al., 2013), but these findings are disappointing.

Understanding optimal design features and implementation processes for computerised therapies will be an important step in increasing their impact. Although some computerised therapies (Coyle, McGlade, Doherty, & O'Reilly, 2011; Stallard, Richardson, Velleman, & Attwood, 2011) are designed to be used with a therapist, most offer little or no personalised support; this is of interest in several ways. Firstly, a therapeutic relationship appears to be a critical 'active ingredient' in face-to-face models of therapy (Weisz, McCarty, & Valeri, 2006) and yet many computerised therapies are effective while offering little human contact. This raises questions about how computerised therapies work, and if the active ingredients might in some way differ from those offered in face-to-face models (Cavanagh, & Millings 2013). Secondly, increased human contact in conjunction with an online intervention has been the main change proposed to increase adherence (Christensen, Reynolds, & Griffiths, 2011; Newman et al., 2011; Richards et al., 2012). However, if CCBT is a different experience from face-to-face therapy as young people have suggested it is (Fleming et al, manuscript in preparation), then alternative elements such as gaming or telepresence might also be important. In the view of the authors, computerised therapies for depression have yet to maximise the immersive, experiential and user-centred potential of online experiences.

As the focus shifts to increasing participation and engagement with online interventions, recent research (Merry et al., 2012; Shandley, Austin, Klein, & Kyrios, 2010) has begun to explore the potential contribution of gaming in mental health interventions. Once the domain of predominantly young western males, computer game-play is a now worldwide phenomenon with a diverse participant base. Well-designed computer games have been shown to have multiple benefits including increased motivation for learning, improved attention and problem solving, and increased social engagement (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Papastergiou, 2009) 'Serious games' are games or programs with gaming

features which utilise these features for purposes such as learning or health (Arnab et al., 2014). Serious games have been effective for improving knowledge and adherence to treatment in conditions such as asthma, diabetes and cancer (Murray, Burns, See, Lai, & Nazareth, 2005; Stinson, Wilson, Gill, Yamada, & Holt, 2009). There are a number of features of serious games that may align well with treatment. The combination of a narrative within games, together with clear learning objectives can facilitate deep learning (Dondlinger, 2007). Visual imagery and immersion may promote understanding of abstract concepts and improve retention (Andrews, 2011; Salzman, Dede, & Loftin, 1999). Social Learning Theory describes the importance of learning from others who are credible and likeable (Baranowski, Buday, Thompson, & Baranowski, 2008) which, in a gaming world, can be achieved through interactions with virtual characters. Participants who may be particularly sensitive to criticism or rejection are able to acquire and rehearse skills in a non-threatening context where choices are associated with clear outcomes (Read, & Shortell, 2011). This rehearsal and feedback can be an effective tool for behaviour change (Read et al., 2011) and has been shown to enhance locus of control and self-efficacy (Goh, Ang, & Tan, 2008). In these ways, features of serious gaming might offer opportunities to increase the impact of computerised therapies for depression.

Serious gaming might also offer opportunities to increase the appeal of computerised therapies for depression, at least for some users. People playing popular games find it hard to tear themselves away, unlike users of mental health computer-based interventions, where motivating people to complete the intervention has been troublesome.

Connolly et al. (2012) reviewed empirical evidence on serious games and Primack et al. (2012) reviewed video games for health-related outcomes, however neither identified any games for depression. In this paper we aim to review evidence-based serious games for depressive symptoms and consider clinical and research implications. For the purposes of this paper, we focus on online digital or computerised interventions which are designed to reduce, treat or

prevent depression, and which utilise elements of gaming (Prensky, 2001) as an integral and primary method for achieving their purpose.

Defining serious gaming

There is no one definition of serious gaming. Indeed, 'gaming' itself does not have a single definition. Prensky (2001) defined gaming as having six structural elements: rules, goals and objectives; outcomes and feedback; conflict, competition, challenge or opposition; interaction and representation or story. However, not all of these elements are present in every game (Marsh, 2011). We propose gaming is a polythetic concept as described by Wittgenstein (Wittgenstein, & Anscombe, 2009), i.e. something which is discussed as if it is connected by one underlying essential factor but is instead connected by a series of overlapping similarities (or 'family resemblances'), where no single factor is necessarily common to all. Secondly, we propose that serious games are not so much a category as a continuum, from those in which gaming is the primary purpose, to those which incorporate elements of gaming but which would be unlikely to appeal to those who did not aspire to their more serious goal. For the purposes of this analysis, we defined 'serious games' as interventions which are games or utilise elements of gaming (Prensky, 2001) as an integral and primary method for achieving their purpose.

Virtual reality can offer simulation of real life experiences for training or rehabilitation purposes and/or offer gaming in virtual environments (Designing Digitally Incorporated, n.d.). We propose that virtual reality interventions are not inherently games, unless they include significant features of gaming.

METHODS

We aimed to review serious gaming interventions for depression. Studies were eligible for inclusion if they were English language peer-reviewed articles, published after the year 2000 (given that reviews in the last 10 years had

identified no serious games for depression). Given that this is an emerging field, we included any study design (randomised controlled trials (RCTs), controlled clinical trials (CCTs) or single group designs (open trials)).

The intervention had to be delivered online and/or via digital technology, including via a CD-ROM, a tablet, the internet, computer, smart phone, Nintendo or any other computerised device.

We defined serious gaming as outlined above. For the purposes of this analysis, we included interventions which utilise elements of gaming (Prensky, 2001) as an integral and primary method for achieving their purpose.

We included trials where the purpose of the serious game was to treat or prevent depression. We included programs where stated aims were to reduce emotional/mental distress, anxiety or

promoting emotional wellbeing where this appeared to include depression or depressive symptoms. This somewhat complex criterion was required as programs did not utilize standard ways of describing their purpose. For example, one study described an intervention as being for depression and anxiety (Stallard et al., 2011), while another study by the same group described the same program as being for emotional health issues (Attwood, Meadows, Stallard, & Richardson, 2012). Interventions that were primarily for a physical health issue (e.g. cancer) or to deal with symptoms such as auditory hallucinations, PTSD, phobias, specific phobia or anxiety diagnoses, or cognitive decline were excluded, as even if these have an impact on low mood, they would not normally be disseminated for general use to treat depression.

Table 1. General characteristics of included studies

<i>Study ID</i>	<i>Program</i>	<i>Study Design</i>	<i>Size</i>	<i>Age (years)</i>	<i>Nature of participants</i>
Attwood, et al., 2012	Think Feel Do	Open Trial + CCT (vs AP)	RCT: 22 Open trial: 12	10 to 12	Recruited from school with moderately severe emotional problems
Stallard, et al., 2011	Think Feel Do	RCT (vs WL)	RCT: 20	11 to 16	Referred population with anxiety or mild to moderate depression
Merry et al., 2012	SPARX	RCT (vs TAU)	187	12 to 19	Recruited from primary healthcare sites with significant depressive symptoms
Fleming et al., 2012	SPARX	RCT (vs WL)	32	13 to 16	Recruited from alternative education schools (for those excluded from mainstream education) with possible or probably depression
Lucassen et al., 2013	SPARX-Rainbow	Open Trial	21	13 to 19	Recruited from youth organisation and schools with significant depressive symptoms
Stasiak et al., 2012	The Journey	RCT (vs AP)	34	13 to 18	Self-referred to school counsellor with significant depression symptoms
Knox et al., 2011	The Journey to the Wild Divine; Freeze Framer	CCT (vs WL)	30	9 to 17	Referred population with a range of psychological/emotional problems
Coyle et al., 2011	gNats Island	2 Open Trials	Trial 1: 6 Trial 2: 15	11 to 16	Referred population with a range of psychological/emotional problems
Shandley et al., 2010	ReachOutCentral	Open trial	266 (154 completed post scores)	18 to 25	Unselected population of volunteers but aimed to prevent alcohol misuse, psychological distress, coping skills, resilience

Note: RCT: Randomised Controlled Trial; CCT: Controlled Clinical Trial; WL: Waitlist; TAU: Treatment as Usual; AP: Attention Placebo

To be included trials had to report pre- and post-intervention measurement of depression, including continuous measures of depression symptom severity based on validated standardised symptom self-report or observer-administered scales or dichotomous measures of the presence or absence of depressive disorder including structured clinical interviews or a pre-designated cut-off point on a continuous measure of depression. For the purposes of this paper we also examined any other outcomes reported in our included studies.

Search strategy and key words

We undertook electronic searches of PsycInfo, Medline and EMBASE (from inception to 21 June 2014) using a combination of terms relevant to online computer games (e.g. computer, online, web, internet or digital, with game/gaming, serious game/gaming, video game/gaming, electronic game/gaming, virtual, play, avatar or fantasy) and depression (e.g. Depressive Disorder, Affective symptoms, Depression, Dysthymic Disorder, subclinical/threshold depression) (contact the first author for details). Titles and abstracts were searched by one of three authors to exclude studies that obviously did not meet the inclusion criteria. Full text articles of studies that appeared relevant or possibly relevant for inclusion were requested and inspected independently by two of six authors with disagreements resolved by discussion. In addition, we searched references of key reviews of online or gaming interventions undertaken in the last 10 years as well as the reference lists of full text articles that appeared relevant or possibly relevant for inclusion. Finally, we carried out a search of Google using key gaming terms and known program names and their authors.

Data extraction

Six authors extracted data into a data extraction form that had been piloted with one paper. Data relevant to the characteristics of the trial and outcome data (see Tables 1 and 2) and the

nature of the interventions with regard to the gaming elements (see Table 3) were extracted. A seventh author (SH) checked this data extraction and resolved any anomalies, inconsistencies or queries with regard to this information with the other authors.

RESULTS

Results of the search

We retrieved 2,137 publications; 274 were deleted due to being published before the year 2000, and a further 1,831 were excluded based on title and abstract. We retrieved 32 publications for full inspection. Ancestry searching of reviews and possibly relevant studies resulted in retrieval of a further eight studies for inspection and the Google search resulted in a further three studies for inspection. Of the 43 studies interrogated for inclusion, 9 studies relating to six different interventions were eligible for inclusion.

For the majority of possibly relevant studies that were excluded, the reason for exclusion was that the intervention was exclusively a Virtual Reality simulation that did not incorporate gaming as an integral or primary strategy or was an intervention that was aimed at other conditions. For example, many were interventions aimed to increase exercise in various populations, were aimed to reduce cognitive impairment in the elderly, or were for specific conditions such as ADHD, or accident-related trauma. Other programs did not include pre- and post-intervention measures of depression.

Two studies required particular consideration for inclusion or exclusion. Coyle et al. (2011) were marginal on the pre- and post-intervention measurement of depression criteria. They utilised the Child Behaviour Checklist (CBCL); Youth Self Report (YSR) and reported that young people improved on these measures, but they do not report the data. This study was included given the early state of the field of serious gaming for depression. A second study (Alvarez, Sotres, Leon, Estrella, & Sosa, 2008), was aimed at people with depression and included number sequencing games. However, the

Table 2. Depression results

<i>Study ID</i>	<i>Program</i>	<i>Depression measure</i>	<i>Result</i>
Attwood et al., 2012	Think Feel Do	Study 1 (CCT): none Study 2 Open Trial: Adolescent wellbeing scale	Study 1: NA Study 2: Statistically significant pre to post intervention improvements in the group who received 'Think Feel Do' ($Z=-2.09, p<.05$)
Stallard et al., 2011	Think Feel Do	Adolescent wellbeing scale	Statistically significant pre to post intervention improvements in the group who received 'Think Feel Do' $T(5)=2.49, p<.05$
Merry et al., 2012	SPARX	Children's Depression Rating Scale-Revised (CRDS-R) Reynolds Adolescent Depression Scale-Second Edition (RADS-II) Mood and Feelings Questionnaire (MFQ) Remission	CDRS-R: Per protocol mean difference 2.73 (Confidence Interval -0.31 to 5.77, $p=.079$) RADS-II: Per protocol mean difference 3.65 (Confidence Interval -0.15 to 7.45, $p=.060$) MFQ: Per protocol mean difference 3.74 (Confidence Interval 0.33 to 7.16, $p=.032$) Remission: Per protocol remission rates were significantly higher in the SPARX group (43.7%) compared to treatment as usual (26.4%) ($p=.030$)
Fleming et al., 2012	SPARX	Children's Depression Rating Scale-Revised (CRDS-R) Reynolds Adolescent Depression Scale-Second Edition (RADS-II) Remission	CDRS-R: Significantly greater reductions in depression for those using SPARX ($F=18.11, p=.000$) Significantly greater reductions in depression for those using SPARX ($F=4.13, p=.052$) Remission: Remission rates were significantly higher in the SPARX group (78.9%) compared to waitlist (36.4%) ($p=.004$)
Lucassen et al., 2013	SPARX-Rainbow	Children's Depression Rating Scale-Revised (CRDS-R) Reynolds Adolescent Depression Scale-Second Edition (RADS-II) Mood and Feelings Questionnaire (MFQ)	CDRS-R: Statistically significant pre to post intervention improvements in the group who received SPARX (mean change -7.43; Confidence Interval -10.79 to -4.07, $p<.0001$) RADS-II: Statistically significant pre to post intervention improvements in the group who received SPARX (mean change -7.90; Confidence Interval -12.17 to -3.64, $p=.001$) MFQ: Statistically significant pre to post intervention improvements in the group who received SPARX (mean change -6.19; Confidence Interval -11.13 to -1.25, $p=.02$)
Stasiak et al., 2012	The Journey	Children's Depression Rating Scale-Revised (CRDS-R) Reynolds Adolescent Depression Scale-Second Edition (RADS-II)	CDRS-R: Significantly greater reductions in depression for those using The Journey (mean change intervention group = 17.6, CI = 14.13 to 21.00; attention placebo group = 6.06, CI = 2.01 to 10.02; $F(1,27)=20.6; p<.001$) RADS-II: Greater reductions in depression for those using The Journey but not statistically significantly different from attention placebo group (mean change intervention group = 13.3, CI = 7.46 to 19.15; attention placebo group = 5.19, CI = -1.40 to 11.77; $F(1,27)=3.39; p<.077$)

Table 2. Depression results (*continuation*)

<i>Study ID</i>	<i>Program</i>	<i>Depression measure</i>	<i>Result</i>
Knox et al., 2011	The Journey to the Wild Divine; Freeze Framer	Children's Depression Inventory (CDI)	Significantly greater reductions in depression for those using The Journey to the Wild Divine and Freeze-Framer (Post-intervention mean scores intervention group=49.00 (SD 11.75) vs Waitlist=54.83 (SD14.88); $F(2,23)=9.39, p=.001$)
Coyle et al., 2011	gNats Island	Study 1: Child Behaviour Checklist (CBCL); Youth Self Report (YSR) Study 2 : No outcome measurement described	No data reported; discussion states that CBCL indicated improvement while YSR symptom scores were less conclusive Discussion states gNats Island had a positive impact on participants
Shandley et al., 2010	ReachOut-Central	Kessler Psychological Distress Scale (K10) Resiliency Short Form (RS)	K10: Report only a significant gender effect ($F(1,264)=11.89, p=0.00$) with females having a higher levels of distress than males. Means scores pre to post-intervention = Females: 28.31 to 27.74; Males 24.14 to 23.76. RS: Mean scores showed no changes for males; whereas resiliency improved for females at follow-up $F(1,177)=15.51, p=0.00$)

purpose of the game was to reduce cognitive impairment, rather than to reduce depression, hence, after careful review, this paper was excluded.

Characteristics of included studies

In total, nine studies were included (Table 1). Seven of the studies reported programs tested with children or adolescents with depressive symptoms or emotional problems and recruited via schools, community organisations or health care providers. These programs included supported interventions (Think Feel Do, Journey to the Wild Divine and Freeze Framer and gNAT Island) and fully self-help interventions (SPARX, Rainbow SPARX and The Journey). One paper (Attwood et al., 2012) reported results from two small studies; in one of the studies 13 opportunistically recruited students participated in a trial of Think Feel Do as universal intervention and in the other, 12 students with 'emotional health problems' participated. One study reported findings from a wellbeing-focused intervention tested with young people recruited online who did not necessary have clinical symptoms (ReachOutCentral).

Study methods

Study methods varied. One paper included description of an open trial, as well as a CCT (Attwood et al., 2012) of 'Think, Feel Do'. A study from the same group reported an RCT of this program (Stallard et al., 2011).

Two of the included studies (Fleming, Dixon, Frampton, & Merry, 2012; Merry et al., 2012) described RCTs of SPARX. A further study from the same group described an open trial of an adapted version of SPARX for young people attracted to the same sex, both sex, or questioning their sexuality (Lucassen et al., 2013). One study described an RCT of The Journey, a program which preceded and influenced the development of SPARX (Stasiak et al., 2012).

One study described a CCT that tested the effectiveness of a game-based biofeedback delivered via two games called Journey to the Wild Divine and Freeze Framer (Knox et al., 2011). The final two studies each described an open trial: gNat Island (Coyle et al., 2011) and ReachOutCentral (Shandley et al., 2010).

The RCTs employed various control groups: Think, Feel Do was compared with a waitlist control (Stallard et al., 2011); SPARX has been

compared with treatment as usual (Merry et al., 2012) and a waitlist control (Fleming et al., 2012); The Journey has been compared to an attention placebo control group. The CCTs tested the effectiveness of Journey to the Wild Divine and Freeze Framer compared with a waitlist control group (Knox et al., 2011) and Think Feel Do with an attention placebo control group (Attwood et al., 2012).

Participants

The RCTs and CCTs were generally small; five had a sample size less than 34; one RCT of SPARX (Merry et al., 2012) included a sample size of 187. Similarly, the open trials were small, all with fewer than 21 participants except in the open trial of ReachOutCentral (Shandley et al., 2010), which enrolled 266 participants and obtained outcome data for 154 of these.

Eight studies focused on children and or adolescents (aged 9 to 19 years); while ReachOutCentral was tested with 18 to 25 year olds.

Participants were recruited via schools or school guidance counsellors in three studies, (Attwood et al., 2012; Lucassen et al., 2013; Stasiak et al., 2012), via alternative high schools in one study (Fleming et al., 2012), and via school counsellors or primary health care in one study (Merry et al., 2012). Participants were recruited via primary health care, hospital or mental health services in a further four studies (Knox et al., 2011; Stallard et al., 2011; Stasiak et al., 2012) and were recruited via a website in the remaining study (Shandley et al., 2010).

The aims of programs were to reduce depression or improve mental health or emotional wellbeing and most described participants as having depression, depressive symptoms (Fleming et al., 2012; Lucassen et al., 2013; Merry et al., 2012; Stasiak et al., 2012) or depression and anxiety (Stallard et al., 2011). One study described participants as having emotional or psychological problems (Coyle et al., 2011); one described participants as having symptoms or a diagnosis of anxiety (Knox et al., 2011); one paper included a non selected sample and a group with 'emotional health problems' includ-

ing anxiety or low mood (Attwood et al., 2012); and one study recruited volunteers with no restrictions on inclusion (Shandley et al., 2010).

Program features

Gaming aspects of included studies are summarised in Table 3. These descriptions are derived to the best of our ability from the limited information describing each program.

Think, Feel, Do is a CBT-based program comprised of six 30 to 45-minute sessions, delivered via a computer or CD-ROM. It is delivered with a facilitator who discusses the program content, provides support and reflects on the lessons being taught in the program with the young person. The user interface is two-dimensional with three cartoon heads (Tom, the thinker; Becky, the feeler; and Izzy the doer) guiding the user through each session. Users choose another cartoon character to represent themselves, who is superimposed into various video vignettes of everyday situations, with users selecting from a range of possible thoughts or feelings that might arise in these situations. In later sessions these selections influence what happens next in the videos so that users become aware of the consequences, and can select different options thus learning how different types of thoughts and feelings can lead to positive or negative outcomes. This program was included, although with the information available, it was challenging to determine whether or not it met serious gaming inclusion criterion of utilizing elements of gaming as an integral and primary method for achieving its purpose.

SPARX is a CBT-based program comprised of seven approximately 30-minute sessions, delivered via a computer on a CD-ROM. There is no therapist or other facilitator involvement. The content utilises a 'bicentric frame of reference' (Dede, 2009) whereby the user meets a virtual 'Guide' who talks to them directly about depression and application of skills learned in the 'game world' to their life. Users choose an avatar to represent themselves and travel into the 'game world' where they explore and take on a series of challenges, such as shooting gNats (Gloomy Negative Automatic Thoughts)

Table 3. Specific gaming elements of each program

<i>Program</i>	<i>Rule, goals and game objectives</i>	<i>Outcomes and feedback to the user</i>	<i>Conflict, competition, challenge or opposition</i>	<i>Interaction</i>	<i>Representation or story</i>
Think Feel Do	The objective is to learn thoughts and actions that lead to positive outcomes	The background music changes on the basis of the user's mood; the choices of possible thoughts and actions determine what happens next	Users have to connect thoughts and feelings and distinguish between negative and positive thinking styles	The three cartoon heads of Tom, the thinker, Becky, the feeler, and Izzy the doer, comment on their own perspectives throughout the program. User chooses another cartoon to represent themselves who is superimposed into the video vignettes. The user is encouraged to keep a diary of the positive things that happen to them between sessions	There does not appear to be an overarching narrative represented beyond the various vignettes
SPARX and SPARX Rainbow	Defeat gNats, Gather SPARX and power gems via tasks to help restore balance in a fantasy world		Various challenges are presented, such as shooting gNats and finding gems	Users take on an avatar and interact with other characters presented as part of the challenges; the user also interacts in the first person with a guide	Restoration of balance in a fantasy world
The Journey	The objective is to travel through the land with the goal of earning points for completing each module	Users are rewarded with simple mini games at the end of each module.	Users have to earn points. There are quizzes that are completed at the beginning of each module.	There is no interaction with other characters; interactive exercises are mentioned but no description is given	The Journey is embedded in a fantasy game-like environment and follows a narrative of a quest through magical lands
The Journey to the Wild Divine and Freeze-Framer	The objective is to complete the various tasks and advance through increasing level of difficulty	Completion of activity is only possible on the basis of the user slowing their breathing and decreasing tension so that they have immediate feedback with regard to this	The challenge is to maintain a state of calm while completing increasingly stressful activities	There is no interaction with other characters	Journey to the Wild Divine has user enter a fantasy world and undertake a journey

Table 3. Specific gaming elements of each program (*continuation*)

<i>Program</i>	<i>Rule, goals and game objectives</i>	<i>Outcomes and feedback to the user</i>	<i>Conflict, competition, challenge or opposition</i>	<i>Interaction</i>	<i>Representation or story</i>
gNats Island	The objective is to travel through a tropical island	Being stung by a gNat (a creature that represents negative automatic thoughts) results in a range of negative thoughts	Opposition is represented by gNats that can sting people, this causes negative thinking	Players have discussions with the characters they meet. Throughout the game players carry an in-game notebook, in which they answer characters' questions and record new ideas	The user has to visit a tropical island and meets a team of wild life explorers
ReachOut Central	The objective is successfully integrate and settle into a new town	Users have a mood meter that can be manipulated by the player on the basis of the activities that they engage in and their mood impacts on conversations and interactions and their progress through the game	Interpersonal challenges are presented and users have to problem solve; users have to engage in activities that improve their mood in order to progress through the game	Users interact with a range of characters; they also have a coach from whom they can seek help at any stage	The user is new to a town and has to work out how to settle in, make friends and find their way around

and solving problems to find the 'gems of power' and restore balance in the game world. At the end of each level, the users return to the Guide to reflect on the lessons learnt and how these lessons may apply in their lives.

The Journey is a two-dimensional CBT-based program comprised of seven 25 to 30-minute sessions, delivered via a CD-ROM with no therapist or other facilitator involvement. It uses elements of gaming to engage the user with the program: users select a character that represents them and are tasked with a mission to travel to their homeland through a fantasy world comprised of seven 'magical lands'. To move between the lands, the user completes a series of lessons and quizzes. The users earn points as they complete tasks and are rewarded with mini games that they can play as part of The Journey.

One intervention includes two games: Journey to the Wild Divine and Freeze-Framer 2.0.

These are delivered along with psychoeducation about the effect of stress on the mind and body and in conjunction with face-to-face therapy in eight sessions. Journey to the Wild Divine involves activities such as making a fire, building a wall, building a bridge, all in a fantasy world and Freeze Framer 2.0 involves activities such as colouring a meadow, making a rainbow and floating in a hot air balloon. Completion of each activity is only possible if the user slows their breathing and evidences decreased tension based on heart-rate variability and skin-conductance levels. Activities include guided imagery and sound to aid relaxation. Players progress through levels of increasing difficulty to practice remaining calm during more 'real-world' stress-inducing events.

GNats Island is a CBT-based program delivered over two to four sessions in conjunction with face-to-face therapy, although it is unclear how much time in each session is dedicated to

the game. The user has to find their way through a fantasy world where little creatures (Negative Automatic Thoughts – gNats) can sting people causing negative automatic thoughts. The user meets a range of characters who introduce strategies for dealing with negative thoughts and beliefs. The user carries a notebook where they can record new ideas or answer questions from these characters throughout the game.

ReachOutCentral is not modularised; the game can be played for as much or as little time as the user wishes. It utilises principles of CBT and is delivered online. Users take on the role of a character who is new in town. The user must work out how to settle in, make new friends and find their way around. Users interact with a range of characters in the game and have a coach, or narrator, who acts as a guide and mentor throughout situations and can be called upon for help at any stage. Users have a mood meter that can be manipulated through their engagement in different activities such as doing homework, sleeping or conversing. The user's mood in turn has an effect on conversation and social interactions (e.g. if mood is low, making friends is more difficult). Consequently, the user is encouraged to perform various game actions that can improve their mood meter (e.g. physical activity, giving up drugs) in order to more easily progress in the game.

Outcomes

A summary of the depression measures used and outcome data for these measures is presented in Table 2.

In the open trial of Think Feel Do reported by Attwood et al. (2012), participants demonstrated significant improvements in depression on the self-rated Adolescent Wellbeing Scale, the generalized anxiety subscale on the self-rated Spence Children's Anxiety Scale and in self-esteem on the Rosenberg Self Esteem Scale. In the CCT reported in this study, Think Feel Do was tested as a universal intervention with a group of boys. Differences between those who received the intervention and those who received an attention placebo were not reported. Depression was not measured. Those who re-

ceived the intervention had significantly improved scores on the total anxiety score of the self-rated Spence Children's Anxiety Scale, as well as on social phobia and generalised anxiety subscales but no significant improvements on parent-rated anxiety or on the parent-rated Strengths and Difficulties Questionnaire (Attwood et al., 2012). In the RCT by Stallard et al. (2011), while young people were randomised to Think Feel Do or a waitlist control, only within-group analyses were undertaken so it is not clear if there were significant differences between groups across the outcome measures. Those who received the intervention did demonstrate significant improvements in depression measured on the self-rated Adolescent Wellbeing Scale, as well as in three of the five subscales of the Strengths and Difficulties Questionnaire (parent-rated), one out of six subscales on the self-rated Spence Children's Anxiety Scale (social phobia), self-esteem on the Rosenberg Self Esteem Scale and on cognitive schemas (Schema Questionnaire for Children) (Stallard et al., 2011).

In the largest RCT included in this review, SPARX was shown to be as effective as treatment as usual in reducing clinician-rated depression on the Children's Depression Rating Scale-Revised (CDRS-R), on self-report depression symptoms measured on the Reynolds Adolescent Depression Scale-Revised Edition (RADS-II) and on the Moods and Feelings Questionnaire (MFQ), with significantly higher remission rates for those who received the intervention compared with those who received treatment as usual (Merry et al., 2012). Those who received the intervention also had significantly greater reductions on self-reported anxiety on the Spence Children's Anxiety Scale. When compared with a waitlist control in students in alternative education settings, SPARX resulted in significantly greater reductions in depression on the CDRS-R, and on RADS-II, as well as significantly higher rates of remission. However, there were no significant differences between groups on anxiety or other measures of psychological functioning (Fleming et al., 2012). In the open trial of Rainbow SPARX there were significant reductions on the CDRS-R, RADS-II and the MFQ, as well as

anxiety on the self-rated Spence Children's Anxiety Scale from pre- to post-intervention (Lucassen et al., 2013).

The Journey was compared with a psycho-educational computer program in an RCT and those who received the intervention had significantly greater reductions in clinician-rated depression on the CDRS-R but not on self-report depression symptoms measured on the RADS-II (Stasiak et al., 2012).

In the CCT of Journey to the Wild Divine and Freeze Framer, there were significant post-intervention differences between those who received the intervention and those who were in the waitlist control group on depression measured on the self-report Children's Depression Inventory as well as on anxiety measured by the self-report Multidimensional Anxiety Scale for Children (Knox et al., 2011).

The remainder of the studies were open trials, which are limited in terms of their ability to answer questions about effectiveness and few outcome data were reported. Coyle et al. (2011), reported no outcome data but stated that in study one there were some improvements in Child Behaviour Checklist (CBCL) scores but not Youth Self Report (YSR) scores and in study two that gNat Island had a positive impact but no outcome measurement is described (Coyle et al., 2011). In the trial of ReachOutCentral (Shandley et al., 2010), depression symptoms were only captured with the Kessler Psychological Distress Scale (which also includes items relevant to stress and anxiety) and there were no significant improvements from pre- to post-intervention. The authors did report that there were significant improvements in resiliency for females, but not for males.

Adherence and satisfaction

In terms of clinician or facilitator supported interventions, 85% of participants in the RCT of Think Feel Do completed all modules (Stallard). Study drop-outs but not adherence data were reported in the studies of gNats Island Journey to the Wild Divine and Freeze Framer.

In terms of the fully self-help interventions (SPARX, SPARX-Rainbow, The Journey and ReachOutCentral); between 60% and 90% of participants completed all 7 modules of SPARX (Fleming et al., 2012, Lucassen et al., 2013, Merry et al., 2012) and 94% completed all modules of the Journey (Stasiak et al., 2012). On average females spent a total of 91 minutes over 1.6 sessions on ReachOutCentral and males spent 69 minutes over 1.5 sessions (Shandley et al., 2010).

All of the studies had some measure of satisfaction, with at least moderate ratings for all the programs. Most studies did not include analysis of program content or detailed user feedback on program design.

DISCUSSION

In this systematic review, we have identified nine studies of six computerised interventions for depression which utilise gaming as a key component. Eight of the studies investigate the use of a tool for children or adolescents with depression or current symptoms. In most of these cases, the game is played on a computer and involves a fantasy world in which the user undertakes a virtual journey as they learn real life skills. Overall there were promising findings in terms of adherence (when reported) and in terms of impact on symptoms. However, all have been carried out by persons involved in the development of the intervention and all but one (Merry et al., 2012) are small trials. The remaining study is of ReachOutCentral (Shandley et al., 2010), an online program where users play the part of a new young person in town. ReachOutCentral was tested with an unselected sample (participants did not need to have symptoms), the average player used it for one to two sessions and there were few notable changes in outcomes. The lack of definitive detail and the limited nature of the trials does not allow meta-analysis at this time. That said, there is sufficient evidence to demonstrate that it is possible to develop game-based interventions to deal with the serious issue of depression; it appears that young people are willing to try these, the programs aimed at those with symptoms appear

to be likely to reduce symptoms of depression, and users report favourably on them.

Existing literature has demonstrated that computerised interventions for depression can be effective and that adherence is enhanced with therapist or paraprofessional support (Spek et al., 2007; Richards et al., 2012). Most of the computerised therapies use text, reading, video, diagrams and quizzes. Many incorporate social learning via videos or text and most include programming logic that allows feedback on user input. Serious gaming can add features of play, mystery and narrative (Klopfer, Osterweil, & Salen, 2009). Serious gaming may be valuable in increasing immersion and can allow the use of visual metaphor and egocentric as well as exocentric learning perspectives (Dede, 2009; Dondlinger, 2007). Whether serious gaming might increase uptake of computerised therapies or increase adherence to them has not yet been tested. Whether serious gaming might also have negative effects is also unknown. It is feasible that serious gaming programs could reduce face validity to some users and might decrease appeal to some groups.

Existing evidence shows that serious games can lead to improvements in diverse social, behavioural and clinical outcomes (Murray et al., 2005; Spek et al., 2007; Stinson et al., 2009). However the field is relatively new, and there has been little investigation of important questions such as the effects of serious gaming interventions on existing consumer-therapist relationships, health service utilisation, equity of access to care and consumer perspectives (Murray et al., 2005; Stinson et al., 2009). This review indicates that serious gaming might also be of use for depression, however at present this literature is very limited. Larger and more independent trials are required. Further, optimal gaming components and design elements have yet to be explored. Most studies provided very little program description and programs cannot be accessed easily for review. It is important that program content and design is reported to allow learning from previous research.

All included interventions focused on children, adolescents or young people (aged 9 to 25 years). This limitation does not reflect the diverse population of game users. While young

people have led the uptake of computerised games, games are now popular among many age groups. Computer gaming programs have been used for cognitive decline among older persons (Lim, & Chun, 2013) and the Playmancer project has developed physical fitness and movement based programs for older people (Kalapanidas et al., 2010). Expansion of serious gaming for depression into other age groups is also worthy of exploration.

The finding that many of the included interventions are delivered via technology such as CD-ROM highlights the important issue of time-lag from program development to published peer-reviewed findings and dissemination. The CD-ROM is rapidly dating and cannot be utilised on many devices. No programs were smartphone-based, even though a large and increasing proportion of internet access is via smartphones. Many of the programs described (with the exception of ReachOutCentral, and, to those with New Zealand IP addresses, SPARX) are not available outside of research settings. In contrast, there are many mental health apps and online programs which are publically available and which have been reported any impact on depression in peer-reviewed literature. Examples include games designed to enhance mood or to educate about depression, gratitude diaries and mood monitoring apps. The public deserve to know if these are safe and effective. Furthermore, the evidence-based clinically-validated sector should avoid lagging behind the rapid prototyping of the commercial sector. A more rapid development, testing and dissemination cycle of evidence-based mental health interventions is required. Models for such systems have been proposed (Glasgow, Phillips, & Sanchez, 2013).

Strengths and limitations

The literature regarding serious gaming is at an early stage. Inconsistent terms used to describe the aims or purpose of computerised programs targeting users with depression and the lack of a consistent nomenclature for serious gaming added complexity in defining included and excluded studies for this review. We have

endeavored to make thoughtful judgments about inclusion criteria and have been explicit about these. Studies are generally small and interventions are heterogeneous. These limitations preclude meaningful data synthesis at this time. It has been difficult to find out much information about the content of the interventions. Ideally we would have been able to complete each one, and an in-depth analysis of the type of game play would be worthwhile as this field develops. These various limitations mean that we can only make very tentative conclusions about the possible appeal and impact of serious games for depression.

We have explored only peer-reviewed literature regarding serious games for depression. Consideration of non peer-reviewed interventions and review of serious games for other aspects of mental health would also be worthwhile.

CONCLUSIONS

As the medium by which we can communicate broadens, it is likely that there is no universal method that will suit all problems and goals of treatment, or the all ways that people wish to access help. Rather, there needs to be a range of well-designed, proven tools which practitioners and users can choose from to suit the diversity of human circumstance and preference.

We are at the beginning of exploring how serious games might impact on depression. The current data suggest that it is possible to develop serious games for depression and that young people are willing to try them. Available data regarding adherence and impact is very limited but is promising. Given the potential gains in terms of increasing access globally, and meeting the needs of those reluctant to seek help through current methods, this is an area ripe for future development and testing.

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