Childhood anxiety prevention:

An evaluation of the applied game MindLight.

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CHAPTER 1

General introduction

General introduction

Anxiety disorders are the most prevalent mental health problems in childhood, affecting one in five children (Beesdo, Knappe, & Pine, 2009). Anxiety symptoms and their associated negative consequences, such as depression and poor academic performance, call for effective prevention programs (Beesdo et al., 2009; Kessler et al., 2012; Owens, Stevenson, Hadwin, & Norgate, 2012). To reduce the burden of anxiety symptoms, prevention programs should be accessible and appealing. Applied games for mental health offer a vehicle for delivering evidence-based preventive techniques while at the same time being accessible and appealing (Kazdin, 2015). Early research shows the potential of applied games (Baranowski et al., 2016); however, limitations in content and research exist. The studies described in the current thesis aimed to address these limitations and examined the efficacy and motivational affordances of the applied game MindLight for children with anxiety problems.

Anxiety: Scope of the Problem

Anxiety is a basic emotional response to danger that manifests physiologically in increased heart rate and sweating, and behaviorally in the tendency to avoid dangerous situations. These physiological and behavioral responses are adaptive when the danger is real (Lang, McTeague, & Bradley, 2016). However, anxiety becomes maladaptive when it persists, interferes with functioning, and is incommensurate to the reality of the danger (American Psychiatric Association, 2013). Anxiety disorders tend to have their onset in childhood (Beesdo et al., 2009). Moreover, they are the most frequent mental disorders in youth, with prevalence rates of around 20 per cent (Beesdo et al., 2009). Left untreated, these problems are likely to recur and increase the risk of developing other problems such as depression and aggression (Beesdo et al., 2009; Fraire & Ollendick, 2013; Kessler et al., 2012). Furthermore, even more children are impaired by subclinical anxiety symptoms, with prevalence rates of up to 49 per cent (Muris, Merckelbach, Mayer, & Prins, 2000). Anxiety symptoms may be less severe than those of clinical anxiety disorders; nevertheless, they too are distressing and interfere with the accomplishment of important developmental tasks during childhood, including acquiring social and emotional skills such as managing feelings, relationship skills, communication, and problem solving (Clarke, Morreale, Field, Hussein, & Barry, 2015). Failure to acquire social and emotional skills, in turn, puts further skills development at risk and contributes to other problems, such as lower academic scores (Owens et al., 2012) and lower general quality of life (Ramsawh & Chavira, 2016). Taken as a whole, the above confirms that preventing childhood anxiety disorders is of critical importance.

Anxiety Prevention Programs

Three categories of prevention programs can be distinguished (Mrazek & Haggerty, 1994) that aim to reduce levels of anxiety symptoms and/or prevent them from developing into disorders: indicated prevention programs target children who show elevated levels of anxiety symptoms;

selective prevention programs for children aim to modify existing key risk factors for developing anxiety disorders, such as an avoidant style of coping and behavioral inhibition (Rapee, 2002); and, universal prevention programs are suitable for children across the general population, regardless of possible risk factors or current symptoms. Several recent meta-analyses (Fisak, Richard, & Mann, 2011; Mychailyszyn, Brodman, Read, & Kendall, 2012; Stockings et al., 2016; Teubert & Pinquart, 2011) have shown reductions in the anxiety symptoms of young people who participate in prevention programs, with universal prevention programs showing lower effect sizes than programs targeting at-risk youth (i.e. selective or indicated; Mychailyszyn et al., 2012; Stockings et al., 2016; Teubert & Pinquart, 2011).

Prevention programs commonly include components of cognitive behavioral therapy (CBT), as this is the first-line treatment of choice for anxiety symptoms (James, James, Cowdrey, Soler, & Choke, 2015). In CBT, children are taught to identify their anxious feelings (i.e., emotions and physical sensations) and apply various techniques in increasingly anxious situations. Specifically, children learn to identify and challenge their maladaptive thoughts of the self, the world, or the future and to construct more adaptive and realistic thoughts (i.e., cognitive restructuring). In addition, they are taught how to relax using progressive muscle relaxation techniques, whereby muscle groups are tensed and then released (N.J. King, Hamilton, & Ollendick, 1988). In this way, they learn to recognize the difference between tension and relaxation and to apply relaxation techniques. Once they have mastered these skills, children are encouraged to actively seek out anxiety-provoking situations and to experience how they can reduce their own anxiety by applying them. This exposure technique is a key element of anxiety interventions (Kendall et al., 2005). Lastly, the children are rewarded for their efforts during the program and taught to reward themselves for similarly trying outside of the program (Dweck, 2017).

Limitations of Conventional Anxiety Prevention Programs

Although research has accumulated a base of evidence confirming the efficacy of conventional anxiety preventions programs, these programs have a number of shortcomings. First, there are several problems of accessibility. Parents of children with anxiety problems do not know where or from whom to seek help (Salloum, Johnco, Lewin, McBride, & Storch, 2016). When they do, a major barrier to seeking mental health services is stigma (Salloum et al., 2016). Parents fear being blamed for their children's mental health problems (Mukolo & Heflinger, 2011), while the young people themselves feel embarrassed and fear disapproval from their peers if they receive mental health care (Corrigan, 2004; Gulliver, Griffiths, & Christensen, 2010). Expectations of a negative response from family, peers, and school staff toward care-seeking results in the underuse of programs (Chandra & Minkovitz, 2006). In addition to these barriers, a preference for help from family and friends rather than professionals creates a treatment gap between youths who experience mental health problems and go on to seek and receive help and those who do not (Gulliver et al., 2010; Rickwood, Deane, & Wilson, 2007; Slone, Meir, & Tarrasch,

2013). Furthermore, even of those who do seek and receive help, a large percentage drop out of mental healthcare prematurely because of the stigma and costs (de Haan, Boon, de Jong, Hoeve, & Vermeiren, 2013; Salloum et al., 2016).

Another reason for dropout lies in a second drawback of anxiety prevention programs: they are not appealing or engaging to children (World Health Organization, 2012). Children are motivated neither to attend the sessions nor to complete the program's homework between sessions (Salloum et al., 2016). Taken together, these shortcomings suggest the need for accessible, cost-effective, and evidence-based alternative delivery methods that minimize stigma and maximize engagement (Salloum et al., 2016).

Applied Games for Mental Health

Applied games, or serious games, might be one such alternative delivery model. Recently, the potential of games that have been designed to improve the mental health of players while entertaining them at the same time has been explored (Lau, Smit, Fleming, & Riper, 2016). These applied games have several advantages over conventional mental health interventions including anxiety prevention programs. First, applied games are potentially more accessible than conventional prevention programs in that the vast majority of households own devices on which to play them, such as personal computers, smartphones, tablets, and game consoles (Entertainment Software Association, 2017). Applied games could thus close the mental health treatment gap by extending the reach of interventions to the large numbers of children who do not receive treatment for their mental health symptoms (Andrade et al., 2014). A second advantage that applied games offer is their appealing and engaging potential, reflected in the fact that almost all young people play games, on average for two hours a day (Lenhart et al., 2008; Rideout, Foehr, & Roberts, 2010). Games are developed to be exactly that: appealing and engaging. Games developers are experts at motivating people to play and continue playing, by making use of motivating characteristics such as challenge, curiosity, control, and fantasy (Malone & Lepper, 1987). Because of their engaging and appealing nature, applied games could reduce the high attrition rates associated with conventional anxiety prevention programs (de Haan et al., 2013). In summary, applied games could potentially overcome the shortcomings of conventional anxiety prevention programs.

Mental health clinicians and researchers have become interested in applied games for children in the last decade (e.g., Lau et al., 2016). However, few such games have been tested for efficacy by well-designed studies (Lau et al., 2016). Randomized controlled trials (RCTs) focusing on children and young people specifically have shown positive effects on a range of mental health symptoms. For example, the game Let's Face It! was found to improve the facial recognition skills of children with an autism spectrum disorder (Tanaka et al., 2010), while the Junior Detective Training Program was shown to enhance social skills and emotional understanding

in children with Asperger syndrome (Beaumont & Sofronoff, 2008). In other studies, children with attention deficit hyperactivity disorder (ADHD) showed improvements in inhibition as well as visuospatial short-term and working memory after playing Braingame Brian (Dovis, Van der Oord, Wiers, & Prins, 2015), and improvements in teacher-rated ADHD symptoms after playing Adventurous Dreaming Highflying Dragon (Weerdmeester, Cima, Granic, Hashemian, & Gotsis, 2016). Studies investigating the efficacy of SPARX (acronym for smart, positive, active, realistic X-factor thoughts) found a decrease in depressive symptoms in adolescent girls with subclinical depression (Poppelaars et al., 2016) and in adolescents seeking help (Merry et al., 2012). And finally, adolescents with elevated levels of anxiety symptoms were found to benefit from playing Dojo, as shown by a reduction in their anxiety symptoms after playing the game in either a school context (Scholten, Malmberg, Lobel, Engels, & Granic, 2016) or residential care (Schuurmans, Nijhof, Engels, & Granic, 2017). Taken together, the evidence suggests that applied games for youth mental health have promise but are just at the beginning.

Limitations of Applied Games Research

As mentioned above, despite their promise applied games for treating youth mental health are still in their infancy and have shortcomings in terms of both their content and the research methods used to evaluate them. Specifically, applied games designed by university staff often resemble digital versions of self-help programs or "chocolate-covered broccoli:" games with a training purpose wrapped up in entertaining elements that are still not much fun (Fairburn & Patel, 2017; Granic, Lobel, & Engels, 2014). The amount of text they contain may not match participants' reading abilities, making them a burden rather than an enjoyable experience (Johansson, Michel, Andersson, & Paxling, 2015). To make full use of their motivating and appealing nature, applied games should be designed in close collaboration with psychologists, games developers, programmers, artists, and stakeholders such as teachers, clinicians, parents, and children (Fleming et al., 2017; Knowles et al., 2014). In such multidisciplinary teams, evidence-based techniques can be integrated with evocative art and design to create engaging gameplay experiences and opportunities to practice skills for coping with anxiety problems (Scholten & Granic, 2018).

Besides these content shortcomings, studies investigating the effect of applied games on mental health symptoms have methodological shortcomings that restrict our knowledge about the size and nature of these effects. Few have used RCTs—the gold standard for evaluating interventions (Baranowski et al., 2016; Grist, Porter, & Stallard, 2017); those that have often incorporated wait-list or no-contact control groups (e.g., Beaumont & Sofronoff, 2008; Tanaka et al., 2010), leaving room for alternative explanations with regard to attention, motivation, behavioral activation, and expectations (Baranowski et al., 2016). In addition, with the exception of Poppelaars et al. (2016), the long-term effects of applied games have received little attention (All, Castellar, & Van Looy, 2016; Grist et al., 2017). To establish prevention efficacy and the

transference of skills outside of game contexts, children's mental health symptoms should be monitored after the games are no longer being played.

Overall, applied games show the potential to reduce children's mental health symptoms but do not meet children's standards in terms of fun and engagement. Past research, while informative and a foundation for future research, has failed to apply the highest standards of intervention research. We aimed to meet both children's engagement needs and the highest research standards, by developing an applied game for children with anxiety problems (MindLight) that could overcome existing engagement shortcomings and testing it with a rigorous research design. This thesis presents the results of this endeavor.

MindLight: Applied Game for Anxiety

To harness the potential of applied games to treat youth mental health and address shortcomings in existing applied games, MindLight was developed. Researchers with expertise in developmental psychopathology and intervention science teamed up with professional games developers. This team collaborated in turn with clinicians and children to produce a game that incorporates evidence-based techniques from intervention science and practice and is appealing and engaging to children at the same time. The goal was to develop a game that trains children to regulate their anxiety. Thus, a game world was created that would trigger (some) feelings of anxiety in order that children could practice regaining their calm. This approach is unique compared with other digital mental health interventions, which focus more on education about anxiety and less on actually practicing regulation strategies in anxious situations.

MindLight's narrative starts with a little boy named Arty being left on the doorstep of his grandmother's house (Figure 1 A). However, evil forces have possessed his grandmother and her house and have turned the place into a dark and scary mansion (Figure 1 B). Arty is faced with the task of saving his grandmother and her house by making it light again (Figure 1 C). In his bedroom, Arty finds a glowing hat with a light attached (i.e., a "mindlight") that teaches him to cope with his fears by changing his state of mind (Figure 1 D). In addition to employing an engaging narrative, the game's developers incorporated gaming elements that would make MindLight appealing. For example, players have to find hidden coins to unlock attention puzzles. The challenging nature of this task motivates children to continue playing. The puzzles stay challenging as well, because their level of difficulty increases during the game. Furthermore, a sense of control is offered by giving children the opportunity to hide in a box if the game becomes too intense. Thus, the narrative and appealing game elements make MindLight fun. Follow the link in the footnote for a gameplay video[1].

1 https://youtu.be/buNaErarLts

Given the importance of combining science with art, evidence-based techniques were translated into game mechanics and integrated into the narrative and game elements. The first evidence-based technique in MindLight is exposure, the most validated element of anxiety treatment (Kendall et al., 2005). A distinction can be made between situational and interoceptive exposure. During situational exposure tasks, children are repeatedly exposed to anxiety-provoking situations. Through this experience they learn that these situations are actually more safe than they usually believe (Rijkeboer & Van den Hout, 2014). In a conventional situational exposure exercise, children with a dog phobia, for example, might be asked to lie on the ground while the therapist walks a dog around and over them. In interoceptive exposure tasks, physical sensations such as shortness of breath or heightened cardiovascular activation are the focus of the exposure. Through repeated confrontation with these internal sensations, children learn that such sensations are tolerable and safe (Boettcher, Brake, & Barlow, 2016). A well-known conventional interoceptive exposure exercise is breathing through a straw (K. Lee et al., 2006), which exposes children to breathlessness and a racing heart. Both situational and interoceptive exposure are techniques to reduce anxiety and both are included in MindLight.

In conventional interventions, children are given exposure homework assignments in order to practice their skills. The problem with these assignments is that children often fail to execute them because they are not motivated to practice (Hudson & Kendall, 2002). In-game exposure tasks can be repeated more often if the game remains engaging enough (Lenhart et al., 2008; Rideout et al., 2010). In MindLight, the exposure tasks are designed in the form of a scary mansion through which children must navigate the avatar Arty. In addition, children encounter cat-like monsters and "fear events." To proceed in the game, children have to approach (rather than avoid) these monsters and shine their light into the monsters' eyes to make them step aside (Figure 2). Children also have to use their light to uncover fear events: threatening objects that turn into everyday ones once revealed (Figure 3). A horror theme—manifested in the scary, dark mansion, monsters, and frightening objects—was chosen because it has the potential to evoke the physical sensations that children commonly experience in anxious situations (Muris, Merckelbach, et al., 2000). Thus, while playing the game children are repeatedly exposed to anxiety-provoking in-game situations and associated somatic sensations. They eventually learn that these situations are safe and that the feeling of anxiety is tolerable.

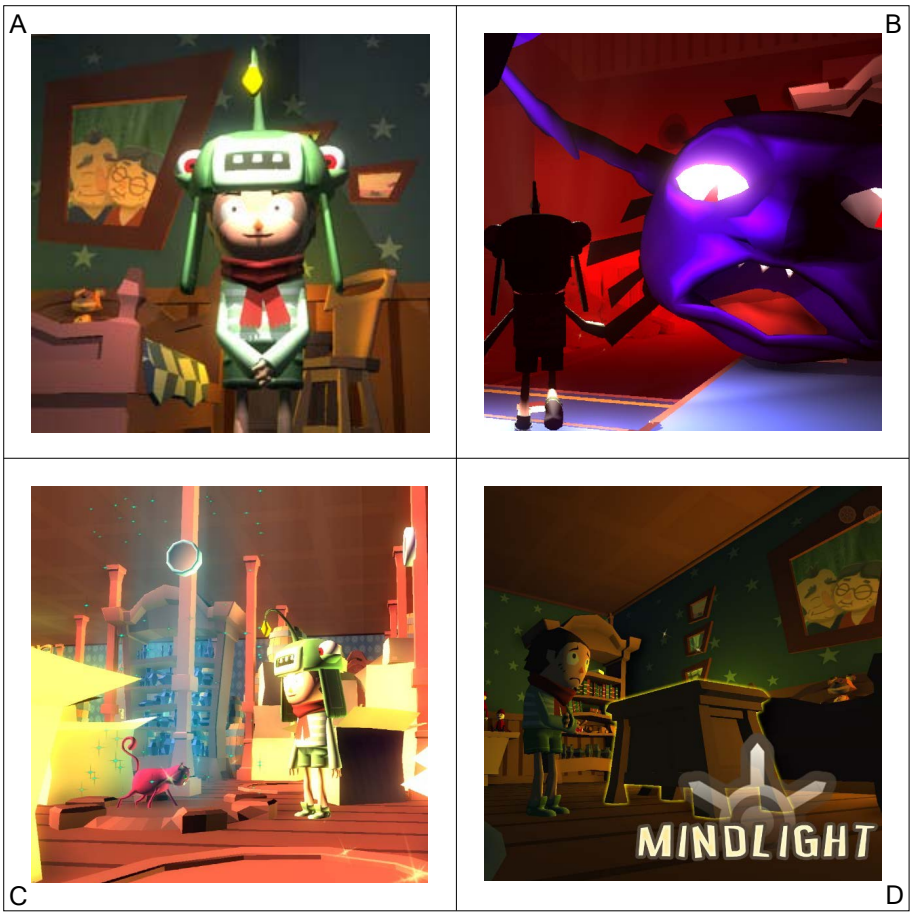


Figure 1. MindLight's narrative, with Arty in front of a picture of his grandfather and grandmother (A), Arty's possessed grandmother in her mansion (B), Arty having made the storage room light (C), and Arty looking for the glowing hat (D).

Figure 2. Arty shining his mindlight into the monster's eyes.

Figure 3. Arty shining his mindlight on a fear event in order to uncover it.

The second evidence-based technique in MindLight is attention bias modification (ABM; Bar-Haim, 2010), a technique that aims to reduce hyper-attention to potential threats (Dudeney, Sharpe, & Hunt, 2015). Conventionally, ABM is intended to retrain the attentional system to attend more to positive stimuli in the environment, using an ABM variant of the dot-probe task (Macleod, Mathews, & Tata, 1986). During this computer task, one threat-related (e.g., an

image of an angry face) and one neutral (e.g., an image of a neutral face) stimulus are briefly displayed on a screen simultaneously. After their disappearance, a target (e.g., '+' or ':') appears at the location of the threat-related or neutral stimulus. Participants must identify the target as quickly as possible. The target location is more often the former location of the neutral stimulus than of the threat-related stimulus, in order to retrain attention from threat-related to neutral stimuli. In MindLight, children have to quickly find, and then attend repeatedly to, positive stimuli (i.e., smiling faces) among several negative stimuli (i.e., threatening faces; Figure 4) in attention puzzles. When they solve an attention puzzle, they are rewarded by parts of the mansion becoming illuminated and monsters disappearing.

Figure 4. Arty attending to a smiling face in an attention puzzle.

The final evidence-based technique in MindLight is neurofeedback, a procedure that presents children with a real-time visual representation of electroencephalogram (EEG) recordings of their brainwaves. During a conventional procedure, children are trained to keep their EEG recordings within certain visual boundaries that are proxies of relaxation (Price & Budzynski, 2009). In MindLight, children wear a one-channel, dry-sensor EEG headset with one sensor on the forehead and one reference point on the ear lobe. The headset detects and converts their brainwaves into a continuous stream of relaxation and focus values (Johnstone, Blackman, & Bruggemann, 2012); these values are then used as input in the game and converted to "mindlight" and "mindbeam" respectively. Mindlight is the light that comes from the lamp on the glowing hat. Children use this light to explore the dark mansion, dazzle monsters, and uncover fear events. The more relaxed children are, the more light their hat emits and the quicker they

can advance through the game. Mindbeam is a beam of light between the glowing hat and the faces of the attention puzzles. To solve the puzzles, children have to attend to the smiling faces; the more focused they are, the quicker they solve them.

Current Thesis

The current thesis aimed to address shortcomings in the research methods used in previous studies investigating the efficacy of applied games. First, very few studies of applied games for youth mental health use the gold standard of efficacy research designs: the randomized controlled trial (RCT). In addition, in studies that do adopt this design the control group they use is often a no-contact or wait-list control group. To rule out the effect of attention, motivation, behavioral activation, and expectations, RCTs with active control groups are needed. **Chapter 2** presents the results of the first RCT, in which the effect of MindLight is compared with the effect of the commercial video game Max and the Magic Marker (i.e., active control group). As explained above, this kind of control group was chosen in order to be able to rule out alternative explanations (Baranowski et al., 2016). Max and the Magic Marker was selected for its age appropriateness and similarity in narrative: a little boy has to conquer obstacles in order to succeed. Importantly, Max and the Magic Marker was not explicitly designed with an anxiety reduction aim in mind and hence does not include evidence-based techniques. To compare MindLight with Max and the Magic Marker in an RCT, we matched the experimental and control groups on engagement and certain game elements (i.e., avatar, narrative, and goal), while varying included evidence-based techniques. This gave us the opportunity to test whether the specific elements of MindLight, rather than more general ones, would influence anxiety.

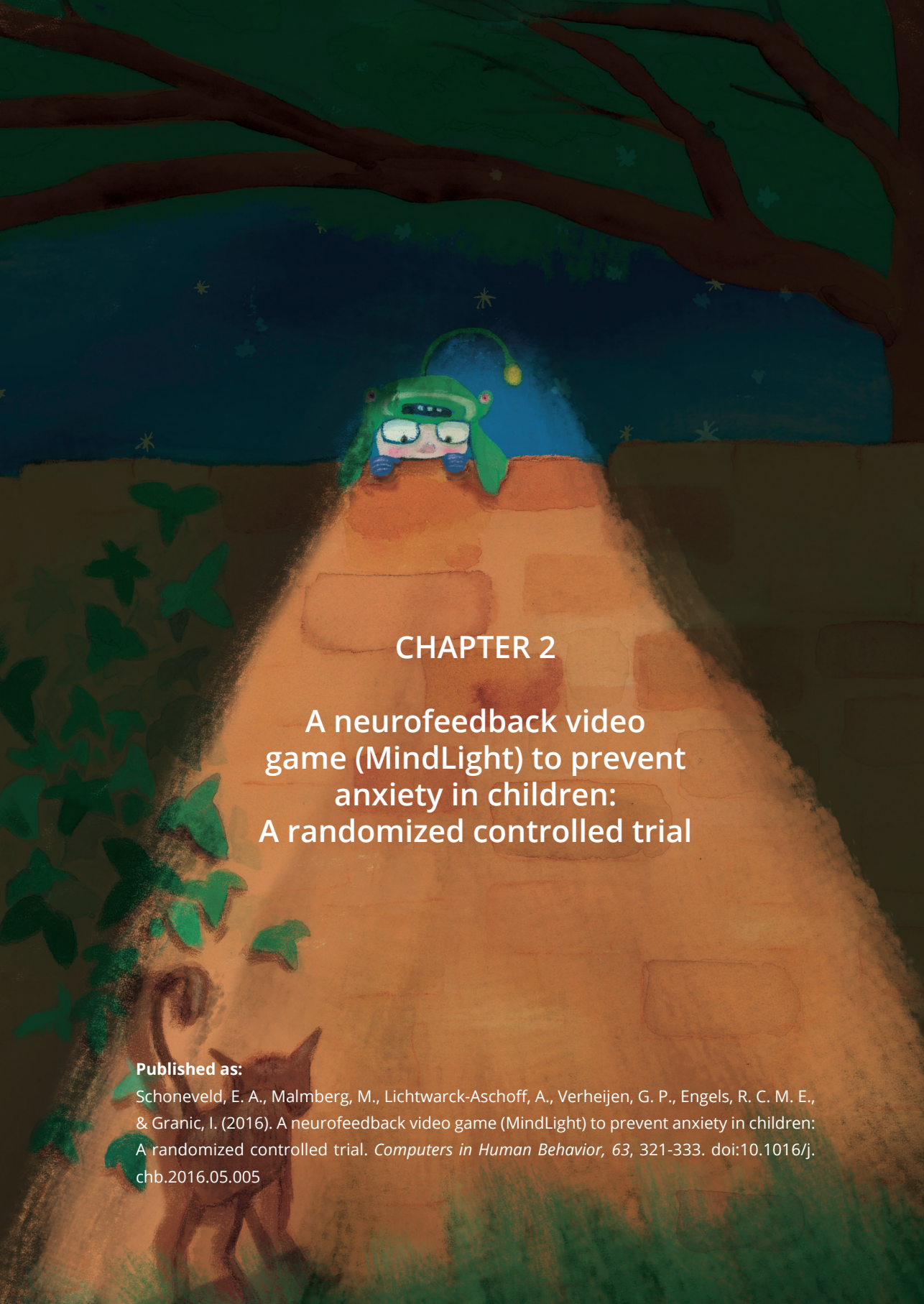
A next step was to more rigorously test for the efficacy of MindLight by demonstrating non-inferiority (i.e., equal efficacy) to the first-line treatment of choice for anxiety symptoms: CBT (A. C. James et al., 2015). To date, there are no studies that have directly compared applied games for anxious children with CBT (Fleming et al., 2017). To fill this gap, a non-inferiority RCT was conducted in which MindLight was compared with the evidence-based anxiety prevention program Coping Cat (van Starrenburg, Kuijpers, Kleinjan, Hutschemaekers, & Engels, 2017). **Chapter 3** describes the main outcome results of this second RCT, including parent- and child-reported anxiety symptoms.

Children who are anxious often also show symptoms of depression (Lavigne, Hopkins, Gouze, & Bryant, 2015) and conduct problems (Kidwell, Van Dyk, Guenther, & Nelson, 2016; Priddis, Landy, Moroney, & Kane, 2014). In addition, anxious children have difficulties with peer relationships (Hoglund & Chisholm, 2014) and low levels of self-efficacy (Mathews, Koehn, Abtahi, & Kerns, 2016; Niditch & Varela, 2012; O'Neal & Cotten, 2016). Given the detrimental effects of these problems on children's functioning, it seemed important to examine the effect

of anxiety prevention programs on these mental health indicators in addition to the primary target of anxiety symptoms. **Chapter 4** describes these secondary outcome results following the second RCT.

Furthermore, children differ in their response to prevention programs. For some, their mental health symptoms decrease, while for others the programs are ineffective. **Chapter 4** also answers the research question: for whom are MindLight and CBT effective? In line with previous research on CBT-based anxiety prevention programs, several outcome predictors were tested: baseline anxiety, maternal mental health problems, and self-efficacy.

We also sought to address a second shortcoming of applied games research: the focus on short-term outcomes. Children participating in our first RCT were assessed three months after they had finished the game. Those results are described in **Chapter 2**. In addition, our second RCT included both three- and six-month follow-up assessments, which are presented in **Chapters 3 and 4**. Furthermore, looking ahead the current thesis aimed to assess MindLight's implementation potential. Outside of a research context, the game should be so appealing and engaging to play that children would themselves choose to play it and want to continue playing. Therefore, we conducted focus group interviews with the children who played MindLight to assess its motivational affordances. The findings of these interviews are described in **Chapter 5**. Concrete suggestions and recommendations for the further development of MindLight are also included in this chapter. With these recommendations, our aim is to inspire games designers to make engaging and motivating applied games that have a beneficial impact on children's mental health. Lastly, **Chapter 6** presents a summary and discussion of the main findings, including limitations and implications for applied games research, applied game design, and clinical practice.



CHAPTER 2

A neurofeedback video game (MindLight) to prevent anxiety in children: A randomized controlled trial

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Abstract

Childhood anxiety is a global mental health concern. Interventions are needed that are effective, but also cost less, are more accessible and engage children long enough to build emotional resilience skills through practice. The present randomized controlled study aimed to examine the prevention effects of a neurofeedback video game, MindLight, developed based on evidence-based practices with anxious youth. Over 750 children (7-13 years old) in elementary schools were screened for elevated anxiety; 136 selected children were randomly assigned to play MindLight or a control game. Self- and parent-reported anxiety was assessed at pre-, post-intervention and 3-month follow up. Intent-to-treat analyses revealed an overall significant reduction in child- and parent-reported anxiety, but the magnitude of improvements did not differ between conditions. Future research comparing MindLight to cognitive-behavioral interventions is suggested, as well as testing a range of specific (e.g., exposure) and non-specific (e.g., expectations, motivation) therapeutic factors as mediators of outcomes.

Anxiety disorders are the most frequently diagnosed mental health problems, leading to devastating long-term outcomes that affect a huge proportion of children across the globe. Effective prevention programs are urgently needed; however, even our most advanced programs often lead to disappointing outcomes (Fisak et al., 2011; Mychailyszyn et al., 2012). Video games promise a new, playful training ground that may address limitations of past prevention approaches. The average 8 to 14 year old spends more than one hour per day playing video games (Rideout et al., 2010). By the time adolescents reach the age of 21, they will have spent at least 10,000 hours playing these games (McGonigal, 2011). Instead of spending this enormous chunk of time beating zombies in post-apocalyptic lands or taming dragons for treasure, what if these playful interactions were also training skills that prevent mental health problems such as anxiety disorders?

In medicine and education, enthusiasm for applied games has skyrocketed, capturing the imagination of practitioners and researchers alike (e.g., Kato, Cole, Bradlyn, & Pollock, 2008; O'Neil, Wainess, & Baker, 2005; Ritterfeld, Cody, & Vorderer, 2009; Vogel et al., 2006). The mental health field is poised to benefit enormously from a similar transformation (Granic et al., 2014). Applied games are video games used for non-leisure purposes and they hold immense potential to teach new forms of thought and behavior. Yet validated games for mental health are virtually non-existent. The current study aimed to evaluate, through a randomized controlled trial, a new neurofeedback video game designed to prevent the escalation of anxiety in at-risk children. In addition to testing the game's effectiveness at reducing early signs of anxiety problems, the study addressed serious methodological limitations that have hampered past studies on applied games.

Scope of the Problem

Anxiety disorders are the most prevalent form of psychopathology, and earliest to emerge, affecting up to 18% of children and adolescents (Beesdo et al., 2009). A much larger proportion of youth report sub-clinical anxiety symptoms, which cause immediate impairment as well as increased risk for the development of full-blown anxiety disorders later. The prevalence of subclinical anxiety is estimated at an alarming 40% in children, with mood disturbances peaking in 13 to 15 year olds (Muris, Merckelbach, et al., 2000). Left untreated, anxiety disorders are stable over time and associated with premature withdrawal from school, lowered school performance, substance use, early parenthood, behavioral problems, and suicidal behavior (Essau, 2003; Kendall, Safford, Flannery-Schroeder, & Webb, 2004; Woodward & Fergusson, 2001). Implementation of effective prevention programs, before full-blown anxiety disorders develop, can have far more impact than treatment, especially if these prevention efforts are targeted at the pre-adolescent period, before symptoms peak (Dadds et al., 1999; Hirshfeld-Becker & Biederman, 2002).

Evidence-based Prevention Programs

Meta-analyses have established that programs based on Cognitive Behavioral Therapy (CBT) are among the most effective current approaches for the prevention of anxiety (Fisak et al., 2011; Mychailyszyn et al., 2012; Nathan & Gorman, 2007; Weisz & Kazdin, 2010). CBT approaches attempt to address the varied causal mediators of anxiety by targeting avoidance and withdrawal strategies through exposure techniques coupled with relaxation training. CBT also aims to shift cognitive biases characterized by vigilant attention to, and distorted interpretations of, potential threats by teaching reappraisal and problem-solving skills (Kendall, 2011).

Although CBT is among the best evidence-based practice we have currently, advancing through decades of research and refinement, outcomes remain mixed and effect sizes are in the small to moderate range (Fisak et al., 2011; Mychailyszyn et al., 2012). The main assumption underlying the current prevention trial was that these often disappointing prevention outcomes result from limitations in the delivery model of CBT, not the principles themselves (Kazdin & Blase, 2011; Kazdin & Rabbitt, 2013). Applied video games could provide one potential solution in the "portfolio" (Kazdin & Blase, 2011) of promising delivery models. The cost-effectiveness and scalability potential of using video games for prevention purposes are enormous, if they prove effective.

But more specifically, video games may provide a more effective learning context than conventional classroom-based programs for several reasons (Granic et al., 2014): (1) Motivation: The key predictor of intervention outcomes is motivation for change (C. C. Lewis, Simons, & Kim, 2012; C. C. Lewis et al., 2009; Taylor, Abramowitz, & McKay, 2012). Yet children exposed to prevention efforts at school rarely are motivated to change their behavioral and emotional patterns. Games, in contrast, are intrinsically motivating, offering a strong sense of agency and fun and rewarding children for self-directed goal-setting and perseverance. (2) Practice: The vast majority of prevention programs are psychoeducational in nature, providing a great deal of knowledge but few opportunities to put this knowledge into practice. CBT tries to address this problem through role-playing and homework assignments (Kendall, 2011), but these exercises are time-limited, potentially embarrassing, unconvincing as simulations, and often boring. Video games engage players in authentically emotional experiences and provide opportunities to practice new regulatory skills until they are automatized and can be generalized outside the game. (3) Personalization: Conventional prevention approaches are unable to tailor interventions to the diverse needs and learning paces of at-risk children. By design, video games are self-tweaking systems that adjust dynamically to the player's actions. Each player's in-game progress dictates the degree of difficulty and reinforcement, maintaining an optimal balance for individual players (Liu, Agrawal, Sarkar, & Chen, 2009). (4) Access and cost: Approximately 80% of youths who need mental health care receive no services (Kataoka, Zhang, & Wells, 2002). Those most in need of care have a difficult time accessing programs because of ethnic

disparities, geographical or life-style factors (e.g., Wells, Klap, Koike, & Sherbourne, 2001). Cost is also a major barrier to access for many in need (Collins, Westra, Dozois, & Burns, 2004). Games are relatively inexpensive and provide easy, in-home access to a potentially large base of individuals in need.

MindLight: Evidence-based Game Design

Video games hold immense promise as novel intervention engines through which evidence-based techniques could be delivered through an appealing context. But designing video games that can compete with children's high expectations for fun, immersion and sophisticated design requires expertise that research psychologists, by training, lack. The design and development of MindLight was a cross-disciplinary collaboration among academics in developmental psychopathology, clinicians, professional game designers (artists and programmers) and the target users themselves (children).

The goal in designing MindLight was to translate the empirically-sound, but often dull, clinical techniques for anxiety reduction into game mechanics that could provide children with hours of immersive practice. The imperative was to make a game that did not explain how to cope with anxiety (i.e., psychoeducation), but one that trained children, playfully. Thus, the game needed to trigger authentic feelings of (some) anxiety, over the full course of the game, so that players were motivated to learn to regulate that anxiety and to practice regaining their calm after anxious feelings were repeatedly evoked.

To create this game world, MindLight starts with little Arty left at the doorstep of a scary mansion faced with the task of saving his grandmother from the evil forces that have possessed her and the house. There he finds a glowing headset that teaches him (and the player) to overcome his fears by changing his state of mind. Several theoretically-grounded, evidence-based strategies for decreasing anxiety are embedded in the game. The first is neurofeedback training, a procedure that conventionally presents individuals with real-time electroencephalogram (EEG) recordings from their own brain, on a computer screen. Changes in brainwave patterns (i.e., reduction in relative beta power and increases in relative alpha power) have been identified as proxies of relaxation. Participants are guided through relaxation methods to keep their EEG waves consistent with those proxy indices (Price & Budzynski, 2009). In MindLight, children use a one-channel, dry-sensor EEG headset (Johnstone et al., 2012) that transforms the raw EEG values and converts them to gradations in a light that glows from the avatar's head in the game. The more relaxed players become, the brighter the mindlight shines; the light is the only way that players can see in the dark haunted house (Figure 1). When players become anxious, the light dims and they are forced to regain their calm to see again; thus through neurofeedback reinforcement mechanics, the child is trained to identify and shift his mind states.

Figure 1. Screenshot of light shining when player is calm.

The second evidence-based strategy incorporated in the game is exposure training, the most empirically-validated treatment component of CBT for anxious individuals (e.g., Feske & Chambless, 1995). The game uses mechanics that encourage players to try a variety of relaxation techniques (e.g., deep breathing, self-talk) while they approach (rather than avoid) fear events. Figure 2 shows an example of a fear event in which players must relax and grow their mindlight to discover the benign nature of a seemingly threatening stimulus. Threats also become increasingly difficult to avert and ignore throughout the game (e.g., black cats more frequently stalk and screech at the avatar) and the only way to thwart these threats is by remaining calm and moving towards them. When players successfully maintain a calm state after repeated attacks (e.g., by cat-like monsters) they are rewarded by the critter becoming "decloaked" and turned into a friendly kitten that follows them throughout the game as a reminder of past fears conquered.

The final evidence-based strategy incorporated in the design of MindLight is attention bias modification (ABM), a training protocol based on evidence that attentional biases characterized by hyper attention towards potential threats play a role in the pathogenesis of childhood anxiety (Muris, 2006). ABM seems to reduce anxiety (at least in the short term) by retraining the attentional system to attend proportionally more to positive stimuli compared to negative material (Bar-Haim, 2010; Bar-Haim, Morag, & Glickman, 2011). The problem with conventional ABM training is that it is based on a modified dot-probe task, a task that is exceedingly boring and difficult to keep individuals (especially children) engaged with (Hakamata et al., 2010). MindLight uses the main principles from the dot-probe training but applies gaming elements.

Using a combination of mouse-clicks and the neurofeedback device, children are rewarded for attending, and quickly responding to positive stimuli (e.g., smiling faces) and disattending, or shifting attention away from, negative stimuli (e.g., angry faces; Figure 3).

Figure 2. Screenshot of uncovering a fear event.

Figure 3. Screenshot of ABM puzzle with threatening and happy faces.

Methodological Considerations

We sought to test the effects of MindLight on the prevention of childhood anxiety with research design elements that address limitations in the vast majority of evaluations conducted on applied games. First, very few studies on applied games use randomized controlled trials (RCTs) that conform to CONSORT standards (Schulz, Altman, Moher, & CONSORT Group, 2010). Almost none have been conducted in the mental health arena (Baranowski, Buday, Thompson, & Baranowski, 2008; Granic et al., 2014; for exception, see Merry et al., 2012). In order to be confident about the benefits and generalizability of MindLight, or any other applied game, RCTs with standardized assessment measures and adequate sample sizes are essential (Baranowski et al., 2008; Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Girard, Ecalle, & Magnan, 2013; Granic et al., 2014; Kane, Wang, & Garrard, 2007; Primack et al., 2012). In addition, the almost exclusive focus on short-term effects is a serious concern with past approaches. Immediate, short-term effects are not enough to establish the prevention promise of a new applied game; rather, a reasonable longitudinal follow-up assessment, after the game is no longer being played, is required to establish transfer and "real-world" relevance.

Another serious limitation of practically all studies on applied games is the choice of appropriate control groups (Connolly et al., 2012; Girard et al., 2013). Active control groups, rather than wait lists or no-contact control groups, are essential to insure that attention, motivation, behavioral activation, and expectations do not account for improvements in the experimental condition (Boot, Simons, Stothart, & Stutts, 2013; Christensen, Griffiths, & Jorm, 2004; White et al., 2013). Moreover, the large impact of personal expectations on the outcomes of experiments has been well-established, and it is crucial to equalize these expectations across conditions (Boot et al., 2013).

Design and Hypotheses

The current study aimed to test the effect of MindLight on children with elevated levels of anxiety, with particular attention to addressing weaknesses in past research designs. Specifically, we conducted a sufficiently powered, 2-armed indicated prevention RCT, with standardized, reliable, and multi-informant measures of outcomes and included a three-month follow-up assessment. Our active control group played Max and the Magic Marker (herein shortened to Max), an award-winning, commercially successful game that was carefully selected for its high quality (insuring engagement), age-appropriateness, and its inclusion of a child "underdog" avatar who had to conquer fearful obstacles. Unlike MindLight, however, Max was not explicitly designed to incorporate evidence-based anxiety-reduction techniques.

To minimize differential expectations that may bias outcomes, before children knew the condition to which they were assigned, both games were described to participants and they were told at that time that both games could help with feelings of anxiety. Expectations of the

effects of both games on anxiety problems were then also measured and used to test whether the manipulation to equalize expectations worked and to control for those expectations if differences did emerge.

Our primary hypothesis was that children who played MindLight, compared to Max, would report reduced symptoms of anxiety at post-intervention and 3-month follow-up. We also expected parents' reports of children's anxiety to show improvements in the MindLight group, compared to Max. We examined age and gender as possible moderators of outcomes, with no hypotheses put forward, given that the narrative and art of both games was designed to appeal to both genders and across the age span of 8 to 12 years old.

Because MindLight has never been evaluated or implemented, our second set of hypotheses dealt with the appeal of the game. The fundamental attraction of video games is that they are deeply engaging and keep children motivated to play. In order to consider the design of MindLight at least partially successful, it had to engage youth through mechanics that first and foremost prioritize this fun, otherwise a key rationale for turning to games as an effective intervention tool is lost. However, our clinical and scientific aim was also to induce anxiety the same premise for all exposure therapy with this target group in order to create a compelling context that motivated children to effectively regulate that anxiety. Thus, we had the difficult but critical goal of both inducing anxious feelings and making this experience an engaging and fun one. We hypothesized that children would find MindLight anxiety-inducing, in line with the intervention exposure goals of the game and we also tested whether MindLight was rated equally appealing as the commercially successful control game Max.

Materials and Methods

Procedure

A total of 78 primary schools in the southeast part of the Netherlands were contacted by telephone to provide information on the study and to ask if they were interested in participation. Eight schools agreed to participate and two members of the research team visited these schools to provide more detailed information. The design and data collection procedures were approved by the ethics committee of the Faculty of Social Sciences of the Radboud University (ECSW2013-0410-139). The trial was registered in the Dutch Trial Register (Nederlands trial register; www.trialregister.nl; Trial ID: NTR4366).

Participants were recruited through two phases: a screening (November 2013 to January 2014) and inclusion phase (February 2014 to July 2014). In the screening phase, all students from 3rd to 6th grade and their parents received a letter with information about the study goals and

the screening procedure. Five schools participated in a passive consent procedure in which parents were sent an information letter about the screening process and if they preferred that their child did not participate, they indicated so by returning the letter with that information included. The other three schools followed an active consent procedure during which a letter was sent to parents indicating that they had to indicate whether they agreed to their child's participation in the screening. All children with parental permission (N = 757) were screened on anxiety symptoms by the child version of the Spence Children's Anxiety Scale (SCAS; Spence, 1998). Questionnaires were completed in the classroom during school hours in the presence of two members of the research team.

In total, 205 (27.1%) children met criteria for elevated anxiety and were selected for potential inclusion in the RCT. Elevated anxiety was operationalized based on Muris, Schmidt, and Merckelbach (2000) total scores. Children were eligible if either (a) the total score on the SCAS was one standard deviation above the mean or (b) at least two subscales of the SCAS were one standard deviation above the mean. The obsessive compulsive disorder subscale was not included, because it is no longer considered an anxiety disorder in the Diagnostic and Statistical Manual of Mental Disorders V (DSM-V; American Psychiatric Association, 2013). After the screening, we eliminated two of the eight schools based on the small number of eligible participants in these schools (n = 2 and n = 12).

The parents of children with elevated anxiety symptoms from the remaining six schools were contacted by telephone, informed about the study goals, and invited to participate with their child. They then gave initial verbal consent. They were also asked if their children were already receiving mental health services, in which case children were excluded from further participation. At pretest (see below) the children were given a consent form for their parents to also give written consent. There were 136 parents who agreed to have their children participate in the RCT (Figure 4). Schools following an active, compared to a passive, consent screening procedure were similar in the proportion of screened children that were selected (26.4% and 26.5% respectively). Subsequent participation rates of selected children were higher in schools with an active (89.7%), compared with passive consent screening procedure (67.8%).

The 136 children and their parents were randomly assigned to either the experimental or the control condition. Children and their parents were asked to fill out questionnaires three days before the intervention started (i.e., pretest) and before knowing to what condition they were randomized. Children completed the questionnaires on laptops in groups of 7 to 19 children (M = 13.40, SD = 3.86) at school, after school hours. Expectations were equalized by providing children with a description of both games, which included a screenshot, and the direction that the obstacles and difficulties can be overcome by using their own minds. Completion of the questionnaires took approximately 45 minutes. Parents were asked to fill out an online

questionnaire and were sent the link by email. Three days after the pretest assessment, children began with play sessions. At that time, half were assigned to play MindLight (experimental condition) and the other half were assigned to Max (control condition).

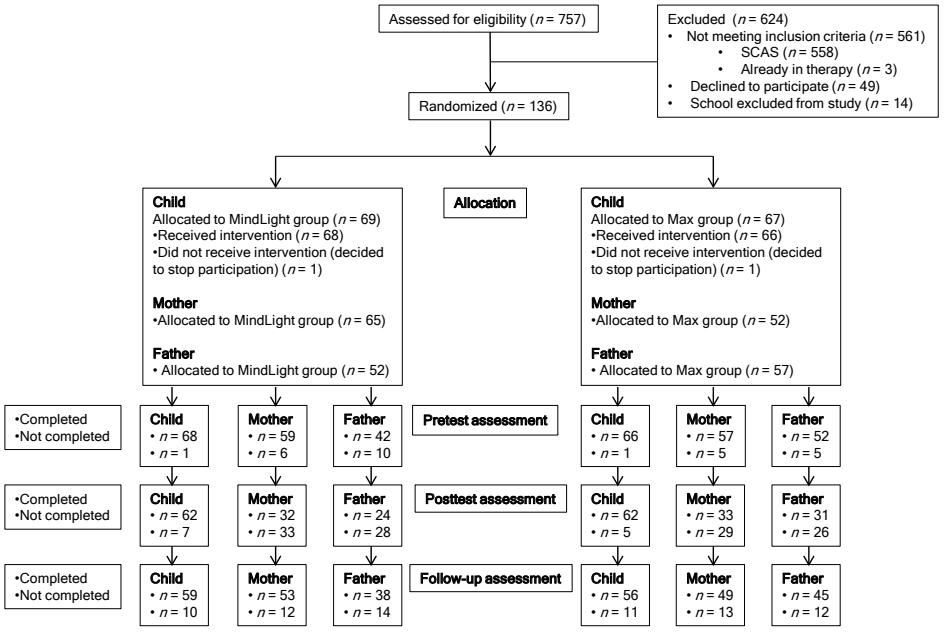


Figure 4. Flow chart of participants through the trial.

In both groups, the children played their video game for 5 one-hour sessions, scheduled twice a week. Each session took place at school after school hours in groups of 7 to 19 children from both conditions and was supervised by two research assistants. The children were seated at least one table away from each other and used earplugs to hear the game sound and to diminish other distractions. At the beginning of the first session, the research assistants gave more information about the game and instructions on how to start the game, separately for MindLight and Max. This introduction was summarized in all subsequent sessions. At the end of the last session, children received a diploma to commemorate their participation in the intervention. The posttest assessment was carried out three days after the final game session and the follow-up assessment three months after posttest (June 2014 to October 2014). The same procedure that was followed at pretest was conducted at posttest and follow-up. The only exception was that, at follow-up, 4 children were visited at home because they had changed schools. Parents received €40 as compensation for completing all the questionnaires.

Sample size

We estimated our targeted sample size based on a small effect size (eta^2) of 0.14 using the statistical power analysis program G*Power 3 (Faul, Erdfelder, Lang, & Buchner, 2007). We based our effect size on previously tested computerized self-help interventions (Merry et al., 2012). Moreover, previous research shows that sampling participants with elevated levels of anxiety, but without a diagnosis, has a negative influence on the expected effect size (Teubert & Pinquart, 2011). The criteria entered were: alpha = 0.05, power = 0.80 and a small effect size (eta^2 = 0.14) two-sided testing. A pre-post (within) by two groups (between) ANOVA requires 70 children in each study condition leading to a total sample size of 140 children.

Randomization

Randomization was carried out by an independent researcher from our research institute and applied within schools. Participants within one school were equally assigned to the Max or the MindLight condition. Randomization was stratified by sex and grade. Four separate groups were created: younger girls (grade 3 and 4), older girls (grade 5 and 6), younger boys (grade 3 and 4) and older boys (grade 5 and 6). Children within these groups were randomly assigned to the MindLight or Max condition using the SPSS random number generator.

Participants

A total of 136 children were randomized (Figure 4). Children ranged in age from 8 to 13 years (*M* = 9.95, *SD* = 1.33) at pretest and 54.8% were girls. The majority of the children were of Dutch descent (89.7%). Most children attended all five game sessions (*n* = 110; 80.9%); mean number of game sessions was 4.71 (*SD* = 0.69). In most cases, both parents participated in the study (*n* = 100). The parent sample consisted of 127 mothers and 109 fathers. At pretest, mothers ranged in age from 27 to 52 years (*M* = 41.17, *SD* = 4.32) and fathers from 32 to 62 years (*M* = 44.65, *SD* = 4.95). The majority of parents were of Dutch descent (88.2% of mothers, 81.7% of fathers). Details about attrition at follow-up for both children and parents are presented in the additional files (see Appendix A).

Game Interventions

Max and the Magic Marker (control condition). Max is a puzzle platform video game (developed by Press Play; http://maxandthemagicmarker.com/) in which children control Max, a small, seemingly vulnerable boy, and use a marker to draw inside the game world. These drawings are used to overcome challenges and fend off enemies. Max begins with an introductory video showing the young boy receiving a marker in the mail which he decides to test. He draws a monster, which becomes real and runs off the paper into another drawing. The monster destroys the drawing and Max is charged with overcoming his fears and destroying the monster. The game has three different worlds inspired by children's drawings, each with five levels with death traps, monsters and puzzles. Max has won several awards including Independent Games Festival and European Innovative Games Award.

We chose Max as the control condition, because active control groups, rather than wait lists or no-contact control groups, are essential to insure that attention, motivation, behavioral activation, and expectations do not account for improvements in the experimental condition (Boot et al., 2013; Christensen et al., 2004; White et al., 2013).

MindLight (experimental condition). MindLight is a neurofeedback video game produced by the PlayNice Institute (http://theplayniceinstitute.com/) and developed with GainPlay Studio (http://www.gainplaystudio.com/). In MindLight, children control Arty and his magical hat Teru using a Microsoft Xbox 360 controller and a one-channel dry-sensor EEG headset. The headset has shown to derive valid measures of alpha, beta and theta EEG power bands from frontal regions corresponding to the F3 site, comparable to research-grade EEG systems, both with adults and children (Johnstone et al., 2012). A description of the gameplay in MindLight is presented in the additional files (see Appendix B).

Measures

Anxiety symptoms. The child and parent versions of the Spence Children's Anxiety Scale (SCAS; Spence, 1997, 1998) were administered to measure anxiety symptoms in children. The children's version (SCAS-C) is a 45 item self-report questionnaire that measures symptoms of six DSM-IV defined anxiety disorders, namely: separation anxiety disorder (6 items); social phobia (6 items); panic disorder and agoraphobia (9 items); physical injury fears (5 items); generalized anxiety disorder (6 items); and obsessive-compulsive disorder (6 items). There are also 6 positive filler items to reduce negative response bias. Each item of the SCAS-C is rated on a 4-point scale: 0 (*never*), 1 (*sometimes*), 2 (*often*) or 3 (*always*). The SCAS-C has shown good concurrent validity and reliability (Muris, Merckelbach, Schmidt, & Mayer, 1999; Muris, Schmidt, et al., 2000; Spence, 1998).

The parent version of the scale (SCAS-P; Nauta et al., 2004) parallel the items of the SCAS-C, with the only difference being that the filler items are not included; it also shows good convergent validity and reliability (Brown-Jacobsen, Wallace, & Whiteside, 2011; Nauta et al., 2004; Whiteside & Brown, 2008). Cronbach's alpha for the child version was 0.88, for mothers, 0.86 and for fathers, 0.87.We calculated two outcome variables based on the SCAS-C. Total anxiety symptoms refers to the mean of all items except the filler items and personalized anxiety symptoms refers to the mean subscale score of the subscale on which the child scored highest at screening.

Time spent playing games. Children were asked how many hours they played video games on average per week. They could answer in an absolute number to this open question.

Game expectations. Expectations of whether the games would improve coping with anxiety were assessed at pretest, before children knew the condition to which they were assigned. All children read a short description of both games. Then they were asked to indicate whether

they believed their "real-life" behavior could be improved by playing MindLight or Max. This was measured with the question "Do you think that playing MindLight/Max can help you feel less afraid?" Children could respond with "*yes*" or "*no*".

Game evaluations. To measure the appeal of the games, we asked children to evaluate the game that they played at posttest and follow-up. Children were asked to answer the following 6 questions on a 5-point scale ranging from 0 (*strongly disagree*) to 4 (*totally agree*), with the name of the game they played inserted in square brackets: 1) Personal Appeal: "I liked playing [the game]"; 2) Appeal to others: "I think [the game] is a nice game for other children"; 3) Relevance: "I can use what [the game] teaches me in my daily life"; 4) Flow: "I forget the things around me when I am playing [the game] "; 5) Anxiety inducing: "I think [the game] is a scary video game"; and 6) Difficulty: "I think [the game] is a difficult video game."

Strategy of analyses

We performed χ^2 tests and *t* tests to investigate whether randomization had resulted in an equal distribution of relevant participant characteristics across the two conditions. Next, we calculated the means and standard deviations of the total anxiety symptoms (both parent and child reports) and the personalized anxiety symptoms (child reports) and conducted *t* tests for independent groups to examine differences between the Max and the MindLight group at each time point. For the main effect analyses, we used Mplus 7 for intention-to-treat (ITT) analyses (Muthén & Muthén, 1998-2012a). Missing data were handled by multiple imputation (MI), using the Markov Chain Monte Carlo (MCMC) method (Graham, 2009). A total of 50 datasets were completed by MI and prepared for data analyses. Mplus reads in the 50 datasets via the TYPE = IMPUTATION option and carries out the desired analysis for each dataset. The results of the 50 data sets were then averaged over the set of analyses. The standard errors of the parameter estimates are computed by averaging the standard errors over the set of analyses and using the between analysis parameter estimate variation (Schafer, 1997).

We performed linear regression analyses with anxiety symptoms (i.e., total and personalized anxiety) as the dependent variable and study condition as independent variable, while controlling for baseline anxiety levels and potential confounders. We also corrected for potential non-independence (clustering) of the data by using the TYPE = COMPLEX procedure in Mplus.

To explore the moderating role of sex and age in the relation between study condition and anxiety symptoms, we calculated interaction terms between condition (0 = Max, 1 = MindLight) and sex (boy = 0, girls = 1) and between condition and age. Beforehand, we centered age to avoid multicollinearity (Kraemer & Blasey, 2004). The interaction terms were then included in the model as predictor variables.

Next, we examined the effects of MindLight on individual levels of anxiety symptoms at baseline (i.e., intercept) and changes in anxiety symptoms over time (i.e., slope) by using Latent Growth Curve Modeling (LGCM) (Duncan, Duncan, & Strycker, 2006). LCGM takes into account individual differences in anxiety symptoms at baseline (pretest) and the rate of change in anxiety over time. Therefore, LCGM provides a good method to look at individual variation in the development of anxiety and to test if the study condition relates to these changes over time. All available pair-wise information in the data was used to deal with missing data (Asparouhov & Muthén, 2010). The Chi-square and *p*-value, the Comparative Fit Index (CFI > 0.95), and the Root Mean Square Error of Approximation (RMSEA < 0.05) were used to assess the goodness of fit of the model (Hu & Bentler, 1999). First, we estimated the initial developmental model for both conditions separately based on the three time points (i.e., pretest, posttest, and follow-up) without any predictors or control variables. Second, we tested if study condition predicted the initial level of anxiety symptoms (i.e., intercept) and/or the rate of change (i.e., slope) in anxiety symptoms. Third, we investigated interaction effects between the study condition on the one hand, and sex and age on the other. Even though we systematically tested interaction effects on the intercept and the slope, we interpreted significant interactions on the slope because we were interested in change over time and not baseline differences.

Results

Descriptive Statistics

Table 1 presents means and *SD*s on baseline assessments including sex, age, and weekly game time, separate for the two conditions; no differences between the two game conditions were found. Table 1 also shows that there were no differences between children in the MindLight and Max conditions on game expectations at baseline, confirming our manipulation to equalize these expectations between the two conditions was successful. As a result, we did not control for any of the demographic, game time or expectations variables in subsequent analyses.

Table 2 shows the means, *SD*s, and *t* values for outcome measures, the total anxiety symptoms (both parents and child reports) and the personalized anxiety symptoms (child report) at all time points for both groups. We found no differences in anxiety symptoms between the MindLight and Max conditions at pretest; at posttest, children in the MindLight group reported lower mean scores on total anxiety symptoms compared to children in the Max group and at follow-up, no differences were found. Furthermore, at posttest 52.2% of children who played MindLight and 41.8% who played Max no longer reported elevated levels of anxiety. At follow-up, these percentages were 46.4% and 50.7% respectively.

Table 1
Similarities on Age, Sex, Weekly Game Time, and Expectations at Pretest by Conditions

			Mindlight	**Max**	**Test result**
Age	Mean (*SD*)		9.93 (1.42)	9.97 (1.24)	$t_{(132)} = 0.19$
Sex	N (%)	Boys	30 (44.1)	31 (47.0)	
		Girls	38 (55.9)	35 (53.0)	$\chi^2_{(1)} = 0.11$
Weekly game time	Mean (*SD*)		4.97 (4.65)	7.92 (14.93)	$t_{(131)} = 1.55$
Mindlight expectations	N (%)	Yes	50 (73.5)	54 (83.1)	
		No	18 (26.5)	11 (16.9)	$\chi^2_{(1)} = 1.78$
Max expectations	N (%)	Yes	34 (50.0)	33 (50.8)	
		No	34 (50.0)	32 (49.2)	$\chi^2_{(1)} = 0.01$

Note: All test results were non-significant. Expectation: answer on question "Do you think that playing MindLight/ Max can help you feel less afraid?".

Table 2
Means, Standard Deviations and T-values of Anxiety Symptoms and Game Evaluations Separately by Conditions

	Pretest		
	MindLight	Max	*t* value (*df*)
Child anxiety			
Child: Total anxiety	0.88 (0.34)	0.97 (0.39)	1.42 (132)
Child: Personalized anxiety	1.29 (0.51)	1.33 (0.49)	0.51 (132)
Mother: Total child anxiety	0.45 (0.24)	0.45 (0.23)	-0.02 (115)
Father: Total child anxiety	0.38 (0.21)	0.41 (0.24)	0.64 (92)
Game Evaluations			
Anxiety-inducing	-	-	-
Appeal to self	-	-	-
Appeal to others	-	-	-
Relevance	-	-	-
Flow	-	-	-
Difficulty	-	-	-

Note: * = $p<.05$; *** = $p<.001$.

Correlations between variables across time points are presented in Table 3. The cross-sectional correlations between child and parent reports on anxiety symptoms were not significant at pretest and posttest. At follow-up, the child and maternal reports were positively correlated. Lastly, maternal and paternal reports were positively correlated. *t* tests comparing boys and girls on anxiety symptoms and game time were conducted. Girls scored higher on all but one (i.e., paternal reports) pretest anxiety scores (total anxiety: $t(132) = 4.18$, $p = 0.000$; personalized anxiety: $t(132) = 2.55$, $p = 0.012$; maternal report: $t(115) = 2.12$, $p = 0.036$; paternal report: $t(92) = 1.51$, $p = 0.135$), all posttest anxiety scores (total anxiety: $t(122) = 3.47$, $p = 0.001$; personalized anxiety: $t(122) = 2.89$, $p = 0.005$; maternal report: $t(60) = 2.24$, $p = 0.029$; paternal report: $t(53) = 2.13$, $p = 0.038$) and maternal follow-up anxiety scores (total anxiety: $t(112) = 0.94$, $p = 0.347$; personalized anxiety: $t(112) = 1.06$, $p = 0.293$; maternal report: $t(98) = 2.26$, $p = 0.026$; paternal report: $t(80) = 1.79$, $p = 0.077$). Boys reported more hours of game play per week than girls ($t(131) = 3.45$, $p = 0.001$).

Posttest			**Follow-up**		
MindLight	Max	*t* value (*df*)	MindLight	Max	*t* value (*df*)
0.75 (0.40)	0.92 (0.40)	2.36 (122)*	0.70 (0.36)	0.78 (0.34)	1.16 (112)
1.14 (0.58)	1.23 (0.48)	0.99 (122)	1.02 (0.54)	1.09 (0.48)	0.80 (112)
0.39 (0.22)	0.39 (0.21)	0.17 (60)	0.35(0.21)	0.39(0.24)	0.82 (98)
0.32 (0.19)	0.37 (0.25)	0.81 (53)	0.27(0.18)	0.37(0.27)	1.70 (80)
2.23 (1.38)	1.63 (1.31)	-2.47 (122)*	2.26 (1.63)	1.79 (1.40)	-1.67 (111)
1.90 (1.38)	2.74 (1.24)	3.57 (122)***	2.14 (1.63)	2.82 (1.19)	2.54 (111)*
2.29 (1.22)	2.69 (1.08)	1.95 (122)	2.32 (1.47)	2.82 (1.10)	2.07 (111)*
1.68 (1.29)	1.72 (1.28)	0.19 (121)	1.79 (1.52)	1.93 (1.41)	0.50 (111)
1.94 (1.37)	2.42 (1.30)	2.02 (122)*	2.26 (1.46)	2.70 (1.20)	1.72 (111)
2.00 (1.37)	1.98 (1.23)	-0.07 (122)	2.35 (1.42)	2.16 (1.26)	-0.75 (111)

Table 3
Correlations of Child Characteristics and Anxiety Symptoms Across Time Points

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. Age	-												
2. Weekly game time	-.00	-											
Pretest													
3. Total anxiety (child)	.00	-.08	-										
4. Personalized anxiety (child)	.05	-.05	**.77**	-									
5. Total anxiety (mother)	.01	-.14	.13	.14	-								
6. Total anxiety (father)	-.10	-.16	.13	-.00	**.45**	-							
Posttest													
7. Total anxiety (child)	.13	.09	**.75**	**.54**	.19	.16	-						
8. Personalized anxiety (child)	.14	.11	**.66**	**.73**	**.22**	.10	**.77**	-					
9. Total anxiety (mother)	-.15	-.13	.09	.00	**.82**	**.39**	.03	.03	-				
10. Total anxiety (father)	-.18	.07	-.04	-.14	**.41**	**.72**	-.04	-.10	**.45**	-			
Follow-up													
11. Total anxiety (child)	.14	.05	**.60**	**.57**	.18	.15	**.74**	**.64**	-.03	-.06	-		
12. Personalized anxiety (child)	.17	.08	**.49**	**.67**	**.20**	.07	**.52**	**.76**	.01	-.13	**.72**	-	
13. Total anxiety (mother)	-.08	-.31	**.22**	.19	**.72**	**.39**	.20	.15	**.82**	**.53**	**.31**	**.23**	-
14. Total anxiety (father)	-.06	-.21	.14	.17	**.45**	**.69**	.10	.13	**.36**	**.76**	.22	.17	**.56**

Note: Correlations between variables 1-14 are Pearson correlations. Correlations in bold are significant with at least $p < .05$.

Main Effects of MindLight on Anxiety Symptoms

Intention-to-treat (ITT) linear regression analyses were performed to test the effect of MindLight compared to Max on anxiety outcomes. No significant effect of game condition on any of the anxiety outcomes were found (total anxiety symptoms child report: $b = 0.06$, $p = 0.14$; personalized anxiety symptoms: $b = 0.09$, $p = 0.12$; total anxiety symptoms mother report: $b = 0.06$, $p = 0.36$; total anxiety symptoms father report: $b = 0.10$, $p = 0.07$). The within-groups effect size for change in total anxiety symptoms (child reports) from pretest (d_{av}) was 0.32 at posttest and 0.60 at 3-month follow-up in the MindLight condition, and 0.20 at posttest and 0.57 at 3-month follow-up in the Max condition. For personalized anxiety symptoms, the within-groups effect size for the MindLight group was 0.29 at posttest and 0.60 at 3-months follow-up, and for the Max group 0.27 at posttest and 0.49 at 3-month follow-up. Finally, the within-groups effect size for parental anxiety reports at 3-month follow-up was 0.26 for maternal reports and 0.35 for paternal reports in the MindLight condition. In the Max condition, this effect size at 3-month follow-up for maternal reports was 0.31 and 0.32 for paternal reports.

Latent Growth Curve Models

To determine the most appropriate growth function that best reflected change in anxiety symptoms over time, we tested a linear growth function with intercept and slope as latent variables for all anxiety outcome measures separately. Almost all models showed a reasonable

fit to the data (total anxiety symptoms child report: $\chi^2(2) = 6.85$, $p = 0.033$, CFI = 0.976, RMSEA = 0.135; personalized anxiety symptoms: $\chi^2(2) = 4.23$, $p = 0.121$, CFI = 0.989, RMSEA = 0.091; total anxiety symptoms mother report: $\chi^2(2) = 4.70$, $p = 0.096$, CFI = 0.983, RMSEA = 0.106; total anxiety symptoms father report: $\chi^2(2) = 2.03$, $p = 0.363$, CFI = 1.000, RMSEA = 0.011). In some cases the RMSEA-value was too high. Yet, cut-off points of 0.05 and 0.10 are too restrictive for our sample size (Chen, Curran, Bollen, Kirby, & Paxton, 2008) and acceptable models might be unnecessarily rejected (Herzog & Boomsma, 2009). The slope was significant for all models, indicating that levels of anxiety symptoms significantly decreased over time. Figure 5 shows the rate of change over time for total anxiety symptoms (child reports), separate by condition. The rates of change for both conditions in the other models were similar to the one presented in Figure 5.

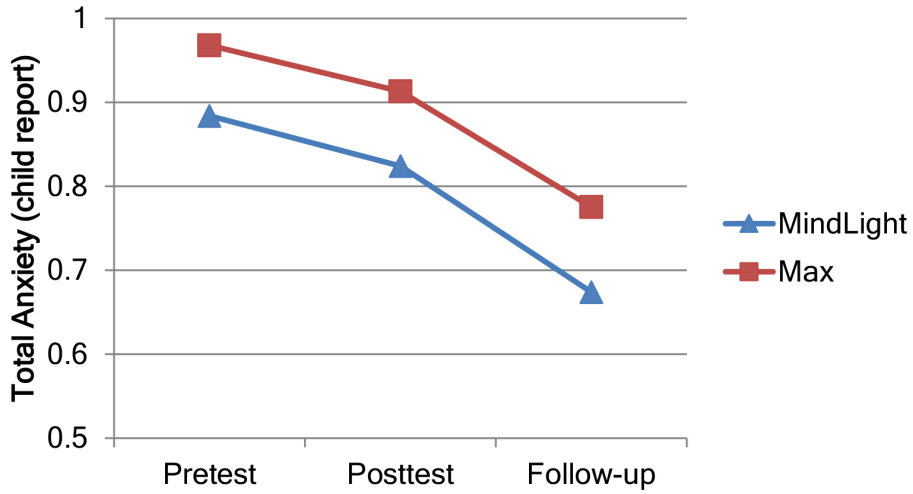


Figure 5. Rate of change over time for total anxiety symptoms (child report), separately for game conditions.

Next, game condition was included in the model as a predictor of the rate of change in child- and parent-reported anxiety symptoms. Table 4 shows that condition was neither related to the intercepts nor slopes for the anxiety outcomes. These results indicate that the initial level of anxiety symptoms and the improvement in anxiety symptoms over time did not differ between MindLight and Max.

We examined whether sex or age of the child moderated the relation between game condition and the initial level of child- and parent-reported anxiety symptoms (i.e., intercept) or the rate of change (i.e., slope) in anxiety symptoms (Table 4).We only found an interaction effect on the intercept (i.e., moderation of age on the association between condition and.personalized anxiety symptoms). No interaction effects were revealed with the slopes of anxiety symptoms

Table 4
Initial Level (Intercept) and Rate of Change (Slope) in Anxiety Symptoms on Condition and Moderators

	Intercept	Slope				
	***B* (*p*-value)**	***B* (*p*-value)**	**χ^2(*df*)**	**χ^2 *p*-value**	**CFI**	**RMSEA**
Condition as predictor						
Child: Total anxiety	.102 (.102)	-.001 (.945)	7.54 (3)	.057	.977	.106
Child: Personalized anxiety	.050 (.551)	.023 (.258)	4.37 (3)	.225	.993	.058
Mother: Total child anxiety	-0.009 (.830)	-.004 (.656)	4.90 (3)	.179	.988	.072
Father: Total child anxiety	-0.057 (.215)	-.008 (.482)	2.16 (3)	.539	1.000	.000
Sex as moderator						
Child: Total anxiety	-.053 (.762)	-.014 (.649)	8.06 (5)	.153	.986	.068
Child: Personalized anxiety	-.099 (.545)	-.004 (.925)	5.73 (5)	.333	.997	.033
Mother: Total child anxiety	-.005 (.950)	-.012 (.525)	4.93 (5)	.425	1.000	.000
Father: Total child anxiety	-.116 (.194)	-.003 (.909)	2.81 (5)	.730	1.000	.000
Age as moderator						
Child: Total anxiety	-.072 (.131)	.001 (.931)	14.22 (5)	.014	.955	.117
Child: Personalized anxiety	-.200 (.001)	.007 (.631)	5.58 (5)	.349	.997	.029
Mother: Total child anxiety	.004 (.900)	.004 (.900)	7.72 (5)	.173	.982	.067
Father: Total child anxiety	.002 (.943)	.007 (.352)	2.822 (5)	.727	1.000	.000

Game Evaluations

To address the secondary aim of this study and examine the success of MindLight's game design, analyses were run comparing MindLight to Max on the six game evaluation items. In line with our expectations and design goals, MindLight was rated significantly more anxiety-inducing than Max, suggesting that the game had its intended emotional and exposure effect (Table 2). Also consistent with design goals, no differences between the games were found on reported difficulty, relevance, and the extent to which children believed the games would appeal to other children. Children rated Max, compared to MindLight, significantly more appealing to themselves and more likely to induce feelings of flow.

Discussion

The current study evaluated a newly-developed applied game that combines evidence-based clinical techniques for reducing anxiety with game design principles aimed to optimize emotional intensity, motivation and engagement. The primary aim of the RCT was to test the prevention effects of MindLight with a selected sample of children with elevated levels of anxiety. Contrary to expectations, results showed no differences on decreases in anxiety symptoms between children who played MindLight and those who played Max. Children in both conditions showed significant improvements on anxiety symptoms by the 3-month follow-up, based both on child and parent reports.

Although the lack of group differences in outcomes contradicted our main hypothesis, it is important to note that both groups did show significant improvements in anxiety symptoms and these differences were not negligible in magnitude. Of course, without the inclusion of a no-contact (e.g., waitlist) control group, we have no evidence that the change in anxiety symptoms is greater than what would be expected from no intervention at all. The within-group pretest to 3-month follow-up effect size for the MindLight group (d = 0.60) on child-reported total anxiety is considered moderate to strong (Cohen, 1988). This effect is slightly higher than a recent meta-analysis found for CBT-based selective prevention programs with anxious children (d = 0.53) and much higher than no-contact or waitlist control groups from that same meta-analysis (d = 0.04) (Mychailyszyn et al., 2012). Direct comparisons of effect sizes from separate sets of studies cannot be made without caution; however, it is unlikely that a passive control condition would have shown equal effects. Although no conclusions can be drawn from these indirect comparisons, they do offer some promise for directing future hypotheses.

Moreover, we saw improvements not only on children's reports of their own anxiety, but also on parents' reports, suggesting a more robust effect than found with comparable prevention studies of children's anxiety, which rarely find cross-informant agreement (e.g., Mychailyszyn et al., 2012). Three-month follow-up results showing continued improvements (after the games were no longer being played) further suggest that our results were not just a function of a placebo effect.

The fact that Max had similar, relatively strong effects on anxiety reduction as MindLight, a game explicitly designed to target anxiety problems, needs further discussion. Consistent with a large body of evidence in the therapy literature (Stice, Rohde, Seeley, & Gau, 2010), non-specific factors may drive improvements in well-designed game interventions. One important non-specific factor is expectations. Given that expectations of efficacy may drive a large majority of intervention effects generally, and experimental game effects more specifically (Boot et al., 2013), we took great care to equalize children's expectations at baseline, before they were randomly assigned to game conditions. But in addition to equalizing them, we were also priming children with expectations of effective anxiety reduction. This priming could have, in part, led to the reported improvements we saw in both groups.

A second non-specific factor may have been motivation: Motivation for change is among the best predictors of treatment outcomes (C. C. Lewis et al., 2012; C. C. Lewis et al., 2009; Taylor et al., 2012). A recent study that examined children's motivation for playing video games in general showed that they often play in order to reduce stress and increase feelings of autonomy that they otherwise find lacking in their real life. These motivations for playing games seem particularly pronounced for children with clinically elevated mental health symptoms (Ferguson & Olson, 2013). Indeed, a wide range of video games have been shown to increase positive

mood and decrease stress and anxiety (Fish, 2011; Russoniello, O'Brien, & Parks, 2009; Russoniello, O'Brien, & Parks, 2009). Children in our study may have been motivated to play both games because they believed they would feel better as a result (that is precisely the beliefs we primed them with). If they indeed experienced those mood enhancements, their confidence in regulating their own anxiety may have been reinforced even with Max, a game not explicitly designed to teach anxiety reduction techniques. These non-specific factors - motivation to play and improved mood after game-playing - may have drowned out the influences of the specific evidence-based mechanics that were designed into MindLight.

In addition to these non-specific factors, specific action mechanisms common to MindLight and Max may have accounted for improvements in both groups. In a recent review (Granic et al., 2014), it was suggested that a wide range of commercial games have the potential to prevent mental health problems, even though they were not developed for this purpose. For example, games as diverse as Tetris (E. L. James et al., 2015), Bejeweled (Russoniello, O'Brien, et al., 2009), and Portal2 (Shute, Ventura, & Ke, 2015), designed for entertainment purposes, have preliminary evidence that they improve post-traumatic stress disorder (PTSD) symptoms, depression, and cognitive decline, respectively.

More specifically for our purposes, exploratory, puzzle games such as Max and MindLight may train resilience in the face of failure and reappraisal skills, increase self-efficacy and provide short-term distraction (Granic et al., 2014) - all factors related to the reduction of anxiety (e.g., Aldao, 2013; Aldao, Nolen-Hoeksema, & Schweizer, 2010). In both games, continued perseverance in the face of failures is continuously encouraged and re-appraisals of problems are rewarded. The fact that children had to play both games for the full hour also reinforced perseverance and may have provided a sense of coping and mastery, which may in turn have decreased feelings of anxiety. Both games also included a young underdog avatar who had to face and conquer seemingly insurmountable challenges; identification with these avatars may have helped children adopt resilience appraisals for themselves. Finally, there is increasing evidence for the benefits of short-term distractions on mood regulation (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008), through the disruption of rumination. Video games provide an efficient dose of these short-term distractions (Jameson, Trevena, & Swain, 2011), thus both games may have disrupted rumination during school hours, over the study trial, leading to fewer anxious moods that then extended beyond the play periods. In sum, our effort to find the most appropriate control game may have led to a game that included training mechanics related to improvements in anxiety. To move beyond speculation, it seems important for future studies to test both non-specific and specific mediators of outcomes within the context of an RCT.

An important secondary aim of this study was to establish whether our design goals for MindLight were met. As expected, our findings showed that children who played MindLight rated the game significantly more anxiety-producing than those who played Max. This was encouraging because one of the main limitations of conventional psychoeducational approaches like CBT is they often fail to provide the emotional context that encourages the practice of regulation skills. To improve on these limitations, it was important that MindLight expose children to fearful stimuli to trigger authentic feelings of anxiety, so that players would be motivated to learn and practice effective strategies for reducing that anxiety.

We worked with talented, commercial game developers passionate about game design with the hopes that this cross-disciplinary collaboration could produce a game that would engage and delight like most of the commercial games children already play regularly. Our results showed that we were at least partially successful; children in both groups were equally likely to report believing other children would like MindLight and Max and they found both games equally difficult. Thus, in these domains at least, MindLight seemed to have been as successful in appealing to and engaging children as Max, a multi-award winning commercial game that has been successful on the market for several years and garnered some of the highest accolades for a game in this age group (http://maxandthemagicmarker.com/). Results also showed that children rated Max more appealing to themselves and more likely to induce flow than MindLight. As we considered these findings, and the qualitative reports from children who played the game, it seems important that future iterations of MindLight include more opportunities for "free time" in which silly, purely fun gameplay is encouraged and designed for. It is not surprising that perpetually facing fearful stimuli and needing to remain calm could become tiring at times. Moreover, the ongoing "shock events" that occur throughout the game to challenge players to regain their calm composure may, at the same time, disrupt any potential for feeling flow. Upon reflection, flow may not be the state that a game like MindLight aspires to, given that ongoing disruptions of calm is necessary to train the ability to regain those calm feelings in the face of anxiety.

Limitations and Future Directions

One important limitation of the current study is the potential biases inherent in both the child- and parent-reported outcome measures. Given the internalizing, hidden nature of anxiety, self-reports of anxiety are broadly considered to be the most reliable questionnaire measures, compared to teacher or parent reports (Hourigan, Goodman, & Southam-Gerow, 2011; Lagattuta, Sayfan, & Bamford, 2012; Lahikainen, Kraav, Kirmanen, & Taimalu, 2006). However, because children were led to hold expectations that both games could improve their anxiety, those beliefs may have biased their reporting of symptoms at posttest and follow-up. The same biases may have been present for parents who reported on their children's anxiety symptoms. Future studies may be improved by using observational measures (e.g., speech task; Buske-

Kirschbaum et al., 1997), more implicit tests of anxiety (Egloff & Schmukle, 2002) and perhaps couple these methods with psychophysiological measures to more objectively tap changes in children's reactions to, and recovery from, stress or fears.

A second limitation was the play context. For pragmatic reasons regarding available classrooms, children assigned to both game groups played in the same room. Thus, there may have been contamination between the groups. We limited the potential for children to talk about their play experiences (and what they were learning) during the sessions by providing all participants with earphones that they wore the entire time they played. However, it still may be possible that children in the Max group saw children in the MindLight group trying to breathe deeply to relax or overheard them using positive self-talk. These skills may have transferred across groups and may account for the similar improvements. Not only should future studies avoid possible contagion, but ideally they should examine the real-world relevance of game interventions by having children play in their own homes, alone, at appropriate times of day. Such home-based designs may also provide information about whether spontaneous motivation to play (rather than being asked to play in schools, in groups, at dictated times) impacts positively on outcomes. A clear strength of the current study was that it was run in accordance with rigorous CONSORT standards, in contrast to the vast majority of studies on computerized interventions or applied games (Kiluk et al., 2011). Our control condition was matched to keep possible confounding differences (e.g., in appeal, motivation) to a minimum. However, a key limitation was the lack of a no-intervention control group, precluding evidence that the improvements in children's anxiety were greater than would have occurred without intervention. On balance, we did not want to add to the myriad studies that find a superiority effect over a waitlist control; the consensus from the clinical research field is to move forward through rigorously controlled randomized studies (Boot et al., 2013; Furukawa et al., 2014). Thus, the solution is not to run another study comparing MindLight to a no-contact control, but to compare MindLight to the best evidence-based behavioral interventions for childhood anxiety (e.g., cognitive-behavioral prevention programs such as Coping Cat; Flannery-Schroeder, Choudhury, & Kendall, 2005; Flannery-Schroeder & Kendall, 2000; Kendall et al., 1997; Kendall, Hudson, Gosch, Flannery-Schroeder, & Suveg, 2008). These trials could be designed as non-inferiority studies (Piaggio et al., 2012), with an eye towards measuring outcomes at follow-up, but also cost-effectiveness analysis and assessments of children's engagement and motivation, given that these latter factors are the proposed benefits associated with games over conventional prevention programs.

Our findings suggest that children improved in anxiety symptoms but they do not tell us why. A completely ignored strength of applied games is the immense potential they hold for testing mechanisms of change with tightly controlled experiments. To understand whether the evidence-based principles designed into MindLight in fact had an impact on reducing anxiety symptoms, the modularity of game design can be exploited. For example, experiments could

be run with children playing versions of the game with and without the fear events (thus testing whether exposure is necessary for positive effects). The same kind of experimental design could assess the role of attention bias modification by pulling out the ABM puzzles from the game in one condition and comparing it to the full game in the other condition. Finally, a sham experiment (where in one group, the feedback from the EEG headset would not be contingent on the player's actual state of mind), to test whether the neurofeedback mechanism is necessary for successful intervention effects, may be a fruitful direction to pursue.

Conclusion

Although the current study did not show the anticipated group differences between MindLight and Max, there remains reason to be optimistic about the potential that video games hold for prevention of mental health problems in youth. A great deal more research needs to be conducted on MindLight and its relative effectiveness compared to conventional, evidence-based approaches. Given the potential for scalability, access and cost-effectiveness, it may also be useful to identify games such as Max that are already on the commercial market and hold promise for improving children's emotional health. Remarkably, there are very few video games that have been developed with the explicit aim of improving mental health. The extent to which video games have become the ubiquitous virtual playgrounds for children across the globe highlights the massive potential to develop genuinely innovative approaches to mental health interventions in this medium.

Appendix A

Attrition at Follow-up

Children

Of the total 136 children, 134 (98.5%) completed the pretest assessment. Two children withdrew from the study. A total of 124 children (91.2%) participated in the program and completed the posttest assessment. The remaining 10 (7.4%) children attended the intervention but did not fill out the posttest assessment (Fig. 1). The response rate for the three-month follow-up was 84.6% (n = 115). There were 5 children who did fill out the follow-up assessment, but had not filled out the posttest assessment. We conducted logistic regression analyses with loss to follow-up as dependent variable to examine attrition effects at three-month follow-up for sex, age, ethnicity, study condition, and pretest levels of anxiety symptoms. No differences in loss to follow-up were found for all variables. Nagelkerke R^2 for the regression model was .09.

Parents

Of the 127 mothers, 116 (91.3%) completed the pretest assessment. Two mothers withdrew from the study. The response rate for the posttest assessment was 51.2% (n = 65). Due to a mistake in our computerized procedures for sending assessment questionnaires, almost half of the sample of parents at posttest did not receive questionnaires at posttest assessment. A total of 102 (80.3%) mothers completed the three-month follow-up assessment. There were 47 mothers who did fill out the follow-up assessment, but had not filled out the posttest assessment. We conducted logistic regression analyses with loss to follow-up as dependent variable to examine attrition effects at three-month follow-up for sex, age, education, ethnicity, study condition, and pretest levels of anxiety symptoms. No differences in loss to follow-up were found for all variables. Nagelkerke R^2 for the regression model was .21.

Of the 109 fathers, 94 (86.2%) completed the pretest assessment. One father withdrew from the study. The response rate for the posttest assessment was 50.5% (n = 55), again, very low due to errors in sending out the assessment battery on time. A total of 83 (76.1%) fathers completed the three-month follow-up assessment. There were 39 fathers who did fill out the follow-up assessment, but had not filled out the posttest assessment. We conducted logistic regression analyses with loss-to follow-up as dependent variable to examine attrition effects at 3-month follow-up for sex, age, education, ethnicity, study condition, and pretest levels of anxiety symptoms. Fathers lost to follow-up were more likely to have reported a higher pretest level of anxiety symptoms (Exp(B) = 934.85, 95% confidence interval (CI) = 10.252, 85249.59, p =.003) compared to fathers who completed the 3-month follow-up assessment. No differences in loss to follow-up were found for sex, age, education, ethnicity or study condition. Nagelkerke R^2 for the regression model was .57.

Appendix B

Description Gameplay MindLight

The game begins with an introductory video showing a little boy, Arty, being dropped off at his grandma's mansion by his parents. The mansion is dark and full of shadows and grandma is covered in shadow as well, turning her evil. The player then has to navigate Arty through the mansion by using a Microsoft Xbox 360 controller or keys on the computer keyboard. The first room they encounter is the bedroom. They will find a chest that glows when the player is near. Every time an object glows, players can interact with this object by pushing a button on their controller or keyboard. By pushing a button when near the chest in the bedroom, an instruction video starts introducing the player to Teru, a magical hat that shines light. Teru proposes to combat the darkness and shadows by shining the light together with Arty. He explains that if Arty is relaxed, Teru will shine more brightly. After the bedroom, the player encounters the practice rooms.

When the player enters the first practice room and is near a glowing lamp on the ceiling, an instruction video explains the player to turn on the lamp by focusing long enough. The mindbeam, a visual line between Teru and the lamp, gives feedback about the performance of the player. When the beam is wavy and purple, the player is not focusing well enough. When the beam is straight and blue, the player performs well and the lamp will turn on when focusing long enough. In the second practice room, players can practice relaxation. When the player enters the room and a large expanding and shrinking black ball is near, an instruction video explains the player to walk close by and decloak the blackness by relaxing enough. Feedback about relaxation is constantly given in the form of the brightness of Teru's light. The more relaxed the player is, the brighter Teru's light will be. If Teru's light touches the black ball, pieces of shadow will fly off of it. When the player relaxes long enough, the blackness disappears and a cat and a glowing coin appear. The coin can be collected by pushing a button and the number of coins collected is presented at the right top corner on the screen. The number of to be collected coins is presented at the same place as transparent coins.

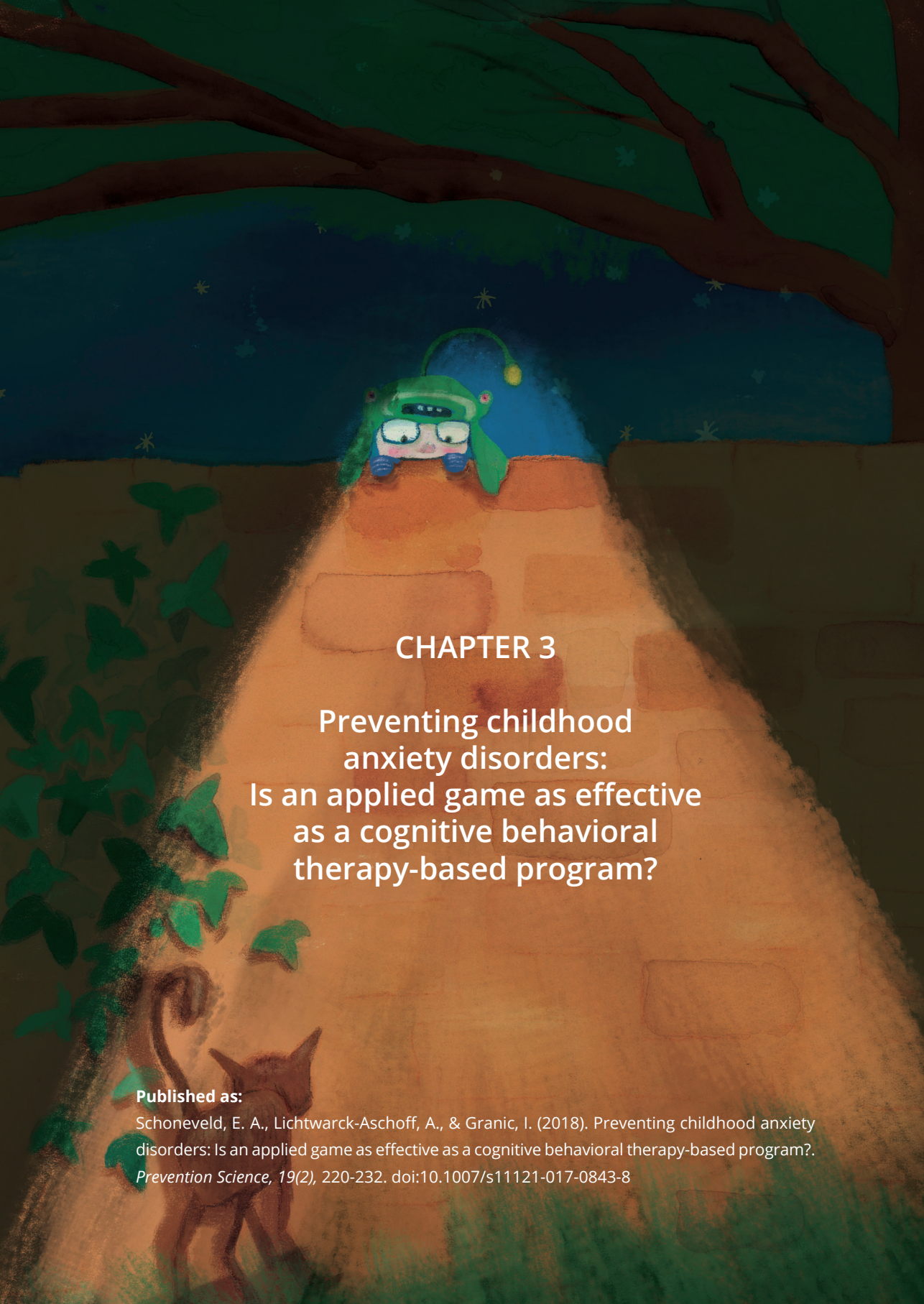
In the hallway between the second practice room and the third practice room, players find a glowing chest. When the player is near this chest, an instruction video explains the player to hide in the chest by focusing long enough. Again, a mindbeam between Teru and the chest gives feedback about the performance of the player. When the focus is high, i.e. the beam is straight and blue; Arty will get in the chest faster. The player then gets the opportunity to for example become calm again after being scared by hiding in the chest. By pushing a button, Arty will jump out of the chest and player can keep on exploring the mansion.

In the third practice room, players can collect a second coin and practice the first attention bias modification puzzle. The player sees two paintings of two angry face and two accompanying blue circles on the floor. One of the paintings will quickly change from angry to happy to angry again. An instruction video explains the player to focus on the smiling face. The player has to navigate to this painting, step on the blue circle and focus on this face that then turns happy. Again, a mindbeam between Teru and the painting gives feedback about the performance of the player. After focusing long enough, the paintings turn angry again and after a push on a button, one of the paintings will quickly change from angry to happy to angry again and the player has to navigate to this painting. This repeats until the player has focused well enough for a certain amount of time on the happy face, which solved the puzzle. When the puzzle is solved the whole room turns light and every detail can be seen. A happy music theme plays, glitters float around and a door to the rest of the mansion unlocks.

After being explained all the game mechanics and practicing in the three practice rooms and hallways, the player can now freely explore the mansion and combat the darkness and shadows by shining light. Five more rooms and hallways with different difficulty levels are in the mansion. In every room the player has to search for coins while being attacked by black cat-like monsters, which can be chased away by shining in their eyes. Each room features a shadow creature similar to the black ball in the practice room, upon which players must shine their light to decloak and receive a coin. If all the coins in a room are found, the player can solve a puzzle by focusing on the happy face. As in the third practice room, the room then turns light and a happy music theme plays.

After turning on the lights in all the rooms, the final room is unlocked. This is the hardest room in the game. If the player is successful in finding all the coins and solving the puzzle in this room, all the lights in the mansion will turn on. A happy music theme plays and the black cat-like monsters have turned back into cute cats. Arty then receives a letter from his deceased grandpa with the instruction to bring this to his grandma's room in order to save her. When the player does so, the shadow that covered grandma is removed and she is no longer evil.

A video of MindLight can be found at https://www.youtube.com/watch?v=buNaErarLts.



CHAPTER 3

Preventing childhood anxiety disorders: Is an applied game as effective as a cognitive behavioral therapy-based program?

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Abstract

A large proportion of children experience subclinical levels of anxiety and cognitive-behavioral therapy (CBT) aimed at preventing anxiety disorders is moderately effective. However, most at-risk children do not seek help or drop out of programs prematurely because of stigma, lack of motivation, and accessibility barriers. Applied games have received increased attention as viable alternatives and have shown promising results, but direct comparisons between applied games and the gold-standard CBT are lacking. Our aim was to investigate whether the applied game MindLight is as effective as CBT (i.e., Coping Cat) within an indicated prevention context. We conducted a randomized controlled non-inferiority trial with a sample of 174 children (7- to 12-year olds) with elevated levels of anxiety, comparing MindLight to CBT. Anxiety was assessed with self- and parent-reports at pre- and postprogram, and at 3- and 6-month follow-ups. Intention-to-treat and completers-only confidence interval approach and latent growth curve modeling showed an overall significant quadratic decrease in child- and parent-reported anxiety symptoms over time and, as predicted, the magnitude of improvement was the same for MindLight and CBT. The within-group effect sizes were small to medium at posttest (− 0.32 to − 0.63), and medium to large (− 0.60 to − 1.07) at 3- and 6-month follow-ups. Furthermore, MindLight and CBT were rated equally anxiety inducing, difficult, and appealing; CBT was rated as more relevant to daily life than MindLight. The current study adds to the growing research on applied games for mental health and shows that these games hold potential as alternative delivery models for evidence-based therapeutic techniques.

Anxiety disorders are the most common mental health disorders in childhood, affecting up to 22% of children (Beesdo et al., 2009). A much larger proportion of youth experience subclinical levels of anxiety with prevalence rates up to 49% (Muris, Merckelbach, et al., 2000). These anxiety symptoms commence in childhood and show a chronic and disabling course, especially for individuals showing higher severity and persistence of anxiety symptoms (Asselmann & Beesdo-Baum, 2015). Left untreated, anxiety symptoms are associated with a lower general quality of life (Ramsawh & Chavira, 2016), worse school performance (Owens et al., 2012), and substance use (Pardee, Colder, & Bowker, 2014). Effective anxiety prevention programs delivered during childhood, before full-blown anxiety disorders develop, are urgently needed.

Preventing Anxiety Problems

Many anxiety prevention programs are based on cognitive behavioral therapy (CBT), the first-line treatment of choice for anxiety disorders (A. C. James et al., 2015). In CBT, youth are taught to recognize feelings related to anxiety (i.e., emotions and bodily sensations), to identify and challenge anxious self-talk, to develop coping skills, and to evaluate and reward skill use. In addition, youth are exposed to threatening situations and taught to use relaxation techniques in the face of these threats, a key element of CBT (Kendall & Hedtke, 2006). Various recent meta-analyses show that anxiety prevention programs that target youth with some degree of risk (i.e., selective or indicated) result in small (e.g., Stockings et al., 2016) to moderate (Mychailyszyn et al., 2012) effect sizes.

Outside of research contexts, however, the majority of children who could benefit from these prevention efforts do not seek help (Salloum et al., 2016) and those who do often dropout of service prematurely (de Haan et al., 2013). Stigma associated with mental health care is a major barrier to delivering conventional treatments (Salloum et al., 2016). Children do not want to be identified as mentally ill and parents fear being blamed for their children's problems, further preventing children and parents from seeking the help they need (Mukolo & Heflinger, 2011). In addition, some families may not be able to afford mental health services (Salloum et al., 2016) or simply have difficulties reaching services due to difficulties in transportation (Green, Hunt, & Stain, 2012). Thus, pragmatic reasons often hamper the accessibility of conventional prevention programs. Additionally, high dropout rates are a major threat to the effectiveness of conventional (CBT) programs (de Haan et al., 2013), possibly because the programs are not appealing and engaging to children (World Health Organization, 2012). These barriers call for a reconsideration of our current group-based and clinical expert-led delivery models of prevention programs (Kazdin, 2015).

Applied Games for Mental Health

Recently, applied games have received increasing attention as a viable and cost-effective alternative delivery model for prevention efforts (Kazdin, 2015). The promise of applied games lies in the intrinsically motivating features of games, their high accessibility, reach, scalability,

affordability, and convenience (e.g., Granic et al., 2014). Despite these potential advantages of applied games, reliable outcome evidence from rigorous research designs is needed before these games can be considered evidence-based alternative interventions. Very few studies have tested the effects of applied games according to rigorous scientific standards.

Studies investigating applied games for anxiety that have used randomized controlled trials (RCTs) have shown promising results. Dojo, an emotion management video game that helps youth recognize and control their physiological and emotional arousal, has been found to significantly decrease anxiety symptoms in youth with elevated levels of anxiety (i.e., indicated prevention; Scholten et al., 2016). MindLight is another applied game specifically designed for children with elevated levels of anxiety. The game uses several evidence-based techniques including neurofeedback (Price & Budzynski, 2009), exposure training (Kendall et al., 2005), and attention bias modification (Bar-Haim et al., 2011) which are embedded in a horror-themed survival game that trains children to cope with their anxiety. An initial indicated prevention RCT showed significant improvements in anxiety symptoms after game play and at 3-month follow-up (Schoneveld et al., 2016). However, both the Dojo and the MindLight trials employed alternative, commercial games as their control condition. The more rigorous test for the effectiveness of these applied games is to demonstrate non-inferiority (i.e., equal efficacy) to the effective gold standard in anxiety prevention: CBT. To date, there are no direct comparisons of applied games for children with elevated levels of anxiety and CBT (Fleming et al., 2017); the current study was designed to fill this gap.

Current Study

We ran a two-armed randomized controlled non-inferiority trial (Piaggio et al., 2012) comparing MindLight to CBT within an indicated prevention context. The aim of the current study was to determine whether MindLight was as effective as CBT for children with elevated anxiety symptoms. We choose MindLight over Dojo, because anxiety symptoms are most prevalent in childhood and MindLight is, in contrast to Dojo, designed for children. Based on previous indicated prevention RCTs with MindLight (Schoneveld et al., 2016) and CBT (van Starrenburg et al., 2017), our primary hypothesis was that children with elevated anxiety symptoms in the MindLight condition would show comparable decreases in anxiety symptoms as children in the CBT condition. Further, we aimed to test the effectiveness of the design of the game beyond its impact on anxiety symptoms. Specifically, based on evidence-based exposure principles (Kendall et al., 2005), we tested whether the game elicited the feelings of anxiety that it was designed to trigger, in order for exposure techniques to be relevant. We also examined the game's motivating properties and appeal to children. Our secondary hypothesis was that children would rate MindLight as more appealing compared to CBT but equally anxiety inducing.

Methods

Study Design

In eight primary schools in the southeast part of the Netherlands, children were randomized in a multicenter, stratified, parallel group, equivalence study comparing the effect of MindLight versus CBT between February 2015 and January 2016. An independent researcher from our research institute carried out the randomization with an allocation ratio of 1:1 within school and stratified by sex and grade. Four separate groups of children were created: younger boys (grades 3 and 4), older boys (grades 5 and 6), younger girls (grades 3 and 4), and older girls (grades 5 and 6). Children within these groups were randomly assigned to MindLight or CBT using the SPSS random number generator. The study was approved by the ethics committee of the Faculty of Social Sciences of the Radboud University (EC2013-0410- 139a1) and registered at the Dutch Trial Register (www. trialregister.nl; Trial ID: NTR4993).

Procedure

Participants were recruited in two steps: screening and inclusion. First, all children in grades 3 to 6 from eight primary schools received an information letter for their parents and a screening consent form. All children with active parental permission (N = 791) were screened on anxiety symptoms with the child version of the Spence Children's Anxiety Scale (SCAS; Spence, 1998). Second, eligible children were identified by their elevated anxiety symptoms, operationalized based on Muris, Schmidt, et al. (2000): children were eligible if either (a) the total SCAS score was 1 *SD* above the mean or (b) at least two SCAS subscales were 1 *SD* above the mean. This is in line with recommendations by Spence (2013, December 10), who defined elevated anxiety symptoms as 1 *SD* above the mean. The obsessive-compulsive disorder subscale was omitted because it is no longer considered an anxiety disorder in the DSM-V. Parents of the 221 (27.9%) eligible children were contacted by phone to inform them about study goals, procedure and programs, to assess exclusion criteria, and to invite them and their child(ren) to participate. Exclusion criteria were currently in anxiety treatment, diagnosis of obsessive-compulsive disorder, post-traumatic stress disorder, or autism spectrum disorder. Initial verbal consent of 174 children was provided. Written informed consent was obtained at pretest (see below). The 174 children and their parents were randomly assigned to MindLight or CBT. A week prior to the intervention, before they knew to what program they were assigned, children and parents filled out the questionnaires (i.e., pretest). Parents got a link through e-mail and completed the questionnaire online. Two weeks after intervention termination, children and parents filled out posttest questionnaires. Follow-ups (FUs) were 3 and 6 months after posttest and followed the same procedure as pretest assessments.

Sample Size

The target sample size was estimated using the Jones et al. (1996) calculations for equivalence trials. The equivalence margin for improvement in anxiety score was set at 0.16 SCAS points. This difference corresponds to 0.5 *SD* of the anxiety change score (*M* = 0.14, *SD* = 0.32) at posttest in children allocated to CBT, as found in a previous indicated prevention RCT (van Starrenburg et al., 2017). Based on 80% power (1 − β) to detect a clinically relevant difference in improvement of 0.16 points on the SCAS (α = .05, two-sided), 50 children were required in each group. To account for attrition, 10% was added and another 25% was added to account for the design effect (based on six children per group and an intra-class correlation of 0.05). In total, this led to a required total sample size of 135 children.

Participants

A total of 174 children were randomized (see Figure 1 for flowchart). At pretest, children were between 7 and 12 years old (*M* = 9.97, *SD* = 1.16) and 40.8% were boys. The majority of the children were born in the Netherlands (91.4%). Most children attended at least five MindLight sessions (*n* = 64; 87.7% excluding dropouts) or at least seven CBT sessions (*n* = 66; 91.7% excluding dropouts). In most cases, both parents participated in the study (*n* = 145). The parent sample included 174 mothers and 145 fathers. At pretest, mothers ranged in age from 28 to 49 years (*M* = 41.13, *SD* = 3.67), fathers from 33 to 57 years (*M* = 43.49, *SD* = 4.24). The majority of parents were of Dutch descent (87.9% of mothers, 73.6% of fathers).

Intervention Programs

MindLight. MindLight is a 3D third-person neurofeedback video game produced by the PlayNice Institute (http://theplayniceinstitute.com) and designed by GainPlay Studio (http://www.gainplaystudio.com/). The game starts with Arty left at the doorstep of his grandmother's scary mansion faced with the task of saving his grandmother from the evil forces that have possessed her and the house. At his bedroom, he finds his magical glowing hat Teru that teaches him (and the player) to overcome his fears by changing his state of mind. Several theoretically grounded, evidence-based strategies for decreasing anxiety are embedded in the game (i.e., neurofeedback training, exposure training, and attention bias modification), described in detail in Schoneveld et al. (2016). Children control Arty and Teru using a Microsoft Xbox 360 controller and a Neurosky one-channel dry-sensor EEG headset.

Children played MindLight for six 1-hour sessions, at school after regular school hours every week, except for holidays. Groups consisted of five to ten children and were supervised by Masters students. Children used earplugs to hear the game sound and to diminish distraction. They were seated at least one table away from each other. Supervisors gave instructions about MindLight at the beginning of the first session. At the end of the last session, children received a diploma to commemorate their participation in MindLight.

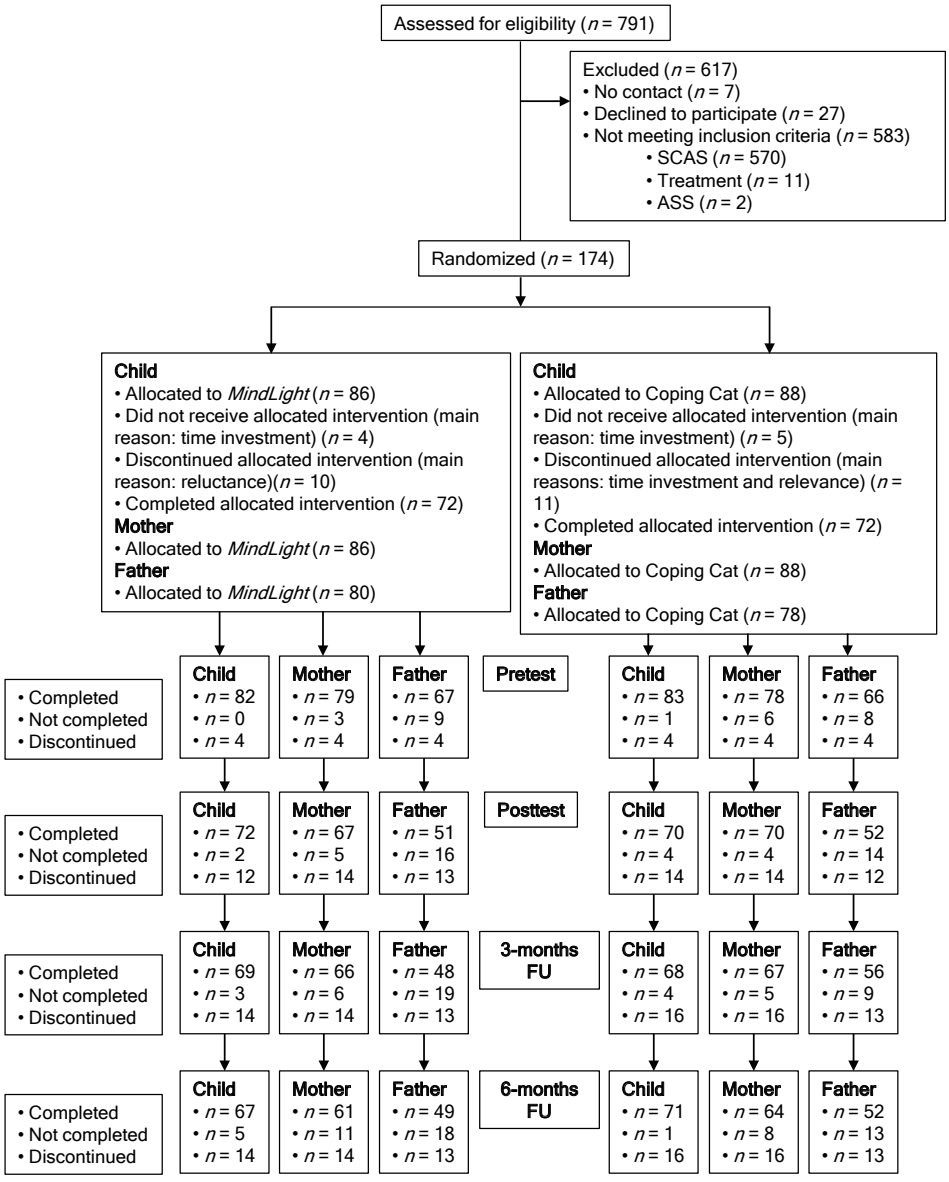


Figure 1. Flow chart of participants through trial.

CBT. Coping Cat is one of the few effective CBT programs for anxious children (Flannery-Schroeder et al., 2005) and was used for the current study. The program teaches children both cognitive (i.e., cognitive restructuring) and behavioral techniques (i.e., relaxation training and exposure). In the current study, a shortened eight-session version of the indicated prevention group-based version of van Starrenburg et al. (2017) was used. We shortened

the Van Starrenburg et al. version of Coping Cat according to the content of the American shortened version of the same program (Beidas, Mychailyszyn, Podell, & Kendall, 2013) in which the problem-solving part was reduced. The first two sessions lasted 1.5 hour and the last six sessions lasted 1 hour, and took place at schools after regular school hours every week, except for holidays. Groups consisted of four to seven children and were led by two psychologists. Parents received information about the progress of their child and general information about the program halfway through the program and at the end via e-mail. At the end of the last session, children received a diploma to commemorate their participation in CBT.

Psychologists (*n* = 15) had knowledge of and experience with CBT. To prepare, all psychologists successfully completed a 2.5-day training by a certified clinician, in which they received information on the protocol, and practiced exposure techniques and role-playing. Over the course of delivering the program, psychologists participated in 1-hour supervision and feedback sessions twice.

Measures

Anxiety symptoms. Children's anxiety symptoms were assessed with the child (45 items) and parent (38 items) versions of the SCAS (Spence, 1997, 1998). The child version of the SCAS includes seven positive filler items to reduce negative response bias. All items are rated on a 4-point scale: 0 (*never*), 1 (*sometimes*), 2 (*often*) or 3 (*always*). Both the child version (Muris, Schmidt, et al., 2000) and the parent version show good convergent validity (Brown-Jacobsen et al., 2011) and good reliability (Whiteside & Brown, 2008). Cronbach's alpha of the child version was 0.91 at pretest, 0.90 at posttest, 0.93 at 3 months FU, and 0.91 at 6 months FU. For the parent version, the Cronbach's alphas were respectively 0.84, 0.80, 0.81, and 0.82 for mothers and 0.83, 0.85, 0.83, and 0.84 for fathers. Four outcome measures were computed: total anxiety, which is the overall mean for child-, mother-, and father-report (except the filler items for the child version) and personalized anxiety, which is the mean subscale score of the subscale that the child scored highest on at screening.

Time spent playing games. Children were asked how many hours they play video games on each day of the week. Time spent playing games was calculated by adding these numbers, representing the total number of hours spent playing video games per week.

Program expectations. Expectations about the effect of the program were assessed at pretest, before the children knew to which condition they were assigned. Children read a short description of both MindLight and CBT and answered the following question: to what extent do you think that MindLight/CBT will help you to feel less afraid? Children could respond on a scale from 0 to 9, with 0 being "*not less afraid,*" 5 being "*little bit less afraid,*" and 9 being "*lot less afraid*."

Children's program ratings. Children were asked to evaluate the program they were assigned to at posttest and FUs. Children rated the following five statements on a 5-point scale: 0 (*totally disagree*), 1 (*disagree*), 2 (*neutral*), 3 (*agree*), and 4 (*totally agree*). "I found it fun to participate in MindLight/CBT"; "I think __ is fun for other children"; "I can use what I learned from __ in my daily life well"; "I found some exercises in __ stressful"; "I found some exercises in __ difficult". Answers on these questions were analyzed separately.

Strategy of Analyses

First, to assess baseline differences between the two conditions, we performed χ^2 tests and *t* tests. Next, *t* tests for independent groups were conducted to examine differences between conditions across time. Tests were performed in IBM SPSS Statistics 21. Second, to test non-inferiority, a two-sided confidence interval (CI) approach was used in both the intention-to-treat (ITT) and CO samples (Appendix A). Non-inferiority of MindLight to CBT could be claimed if the upper bound of the CI for the difference in mean change of anxiety symptoms was below the margin of non-inferiority ($\Delta = 0.16$). Third, latent growth curve modeling (LGCM) was performed in Mplus 7.2 to examine the effect of condition on individual levels of anxiety symptoms at pretest (i.e., intercept) and changes in anxiety symptoms over time (i.e., slope) in the ITT sample. Missing data were dealt with by multiple imputation (MI), using the Markov chain Monte Carlo method. First, we estimated the initial model based on the four time points (i.e., pretest, posttest, 3-month FU, and 6-month FU) without any predictors or control variables. Second, we tested whether condition predicted the pretest levels of anxiety (i.e., intercept) and/or rate of change in anxiety symptoms (i.e. slope). Third, we added participant characteristics (i.e., sex, age, weekly game time, and expectations) to the model and tested whether the interaction between condition and participant characteristics predicted the intercept and/or slope. Results from the LGCM in the completers only (CO) sample are available in Appendix B and C. Lastly, to assess differences between the two programs in children's ratings, we performed *t* tests for independent groups in IBM SPSS Statistics 21.

Results

Descriptive Statistics

Randomization efforts were successful: no differences were found between the MindLight and the CBT group on age, weekly game time, expectations and sex (see Appendix D). Therefore, we did not control for these variables in subsequent analyses. In addition, no differences were found between the programs on dropout rates: $\chi^2(1) = 0.11$, $p = .740$. Means, *SD*s, and *t* values for all anxiety measures at all time points separately for condition are shown in Table 1. Groups did not differ significantly on anxiety symptoms at pretest, nor any other time point.

Non-inferiority

Table 2 presents the change in anxiety symptoms and 95% CIs for both programs over the course of the study. It shows that non-inferiority of MindLight to CBT could be demonstrated at posttest, 3-month FU, and 6-months FU for total anxiety child report, total anxiety mother report and total anxiety father report. For personalized anxiety child report, non-inferiority could only be shown at 3-months FU. At posttest and 6-month FU, the CI lay entirely to the left of 0, indicating significant differences in favor of MindLight. The results of Table 2 are visualized in Figure 2.

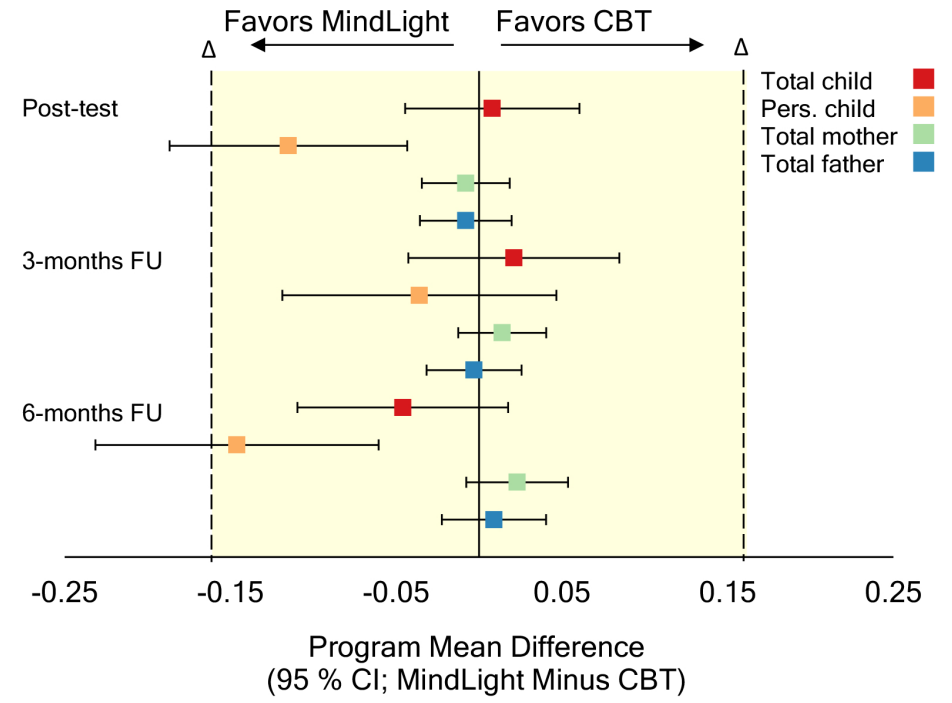


Figure 2. Differences between programs in anxiety symptoms, in relation to non-inferiority.

Latent Growth Curve Modeling

We first fitted a linear growth model with intercept and slope as latent variables for all four anxiety measures separately and found that most model fit indices were unsatisfactory. Second, we added a quadratic term to the growth function. The resulting quadratic growth model with an intercept, a linear slope, and a quadratic slope as latent variables showed a close fit to the data (Table 3). In some cases, the RMSEA value was too high, yet cutoff points of 0.05 and 0.10 are too restrictive for our sample size (Chen et al., 2008) and acceptable models might be unnecessarily rejected. Both the linear and the quadratic slope component were significant for all anxiety measures, indicating that anxiety symptoms decreased significantly over time and that the rate of the decrease slowed over time.

Third, condition was included in the quadratic growth function. Table 3 shows that condition was not related to the intercept, nor the linear, nor the quadratic slope component for all anxiety measures. As predicted, these results indicate that the initial level of anxiety symptoms, the amount of decrease in anxiety measures, and the rate of improvements in anxiety did not differ between conditions. Figure 3 shows the decrease in total child-reported anxiety separate by condition. The pattern in the other models was similar to the one presented in Figure 3. The within-group effect size for change for all four anxiety measures from pretest (d_{av}) are small to medium at posttest, and medium to large at 3- and 6-month FUs (Table 1).

Table 1
Means, Standard Deviations, t values and Within-group Effect Sizes of Anxiety Symptoms and Evaluations at All Time Points Separately for Programs

	MindLight			CBT			
Measure	*M*	*SD*	d_{av}	*M*	*SD*	d_{av}	*t* (*df*)
	Pretest						
Anxiety symptoms							
Total child	0.98	0.41		0.99	0.42		0.24 (163)
Personalized child	1.38	0.57		1.31	0.54		-0.90 (163)
Total mother	0.51	0.26		0.50	0.19		-0.26 (155)
Total father	0.47	0.23		0.46	0.20		-0.29 (131)
Evaluations							
Personal appeal	-	-		-	-		-
Appeal to others	-	-		-	-		-
Relevance	-	-		-	-		-
Anxiety-inducing	-	-		-	-		-
Difficult	-	-		-	-		-
	3-months FU						
Anxiety							
Total child	0.67	0.42	-0.75	0.65	0.39	-0.84	-0.33 (136)
Personalized child	0.99	0.56	-0.69	0.93	0.47	-0.75	-0.67 (135)
Total mother	0.40	0.21	-0.47	0.37	0.16	-0.74	-1.09 (131)
Total father	0.39	0.21	-0.36	0.35	0.16	-0.61	-1.08 (102)
Evaluations							
Personal appeal	2.41	1.29		2.62	1.10		1.07 (136)
Appeal to others	2.71	1.04		2.72	1.01		0.08 (136)
Relevance	1.96	1.24		2.86	1.00		4.67 (136)***
Anxiety.-inducing	2.64	1.24		2.41	1.22		-1.11 (136)
Difficult	1.97	1.29		1.70	1.15		-1.32 (136)

Note. Total child = total anxiety child report; Personalized child = personalized anxiety child report; Total mother = total anxiety mother report; Total father = total anxiety father report.
*** $p < .001$.

MindLight			CBT			
M	*SD*	d_{av}	*M*	*SD*	d_{av}	*t* (*df*)
Posttest						
0.74	0.39	-0.60	0.75	0.34	-0.63	0.13 (140)
1.07	0.59	-0.53	1.13	0.48	-0.35	0.68 (140)
0.42	0.20	-0.39	0.42	0.17	-0.44	-0.25 (135)
0.40	0.21	-0.32	0.38	0.18	-0.42	-0.53 (101)
2.35	1.39		2.77	1.18		1.94 (139)
2.61	1.15		2.59	1.09		-0.09 (139)
2.13	1.38		2.96	0.95		4.15 (139)***
2.71	1.39		2.46	1.34		-1.09 (138)
1.85	1.22		1.99	1.28		0.66 (139)
6-months FU						
0.58	0.34	-1.07	0.64	0.38	-0.88	1.05 (136)
0.86	0.53	-0.95	0.95	0.50	-0.69	1.01 (136)
0.37	0.21	-0.60	0.34	0.15	-0.94	-1.11 (123)
0.34	0.19	-0.62	0.31	0.17	-0.81	-1.00 (99)
2.48	1.31		2.55	1.01		0.36 (136)
2.70	1.10		2.68	0.92		-0.14 (136)
2.18	1.29		2.58	1.08		1.97 (136)
2.55	1.30		2.32	1.17		-1.05 (135)
2.06	1.27		2.11	1.14		0.26 (136)

Table 2
Pretest *and Change in Anxiety Symptoms Over the Study (Intention-to-Treat Sample)*

Assessment	MindLight	CBT	Mean difference[a]	*SD*	95% CI
		Total child			
Pretest	0.98	0.99			
Posttest – pretest[b]	-0.24	-0.24	0.01	0.34	[-0.04, 0.06][c]
3-months FU – pretest[b]	-0.32	-0.34	0.02	0.42	[-0.04, 0.08][c]
6-months FU – pretest[b]	-0.40	-0.36	-0.05	0.42	[-0.11, 0.02][c]
n	82	83			
		Personalized child			
Pretest	0.98	0.99			
Posttest – pretest [b]	-0.31	-0.20	-0.12	0.47	[-0.19, -0.04][d]
3-months FU – pretest [b]	-0.41	-0.38	-0.04	0.54	[-0.12, 0.05][c]
6-months FU – pretest [b]	-0.52	-0.37	-0.15	0.56	[-0.23, -0.06][d]
n	82	83			
		Total mother			
Pretest	0.51	0.50			
Posttest – pretest [b]	-0.09	-0.09	-0.01	0.17	[-0.03, 0.02][c]
3-months FU – pretest [b]	-0.12	-0.13	0.01	0.17	[-0.01, 0.04][c]
6-months FU – pretest [b]	-0.14	-0.16	0.02	0.20	[-0.01, 0.05][c]
n	80	81			
		Total father			
Pretest	0.47	0.46			
Posttest – pretest [b]	-0.09	-0.08	-0.01	0.17	[-0.04, 0.02][c]
3-months FU – pretest [b]	-0.12	-0.12	0.00	0.17	[-0.03, 0.03][c]
6-months FU – pretest [b]	-0.15	-0.16	0.01	0.19	[-0.02, 0.04][c]
n	69	69			

Note. CI = confidence interval.
[a] A negative difference is a difference in favor of MindLight. [b] A negative score means a decrease in the severity of symptoms. [c] The 95% CI of the difference in symptom change lies entirely between the equivalence margins of -0.16 and + 0.16 points, indicating equivalence of MindLight and CBT. [d] The 95% CI of the difference in symptom change lies entirely to the left of zero, indicating significant differences in favor of MindLight.

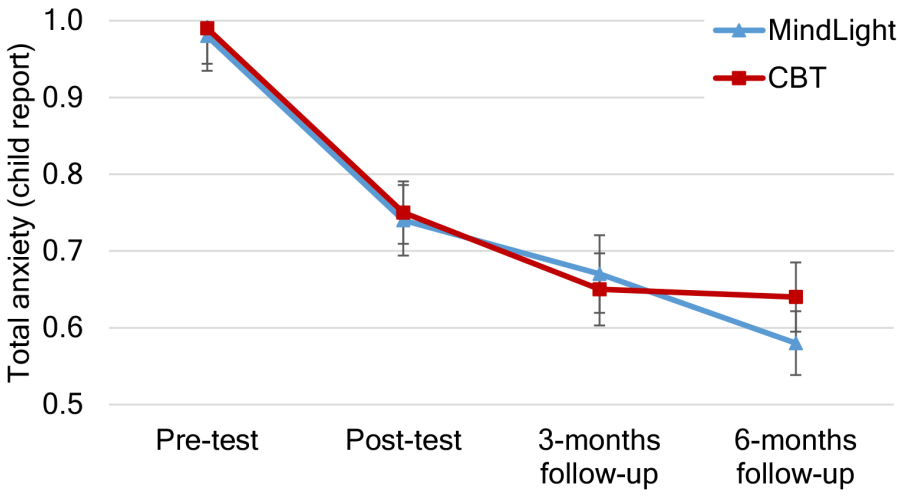


Figure 3. Total anxiety symptoms child report across time by program. Error bars are standard errors.

Fourth, the interaction between condition and sex, age, weekly game time, and expectations were added separately to the quadratic growth function. Table 3 shows that the interaction between condition and sex predicted the initial level of father reported anxiety symptoms: girls who played MindLight showed the highest initial father reported levels of anxiety. Furthermore, the interaction between condition and weekly game time predicted the quadratic slope component of personalized anxiety. This indicates that the rate of decrease in personalized anxiety slowed the most for children who were in the MindLight condition and had the highest amount of weekly game time. All other interactions were non-significant.

Children's Program Ratings

To compare the children's ratings of the programs, we conducted *t* tests on the five rating questions (see Table 1). Children who played MindLight and children who received CBT rated their program equally appealing to themselves across time points. In addition, at every time point, children in both conditions thought their program was appealing for other children. No differences between the programs were found on reported difficulty nor on the extent to which the programs induced anxiety. Children who received CBT rated the program significantly more relevant to their daily life than children who played MindLight.

Table 3
Initial Level (Intercept), Change (Linear Slope Component) and Rate of Change (Quadratic Slope Component) in Anxiety Symptoms on Condition and Moderators (Intention-to-Treat Sample)

	Intercept		Linear slope	
	B	*p*	*B*	*p*
Quadratic growth model				
Total child	0.98	<.001	-1.21	<.001
Personalized child	1.35	<.001	-1.38	<.001
Total mother	0.50	<.001	-0.45	<.001
Total father	0.47	<.001	-0.41	<.001
Program as predictor				
Total child	-0.02	.760	0.20	.505
Personalized child	0.07	.337	-0.09	.821
Total mother	0.00	.899	0.02	.908
Total father	0.01	.823	-0.04	.778
Age as moderator				
Total child	0.04	.423	-0.13	.480
Personalized child	0.01	.884	-0.00	.993
Total mother	-0.02	.534	0.16	.147
Total father	-0.03	.392	0.06	.611
Sex as moderator				
Total child	0.10	.521	-0.10	.875
Personalized child	0.15	.409	-0.31	.736
Total mother	0.10	.188	-0.06	.819
Total father	0.14	.050	-0.17	.564
Expectation as moderator				
Total child	-0.01	.834	-0.13	.375
Personalized child	0.05	.224	-0.36	.093
Total mother	0.01	.514	-0.02	.758
Total father	-0.02	.206	-0.03	.727
Weekly game time as moderator				
Total child	0.01	.164	-0.04	.192
Personalized child	0.02	.073	-0.06	.114
Total mother	0.00	.859	0.00	.878
Total father	0.00	.524	0.01	.380

Note. Total child = total anxiety child report; Personalized child = personalized anxiety child report; Total mother = total anxiety mother report; Total father = total anxiety father report.

Quadratic slope				
B	*p*	χ^2 (*df*)	CFI	RMSEA
0.97	<.001	11.65 (4)	0.96	0.11
1.07	<.001	8.60 (4)	0.97	0.08
0.36	.001	16.65 (4)	0.97	0.14
0.28	.002	14.59 (4)	0.98	0.13
-0.39	.245	3.78 (2)	0.99	0.06
-0.17	.737	6.82 (2)	0.98	0.11
0.04	.826	2.05 (2)	1.00	0.02
0.08	.645	2.30 (2)	1.00	0.03
0.14	.545	3.73 (4)	1.00	0.02
0.08	.824	6.15 (4)	0.99	0.05
-0.24	.123	7.01 (4)	0.99	0.06
-0.04	.777	5.90 (4)	1.00	0.05
-0.23	.756	7.42 (4)	0.99	0.07
-0.09	.935	14.80 (4)	0.96	0.13
0.17	.586	3.17 (4)	1.00	0.01
0.16	.661	2.40 (4)	1.00	0.01
0.17	.311	9.34 (4)	0.98	0.09
0.42	.159	10.66 (4)	0.98	0.09
0.02	.859	7.42 (4)	0.99	0.07
0.07	.447	8.21 (4)	0.99	0.07
0.06	.159	5.99 (4)	0.99	0.05
0.09	.043	4.73 (4)	1.00	0.03
-0.01	.626	4.37 (4)	1.00	0.02
-0.02	.341	3.90 (4)	1.00	0.02

Discussion

The current study represents one of the first of a handful of RCTs on applied games for children's mental health. To date, there have been no other direct comparisons between applied games for anxious children and the CBT gold standard intervention. We aimed to fill this gap by conducting a non-inferiority randomized controlled trial testing equal efficacy of the applied game MindLight and CBT. As predicted, results indicated that MindLight is as effective as CBT in the prevention of anxiety. The CI approach showed affirmatively that MindLight was non-inferior to CBT over the course of the study for total anxiety symptoms reported by children and parents. MindLight showed a larger decrease in child reported personalized anxiety symptoms at posttest and 6-month FU. LGCM analyses demonstrated that children who played MindLight showed the same significant decrease in anxiety symptoms compared to those who received CBT. Three- and 6-month follow-up assessments indicated that improvements were sustained based on both child and parent reports of anxiety measures. Moderation analyses showed that improvements were sustained to a somewhat lesser extent for children who were in the MindLight condition and had the highest amount of weekly game time. A possible explanation for this might be that these children were less engaged than the other children were, because MindLight might have been different than the games they normally play and therefore the effect of MindLight might be smaller (Glenn et al., 2013). Taken together, these results show that MindLight is an effective anxiety prevention program for at-risk children.

In trials assessing non-inferiority, it is essential that the effect of the gold standard—in this case CBT—is comparable to previous trials. Accordingly, in the current study, the CBT condition yielded effects in line with a previous indicated prevention trial (van Starrenburg et al., 2017). Furthermore, efficacy results for MindLight were comparable to those of an initial RCT (Schoneveld et al., 2016). Importantly, both MindLight and CBT demonstrated medium within group effect sizes, which corresponds or exceeds effect sizes reported in recent meta-analyses (e.g., Mychailyszyn et al., 2012).

Current results counter a main concern about applied games: that the acquired skills learned through playing a game may not transfer to children's everyday lives (Girard et al., 2013). First, the measures we used focused on reports of functioning in real-life situations and not on MindLight or CBT specifically. For example, statements on self- and parent reports were "I [my son/daughter] am afraid in the dark" and "I [my son/daughter] worry what other people think of me." Thus, children and parent report that the anxiety-regulation skills children learned in MindLight are not restricted to the game context, but seem to transfer to children's everyday lives. Second, the fact that not only the children themselves but also their parents reported anxiety decreases and that these improvements were maintained up to 6 months imply transference. This finding moves the applied games field forward as most studies focus only

on immediate or short-term improvement. Moreover, the exposure training that is embedded in MindLight resembles the more transdiagnostic technique of interoceptive exposure, in which people are exposed to, and made aware of, the physical sensations of anxiety rather than specifying particular anxiety-inducing situations. It seems that children in the MindLight group may have learned to regulate their physiological arousal generally and appear to use this skill in their daily lives.

As outlined above, stigma, accessibility, and non-motivating programs prevent children and parents from seeking help or cause them to drop out of conventional prevention programs. In the current study, dropout rates did not differ between the programs. They were equally low in MindLight and CBT, because the supervisors (Masters students and psychologists) worked hard to keep attrition in both groups as low as possible. However, in the context of real world, implementation where games like MindLight could be accessible not only during research protocols but also at home; it may still be that applied games are less likely to show high attrition rates. In addition, when looking into the reasons why children did not want to continue the allocated program, differences between MindLight and CBT appeared. Parents of children who dropped out of the CBT program expressed that it took too much time, a reason not mentioned by parents of children who discontinued MindLight. This highlights possibly a relative advantage of MindLight beyond the first-line treatment of choice for anxiety disorders (CBT): less children might drop out of the program because of time investment issues.

Children's Program Ratings

The second aim of the study was to test the emotion-inducing and motivational features of MindLight. An important finding was that children rated MindLight equally anxiety inducing as CBT. Both programs were rated as anxiety evoking (well above the middle of the scale), which is a prerequisite for children to be able to practice their emotion-regulation skills and for exposure techniques to work. In addition, MindLight was rated as equally difficult as CBT. When a game is too difficult, children often experience performance anxiety and give up easily. In contrast, when a game is too easy, children become bored and may lose interest quickly (Nakamura & Csikszentmihalyi, 2002). Overall, children rated the difficulty level somewhere in the middle of the scale, suggesting that MindLight (and CBT) hit the "sweet spot" of challenge and learning. Contrary to expectations, children found MindLight as appealing as CBT. Both were rated as moderately appealing for themselves and others. It may be that children liked CBT because they got personal attention and it was delivered in a group setting with like-minded peers. In MindLight, children were asked to play on their own, at their own pace. This lack of social connection may have made MindLight less fun. Given that the majority of gaming is now social (Lenhart et al., 2008), the constrained and individual nature of their game play might have impeded their feelings of autonomy and relatedness and consequently their motivation to play (Ryan & Deci, 2000).

Lastly, children rated CBT as more relevant to their daily life than MindLight. In CBT, children created their own personal anxiety hierarchy, based on which they chose exercises to practice regulating their anxiety. Children were explicitly told to think about what they do in the CBT sessions, practice the skills through homework assignments in their everyday life, and reflect on those real-life practice sessions. MindLight, on the other hand, has no such meta-cognitive exercises. The game does not explicitly, and regularly, remind children to practice the skills they learn in the game in their everyday experiences. This was an explicit design decision, aimed to decrease the didactic nature that often significantly diminishes the "fun factor" of most serious games. However, as a result, children may have rated MindLight as less relevant. It is important to note, however, that MindLight was still considered modestly relevant; the children did not rate the game as irrelevant. More critically, our results suggest that this meta-cognizing and explicit didactic exercises that ask children to take what they learn in a training session and apply it to real life may not be necessary to produce similar positive improvements as CBT.

Limitations and Future Directions

Expectations about intervention effects are an important source of potential bias. To equalize expectations across conditions, children and parents were told that both programs were aimed at teaching coping skills in stressful situations. This framing, however, could have primed them to believe that the programs could improve children's anxiety and hence biased their reports. Future studies could use, in addition to multiple informants, diverse types of measures to assess whether children change in the way they behaviorally cope with, and physiologically regulate, their anxiety.

A clear strength of the current study was the inclusion of a gold-standard active control condition instead of a no-contact or wait-list control group. RCTs are designed to test whether a certain intervention is effective, but they do not inform us about the mechanisms by which the intervention works. An important future step in this line of research is to examine underlying mechanisms by which games like MindLight might impact anxiety outcomes. Questions about mechanisms of change could be addressed in dismantling studies (Bell, Marcus, & Goodlad, 2013) in which one component of MindLight (e.g., neurofeedback, exposure, or attention-bias modification) is removed and the full version is compared to the dismantled version. Despite the call for dismantling studies for over two decades (Kendall et al., 1997) and their feasibility for childhood anxiety interventions (Whiteside et al., 2015), no studies have been conducted in which the full version of an anxiety prevention program is compared with a version missing one or select few components. Games provide a particularly promising avenue for this precise type of research, given their inherent modularity (Granic et al., 2014).

We are strongly encouraged by the findings of the current trial. However, we see this study not as the end of a develop and evaluation process, but the beginning of a promising and challenging approach. As part of that beginning, it is critical to note that most applied games and digital interventions that are developed and tested in a research setting stay in the scientific community, belying the main purpose of their development in the first place: large, scalable impact at low cost (Hollis et al., 2017). One of the reasons for the lack of implementation success might be absence of a systematic strategy for effective dissemination of evidence-based applied games (Gehring et al., 2017). Our Games for Emotional and Mental Health (GEMH) lab is at the early stages of building this strategic framework which includes (a) a replicable methodology by which games for mental health can be co-developed with partners in diverse disciplines including design, engineering and art; (b) an index of resources essential for not only successful development, but also dissemination and/or commercialization and the digital infrastructure required to maintain these interventions; and (c) a set of rationale for applying diverse research approaches (e.g., playtesting, user research, RCTs, experimental designs, qualitative interviews) that test not just for game design elements, outcomes and mechanisms, but also track the success of commercial uptake and other dissemination markers (www.gemhlab.com).

Ultimately, it may not be necessary to compete with the best commercial AAA games on the market to have an impact on young people's mental health with applied games. Applied games can co-exist with purely education-focused games, just as documentaries co-exist with Hollywood blockbusters, each appealing to individuals for different, and some overlapping, reasons. What does seem to be necessary, however, is for youth to be part of the design and development process so that our games are relevant, appealing, and optimally engaging to their target audience, increasing the probability that they will also be shared with family and friends. Finally, it may be important for scientists to take a more proactive role in engaging commercial industry and making the case for the financial, as well as health, benefits of providing beautiful, entertaining, and scientifically validated mental health tools.

Conclusion

The current study adds to the growing research on applied games for mental health and shows that these games hold potential as alternative delivery models of therapeutic techniques in mental health prevention. In this non-inferiority RCT, the applied game MindLight was shown to be as effective as conventional CBT in reducing child- and parent-reported anxiety levels in 8- to 12-year-old at-risk children. These improvements were maintained at 3- and 6-month follow-ups. Furthermore, MindLight and CBT were rated equally anxiety inducing, difficult, and appealing. Given that there are no clinicians or teachers involved and overhead costs associated with the game are non-existent, MindLight seems a more cost-effective alternative

than traditional anxiety intervention and prevention programs. In terms of school programs, applied games, and MindLight specifically, can easily be added to the toolbox of effective prevention approaches already in place in these contexts. Children with concerns about their own capacities to cope with anxiety may be provided with the choice of the delivery model (games or group face-to-face programs), potentially decreasing stigma, increasing their motivation to participate, and ultimately improving mental health outcomes across a broader range of children.

Appendix A

Pretest and change in anxiety symptoms over the study (completers only sample)

Assessment	MindLight	CBT	Mean difference[a]	*SD*	95% CI
		Total child			
Pretest	0.98	0.99			
Posttest – pretest[b]	-0.24	-0.25	0.01	0.35	[-0.04, 0.06][c]
3-months FU – pretest[b]	-0.32	-0.34	0.03	0.42	[-0.06, 0.9][c]
6-months FU – pretest[b]	-0.41	-0.36	-0.05	0.42	[-0.12, 0.01][c]
N	82	83			
		Personalized child			
Pretest	1.39	1.31			
Posttest – pretest [b]	-0.32	-0.19	-0.13	0.47	[-0.21, -0.06][d]
3-months FU – pretest [b]	-0.41	-0.37	-0.04	0.54	[-0.12, 0.05][c]
6-months FU – pretest [b]	-0.53	-0.37	-0.16	0.56	[-0.25, -0.07][d]
n	82	83			
		Total mother			
Pretest	0.51	0.50			
Posttest – pretest [b]	-0.10	-0.09	-0.01	0.17	[-0.03, 0.02][c]
3-months FU – pretest [b]	-0.12	-0.13	0.01	0.17	[-0.01, 0.04][c]
6-months FU – pretest [b]	-0.13	-0.16	0.03	0.20	[-0.00, 0.06][c]
n	79	78			
		Total father			
Pretest	0.47	0.46			
Posttest – pretest [b]	-0.09	-0.08	-0.01	0.17	[-0.04, 0.02][c]
3-months FU – pretest [b]	-0.12	-0.12	-0.01	0.17	[-0.04, 0.02][c]
6-months FU – pretest [b]	-0.14	-0.16	0.01	0.19	[-0.02, 0.04][c]
n	67	66			

Note. CI = confidence interval.

[a] A negative difference is a difference in favor of MindLight. [b] A negative score means a decrease in the severity of symptoms. [c] The 95% CI of the difference in symptom change lies entirely between the equivalence margins of -0.16 and + 0.16 points, indicating equivalence of MindLight and CBT. [d] The 95% CI of the difference in symptom change lies entirely to the left of zero, indicating significant differences in favor of MindLight.

Appendix B

Initial level (intercept), change (linear slope component) and rate of change (quadratic slope component) in anxiety symptoms on condition (completers only sample)

	Intercept		Linear slope	
	B	*p*	*B*	*p*
Linear growth model				
Total child				
Personalized child				
Total mother				
Total father				
Quadratic growth model				
Total child	0.98	<.001	-1.19	<.001
Personalized child	1.35	<.001	-1.38	<.001
Total mother	0.50	<.001	-0.45	<.001
Total father	0.46	<.001	-0.40	<.001
Program as predictor				
Total child	-0.02	.780	0.25	.415
Personalized child	0.07	.304	-0.12	.774
Total mother	0.00	.902	0.01	.947
Total father	0.01	.842	-0.06	.672

Note. Total child = total anxiety child report; Personalized child = personalized anxiety child report; Total mother = total anxiety mother report; Total father = total anxiety father report.

Quadratic slope					
B	*p*	χ^2 (*df*)	*p*	CFI	RMSEA
		47.40 (8)	<.001	0.69	0.17
		30.51 (8)	<.001	0.84	0.13
		40.03 (8)	<.001	0.89	0.16
		31.14 (8)	<.001	0.94	0.15
0.95	<.001	2.55 (2)	.280	1.00	0.04
1.07	<.001	0.07 (2)	.967	1.00	0.00
0.35	.001	3.62 (5)	.606	1.00	0.00
0.26	.005	1.39 (2)	.498	1.00	0.00
-0.48	.157	3.73 (3)	.292	1.00	0.04
-0.16	.768	6.07 (3)	.108	0.98	0.08
0.06	.769	4.42 (6)	.620	1.00	0.00
0.13	.476	1.62 (3)	.656	1.00	0.00

Appendix C

Initial level (intercept), change (linear slope component) and rate of change (quadratic slope component) in anxiety symptoms on condition and moderators (completers only sample)

Predictor	Intercept		Linear slope	
Anxiety symptoms	*B*	*p*	*B*	*p*
Age				
Total child	0.04	.434	-0.15	.397
Personalized child	0.01	.893	-0.02	.951
Total mother	-0.03	.477	0.21	.052
Total father	-0.03	.391	0.07	.470
Sex				
Total child	0.11	.471	0.00	1.00
Personalized child	0.16	.379	-0.24	.808
Total mother	0.10	.188	-0.06	.813
Total father	0.15	.044	-0.15	.655
Expectation				
Total child	-0.01	.776	-0.20	.176
Personalized child	0.05	.222	-0.42	.044
Total mother	0.01	.461	-0.01	.881
Total father	-0.03	.078	-0.07	.461
Weekly game time				
Total child	0.01	.149	-0.04	.166
Personalized child	0.02	.073	-0.06	.084
Total mother	0.00	.799	0.01	.706
Total father	0.00	.449	0.02	.127

Note. Total child = total anxiety child report; Personalized child = personalized anxiety child report; Total mother = total anxiety mother report; Total father = total anxiety father report.

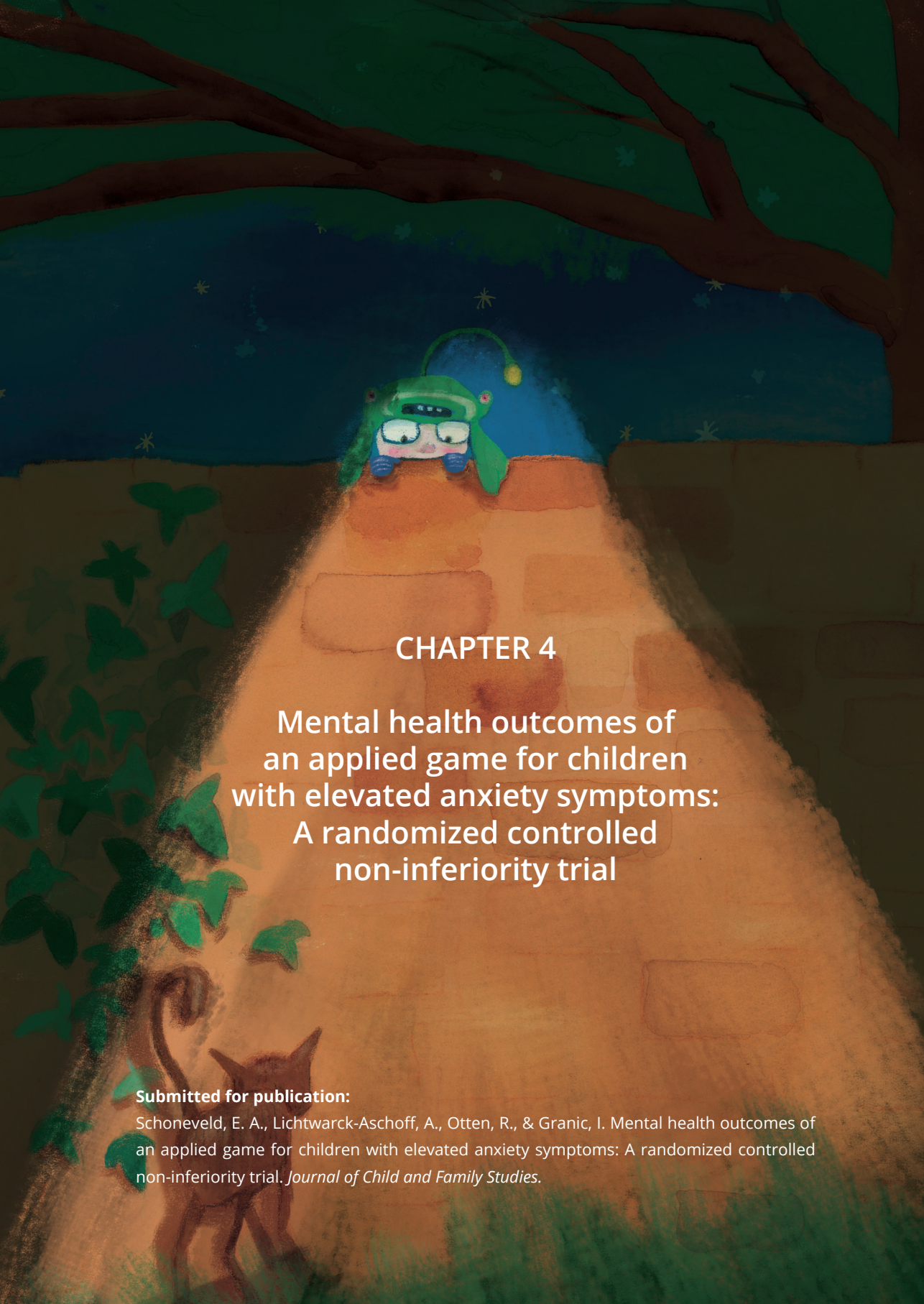
Appendix D

Similarities on age, weekly game time, and expectations at pretest by program

Measure	Statistic	MindLight	CBT	Test result
Age	Mean (*SD*)	9.87 (1.16)	10.07 (1.16)	$t(162) = 1.08$
Weekly game time	Mean (*SD*)	8.97 (9.24)	7.95 (7.20)	$t(161) = -0.79$
MindLight expectation	Mean (*SD*)	6.13 (2.11)	6.10 (2.00)	$t(163) = -0.12$
CBT expectation	Mean (*SD*)	5.81 (2.28)	5.90 (1.94)	$t(161) = 0.28$
Sex	*n* girls (%)	50 (58.1)	53 (60.2)	$\chi^2(1) = 0.08$

Note. All test results were non-significant.

Quadratic slope					
B	*p*	χ^2 (*df*)	*p*	CFI	RMSEA
0.15	.492	4.15 (5)	.528	1.00	0.00
0.13	.730	6.59 (5)	.253	0.99	0.04
-0.33	.041	7.68 (8)	.466	1.00	0.00
-0.05	.644	5.38 (5)	.371	1.00	0.02
-0.40	.595	8.15 (5)	.148	0.99	0.06
-0.20	.862	17.11 (5)	.004	0.95	0.12
0.20	.482	6.37 (8)	.605	1.00	0.00
0.14	.746	1.61 (5)	.900	1.00	0.00
0.27	.078	9.28 (5)	.098	0.98	0.07
0.52	.095	9.75 (5)	.083	0.98	0.08
-0.01	.889	8.28 (8)	.407	1.00	0.02
0.15	.195	6.12 (8)	.634	1.00	0.00
0.06	.130	5.06 (5)	.408	1.00	0.01
0.10	.022	4.27 (5)	.511	1.00	0.00
-0.01	.416	7.97 (8)	.437	1.00	0.00
-0.04	.082	4.22 (8)	.837	1.00	0.00



CHAPTER 4

Mental health outcomes of an applied game for children with elevated anxiety symptoms: A randomized controlled non-inferiority trial

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Abstract

Anxiety disorders are the most prevalent mental health problems in childhood. Engaging, adequate, and appropriate prevention programs are needed. Applied games form a potential alternative delivery model and recent evidence suggests that they could be effective. The present randomized controlled non-inferiority trial investigated the beneficial effects of the applied game MindLight compared to cognitive behavioral therapy (CBT) on mental health outcomes associated with anxiety symptoms: internalizing problems, externalizing problems, and self-efficacy. In addition, we examined for whom both programs might be most effective and analyzed the mental health outcomes, in addition to baseline levels of anxiety and maternal mental health problems, as predictors of outcome. After being screened for elevated anxiety, 174 selected children (8- to 12-year-old) were randomized to play MindLight or to receive a prevention program based on CBT. Study variables were assessed before, after the intervention, and at 3- and 6-months follow-up. Intention-to-treat analyses showed a significant reduction in mother-reported internalizing and externalizing problems and an increase in self-efficacy. Importantly, the magnitude of change did not differ between intervention groups. Non-inferiority analyses showed that MindLight was as effective as CBT in affecting internalizing problems and self-efficacy. However, CBT was more effective in decreasing externalizing symptoms than MindLight. Furthermore, baseline anxiety levels, self-efficacy, externalizing problems and maternal mental health problems did not influence the change of anxiety symptoms over time. In conclusion, applied games, specifically theory-based games such as MindLight, hold potential as effective interventions for not only targeting anxiety symptoms, but also more general mental health outcomes.

Approximately one in five children has an anxiety disorder (Beesdo et al., 2009) and even more children suffer from subclinical levels of anxiety, with prevalence rates up to 49% (Muris, Merckelbach, et al., 2000). Compared to children with low levels of anxiety, these children perform worse at school (Owens et al., 2012), and have a lower general quality of life (Ramsawh & Chavira, 2016). In addition, children with elevated levels of anxiety have more depressive feelings (Lavigne et al. 2015), more difficulties in relationships with their peers (Hoglund and Chisholm 2014), express more conduct problems (Kidwell et al., 2016; Priddis et al., 2014), and show lower levels of self-efficacy (Mathews et al., 2016; Niditch & Varela, 2012; O'Neal & Cotten, 2016) than children with low levels of anxiety. Left untreated, anxiety symptoms show a disabling and chronic course (Asselmann & Beesdo-Baum, 2015). Therefore, effective, accessible and engaging prevention programs are needed that are implemented before full-blown anxiety disorders develop (World Health Organization, 2012).

Decades of research has led to the development of several anxiety prevention programs (e.g., Van Starrenburg's adaptation of Kendall's Coping Cat, Barrett's FRIENDS for Life and Rapee's Cool Little Kids programs). However, conventional programs face several obstacles that hamper their implementation. Specifically, stigma (Mukolo & Heflinger, 2011; Salloum et al., 2016) and program costs (Salloum et al., 2016) impede parents and children from seeking help. Furthermore, conventional programs are moderately effective as shown in various meta-analyses (Fisak et al., 2011; Mychailyszyn et al., 2012; Stockings et al., 2016; Teubert & Pinquart, 2011) and drop-out rates are high (i.e., 28% up to 75%; de Haan et al., 2013), possibly because programs are not engaging, adequate, nor appropriate (World Health Organization, 2012). These obstacles call for a reconsideration of our current group-based and clinical expert-led delivery models of prevention programs (Kazdin, 2015). To overcome those barriers, applied games have recently been put forward as an alternative delivery model of therapeutic techniques used in prevention programs (Kazdin, 2015). In contrast to current services, games might be cheaper than therapists, easily accessible, engaging and not stigmatizing (Granic et al., 2014).

Recently, we tested the effectiveness of the applied game MindLight in two randomized controlled indicated prevention trials (RCTs; Schoneveld, Lichtwarck-Aschoff, & Granic, 2018; Schoneveld et al., 2016). MindLight is an applied game designed for children with anxiety symptoms. The game uses several evidence-based techniques, informed by cognitive behavioral therapy (CBT): exposure (Kendall et al., 2005), attention bias modification (Bar-Haim et al., 2011) and neurofeedback (Price & Budzynski, 2009). These techniques are embedded in a horror-themed survival game that trains children to cope with anxious feelings. For a more elaborate description of MindLight, see previous papers on the applied game (Schoneveld et al., 2018; Schoneveld et al., 2016; Wijnhoven, Creemers, Engels, & Granic, 2015). First, we looked at anxiety symptoms reported by both children and parents (primary outcomes) in one RCT. We found that MindLight was as effective as a commercial game (Schoneveld et al., 2016) in 8- to

12-year-olds with elevated levels of anxiety symptoms. Anxiety symptoms decreased after game play and up to three months later. The second RCT was designed to more rigorously examine the effectiveness of MindLight by comparing the applied game with the first-line treatment of choice for anxiety symptoms: CBT (A. C. James et al., 2015). Children who played MindLight showed the same decrease in anxiety symptoms as children who received CBT (Schoneveld et al., 2018). Importantly, the magnitude of improvement was equal across MindLight and both comparison groups (i.e., commercial game and CBT). In addition, children's age and gender did not moderate effectiveness in both RCTs. The current study is the second study out of the second RCT (Schoneveld et al., 2018) and describes its secondary outcome results.

Improvement in Mental Health Outcomes

In light of these initial positive effects of MindLight on anxiety symptoms, the next steps are to investigate whether MindLight also has beneficial effects on other outcomes associated with anxiety symptoms, and for whom MindLight might be most effective. Children who experience elevated levels of anxiety often also suffer from depressive feelings (Lavigne et al., 2015), have difficulties in relationships with their peers (Hoglund & Chisholm 2014), express more externalizing symptoms such as conduct problems (Kidwell et al., 2016; Priddis et al., 2014), and are generally characterized by low levels of self-efficacy (Mathews et al., 2016; Niditch & Varela, 2012; O'Neal & Cotten, 2016). Given the debilitating effect of these problems on the lives and further development of these children, and the fact that they co-occur as well as contribute to further increases in anxiety, it seems important to investigate whether anxiety prevention programs also have a beneficial effect on those domains.

Previous studies assessing changes in internalizing problems after anxiety prevention programs found that pre-school aged children with an anxiety disorder decreased in internalizing behavior problems from pre- to posttest after receiving an internet-based, therapist assisted, parent-focused, CBT program (Donovan & March, 2014). In addition, Morgan and colleagues (2016) found that highly inhibited children between the age of 3 and 6 years improved significantly in emotional symptoms during an online version of the parenting group program Cool Little Kids. Last, a meta-analytic review showed that interventions targeting anxiety in youth showed significant effects on depressive symptoms for treatment and universal prevention programs, but not in targeted prevention programs (Garber et al., 2016). Thus, it seems that anxiety prevention programs are able to improve other internalizing problems as well.

Whether anxiety prevention programs also have beneficial effects on externalizing problems is unclear, but there are reasons to believe this may be so. Research on the comorbidity between anxiety and aggression could be informative. Two recent reviews about the often-found comorbidity between anxiety and aggression focus on attention control (Fraire & Ollendick, 2013; Granic, 2014). Anxious children pay more attention to potential threats in their

environment (i.e., attentional bias; Bar-Haim et al., 2011) and have less processing capacity left to focus and sustain attention on other stimuli (i.e., attentional control; Eysenck, Derakshan, Santos, & Calvo, 2007; Fraire & Ollendick, 2013; Reinholdt-Dunne, Mogg, & Bradley, 2013). This vigilant focus on the potential negative aspect of the environment might consume most of the available resources. As a result, anxious children may have difficulties inhibiting their impulses and act out and behave aggressively (Granic, 2014). Thus, as anxiety symptoms are decreasing as a result of the prevention program this might free up cognitive resources to better regulate impulses (Hadwin & Richards, 2016) and consequently externalizing problems might decrease. Last, previous research has not focused on changes in self-efficacy following anxiety prevention programs, but it seems important to consider as well. One study assessed self-efficacy in a CBT-program for school-refusing children and found improvements in children's self-efficacy for school situations (N. J. King et al., 1998). However, this study did not investigate self-efficacy as a secondary outcome of the prevention programs.

For Whom are MindLight and CBT effective?

Another important question pertains to the idea that individuals respond differently to prevention programs. There may be important predictors of efficacy to consider. Past research in CBT-based anxiety prevention programs for children has identified several potential baseline predictors, such as baseline anxiety, maternal mental health problems, and self-efficacy. Research investigating the effect of anxiety symptoms at baseline on the response to a prevention program is inconclusive. One study found that higher levels of baseline anxiety were related to greater decreases in anxiety after an indicated CBT-based program (van Starrenburg et al., 2017). However, another study found that children with clinical anxiety show a more limited response to pain-focused CBT (Cunningham et al., 2016).

Further, parents of children with mental health problems often have mental health issues themselves (S. H. Goodman et al., 2011; Powdthavee & Vignoles, 2008). Research has shown that parental problems with mental health can be genetically transmitted (Lubke et al., 2016). Alternatively, parental problems can also impact children's mental well-being through distortions in parenting, for example harsh discipline (Gershoff, 2002) or a controlling parenting style (Chorpita, Brown, & Barlow, 1998). For anxiety specifically, more controlling parents diminish children's sense of personal control, thereby contributing to increases in anxiety (Chorpita et al., 1998). Last, parental modeling of anxious behaviors and cognitions may also contribute to children's anxiety (Fisak & Grills-Taquechel, 2007).

Studies investigating the effect of maternal mental health problems on intervention effectiveness show inconsistent results. One study on the effect of maternal depression on posttraumatic stress treatment in children found that maternal depression was associated with increasing posttraumatic stress symptoms in children (Weems & Scheeringa, 2013), especially for children

with higher baseline levels of these symptoms (Vandervord Nixon, Sterk, & Pearce, 2012). However, another study showed that maternal psychopathology did not predict the effect of a depression and anxiety prevention program for adolescents with parents with mental health problems (Rasing et al., 2018) .

There are no studies that have directly examined the role of self-efficacy on anxiety prevention effects. Therefore, it is unclear whether children with high or low levels of self-efficacy respond differently to anxiety prevention programs. A recent meta-analysis of 155 experimental trials found, however, that self-efficacy has a causal effect on health-related intentions and behavior (Sheeran et al., 2016), indicating that when people believe that they can execute the relevant action, they are more likely to change their health intention and behavior.

Current Study

The first aim of the present study was to report the effect of MindLight on mental health outcomes of children with elevated levels of anxiety symptoms. Specifically, changes in internalizing problems, externalizing problems, and self-efficacy were investigated. Based on previous research, we hypothesized that MindLight and CBT would be effective in decreasing internalizing and externalizing problems, and in increasing self-efficacy. The hypotheses about externalizing problems and self-efficacy were more tentative, since previous studies did not directly assess these mental health outcomes as secondary outcomes of anxiety prevention programs for children. Overall, we did not expect differences between MindLight and CBT, since anxiety symptoms decreased during and after both programs (Schoneveld et al., 2018).

The second aim was to assess possible predictors of MindLight and CBT anxiety outcome: baseline anxiety symptoms, maternal mental health problems, and self-efficacy. We hypothesized that baseline anxiety would, and maternal mental health problems would not predict changes in anxiety symptoms. We tentatively hypothesized that self-efficacy would predict changes in anxiety symptoms. Specifically, we hypothesized that children with higher baseline levels of self-efficacy would show a larger decrease in anxiety symptoms compared to children with lower baseline levels of self-efficacy. We did not expect differences between MindLight and CBT with regard to any of the outcome predictors, hence the moderation effects between these predictors and condition were not assessed.

In sum, the current study is the second study out of a non-inferiority RCT comparing MindLight and CBT (Schoneveld et al., 2018) and 1) described effects on the secondary outcomes internalizing problems, externalizing problems, and self-efficacy and 2) assessed possible predictors of MindLight and CBT anxiety outcome: baseline anxiety symptoms, maternal mental health problems, and self-efficacy.

Method

Study Design and Setting

The study was designed as a randomized, multicenter non-inferiority study with two parallel intervention arms: MindLight and CBT. Details of the randomization procedure are available elsewhere (Schoneveld et al., 2018). Children and mothers were assessed before children received the intervention (pretest), at completion of the intervention (posttest), and three- and six-months post-intervention completion (i.e., 3- and 6-months follow-up). The study was registered at the Dutch Trial Register (www.trialregister.nl; Trial ID: NTR4993) and approved by the ethics committee of the Faculty of Social Sciences of Radboud University (EC2013-0410-139a1). The interventions were conducted in primary schools in the East of the Netherlands.

Procedure

Between January and September 2015, all children in grades 3 to 6 from eight primary schools with active parental consent (N = 791) were first screened on anxiety symptoms with the child version of the Spence Children's Anxiety Scale (SCAS; Spence, 1998). Children were eligible if either at least two SCAS subscales (excluding the obsessive compulsive disorder subscale) or the total SCAS score, was one *SD* or more above the mean found in a large normative sample (Muris, Merckelbach, et al., 2000). Parents of the 221 (27.9%) eligible children were contacted by phone to assess exclusion criteria and invite them and their child(ren) to participate. Children were excluded if they already received anxiety treatment or if they were diagnosed with either obsessive-compulsive disorder, post-traumatic stress disorder or autism spectrum disorder. Parents of 174 (78.7%) children gave initial verbal consent; written informed consent was obtained from parents at pretest, a week prior to the intervention. Children and their mothers then filled out the questionnaires at school or online respectively. Posttest, 3-months and 6-months follow-up assessments followed the same procedure as pretest.

Participants

A total of 174 children were randomly assigned to MindLight or CBT (see Figure 1). The target total sample size was 135 children. Details about the sample size calculation can be found in (Schoneveld et al., 2018). At pretest, children ranged from 7 to 12 years old (M = 9.97, SD = 1.16) and 59.2% were girls. Mothers were between 28 and 49 years old (M = 41.13, SD = 3.67) at pretest, the majority being Dutch (87.9%).

Intervention Programs

MindLight. MindLight is a 3D third-person neurofeedback video game designed by a multidisciplinary team of researchers from the PlayNice Institute and game designers from GainPlay Studio. Several evidence-based, theoretically grounded strategies for decreasing anxiety (i.e., neurofeedback, exposure, and attention bias modification) were translated into game mechanics (for further details, see Schoneveld et al., 2016; Wijnhoven, Creemers, Vermulst, Engels, & Granic, 2017). The game starts with a little boy named Arty who is left at the doorstep of his grandmother's scary mansion. In his bedroom, he finds Teru, a magical glowing hat that faces him with the task of saving grandmother from the evil forces that have possessed her and the house. Teru teaches Arty (and the player) to change his state of mind and thereby overcome his fears. The player controls the movement of Arty using a Microsoft Xbox 360 controller and (s)he controls Teru's light via the Neurosky one-channel dry-sensor EEG headset (i.e., MindWave). Children played MindLight in one-hour sessions at school, after regular school hours, once a week, for six weeks. Children played the game individually but they were seated in a room with about five to ten other children. Children were seated one table away from each other and used earplugs to hear the game sound and to diminish distraction. Master's degree students gave instructions about MindLight and supervised the groups.

CBT. The CBT program used in the current study was an adaptation of Kendall's Coping Cat (Flannery-Schroeder et al., 2005; van Starrenburg et al., 2017). It is one of the few CBT prevention programs for children with elevated anxiety symptoms, that focuses on anxiety-specific symptoms, emphasizes exposure and is freely accessible (van Starrenburg et al., 2017). Specifically, a shortened 8-session (nine hours) Dutch version of the indicated prevention group-based version of Van Starrenburg et al. (2017) was given. In this program, children are taught both cognitive (i.e., cognitive restructuring) and behavioral techniques (i.e., relaxation training and exposure). Children received two 1.5-hour sessions and six one-hour sessions at school, after regular school hours, once a week, for eight weeks. Groups consisted of four to seven children and were led by two CBT trainers (Schoneveld et al., 2018). Parents were informed about the progress of their child halfway through the program and after the last session via e-mail.

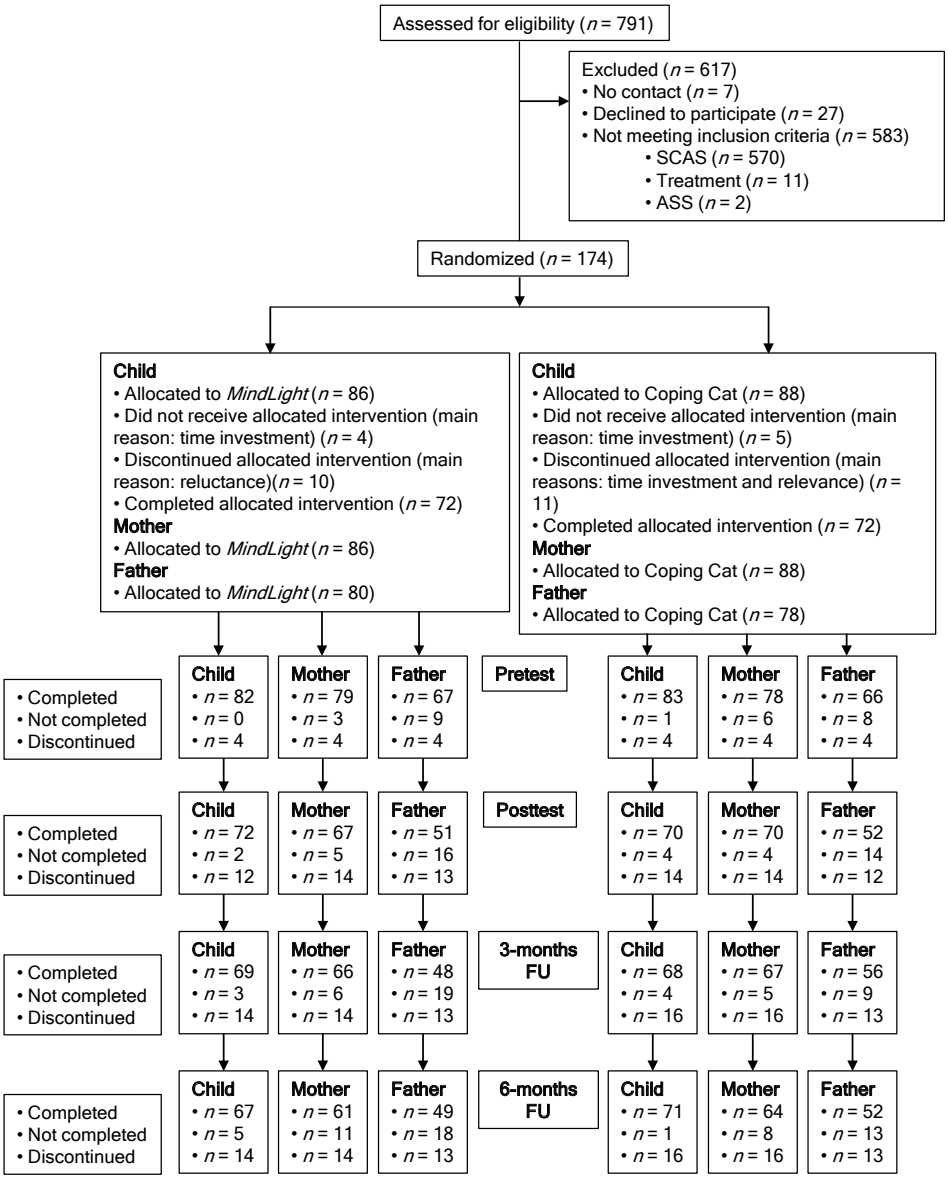

Figure 1. Flow chart of participants through trial.

Measures

Anxiety symptoms. Children's anxiety symptoms were measured with the child (45 items) and mother (38 items) versions of the SCAS (Spence, 1998). To reduce negative response bias, the child version includes seven positive filler items. All items were rated on a 4-point scale: 0 (*never*), 1 (*sometimes*), 2 (*often*) or 3 (*always*). Good convergent validity (Brown-Jacobsen et al., 2011; Muris, Schmidt, et al., 2000) and reliability (Whiteside & Brown, 2008) are demonstrated for both the child and the mother version. In our sample, Cronbach's alpha's were 0.90 – 0.93 for the child version and 0.80 – 0.84 for the mother version across all time points. Two outcome variables were computed: total anxiety child and total anxiety mother, which are the overall means (with the exception of filler items).

Self-efficacy. Children's self-efficacy was measured with the self-report version of the Self-Efficacy Questionnaire for Children (SEQ-C; Muris, 2001). The 24 items were rated on a 5-point scale - 0 (*very bad)*, 1 (*pretty bad)*, 2 (*not good, not bad)*, 3 (*pretty good)*, 4 (*very good*) - and represented three domains of self-efficacy: 1) social self-efficacy: perceived capability for assertiveness and peer relationships, 2) academic self-efficacy: perceived capability to fulfill academic expectations, to master academic subjects, and to manage one's own learning behavior and 3) emotional self-efficacy: perceived capability to cope with negative emotions. The SEQ-C shows satisfactory internal consistency, reliability and validity (Muris, 2001). In our sample, Cronbach's alphas were between 0.73 – 0.84 for academic self-efficacy, between 0.64 – 0.75 for social self-efficacy, and between 0.79 – 0.88 for emotional self-efficacy across all time points. Three outcome variables were computed: social, academic and emotional self-efficacy.

Internalizing and Externalizing Problems. Children's internalizing and externalizing problems were measured with the mother version of the Strengths and Difficulties Questionnaire (SDQ; R. Goodman, 1997; Stone, Otten, Engels, Vermulst, & Janssens, 2010). The SDQ includes 25 items divided in three subscales: 1) internalizing problems: emotional symptoms and peer relationship problems; 2) externalizing problems: conduct problems and hyperactivity / inattention symptoms; 3) prosocial behavior. We used this three subscales division, because it is more valid than the original five subscales division in a low-risk (i.e., without disorders) sample (A. Goodman et al. 2010). We only used the first two subscales in this study. All items were rated on a 3-point scale: 0 (*not true)*, 1 (*somewhat true)*, 2 (*certainly true)*. The two subscales showed good convergent and discriminant validity, and good internal reliability (A. Goodman, Lamping, & Ploubidis, 2010). In our sample, Cronbach's alphas were between 0.72 – 0.75 for internalizing problems and between 0.75 – 0.79 for externalizing problems across all time points. Two outcome variables were computed: internalizing problems, and externalizing problems.

Maternal Mental Health Problems: Depression, Anxiety, and Stress. Maternal mental health problems were assessed with the 21 items version of the Depression Anxiety Stress Scales (DASS-21; Antony, Bieling, Cox, Enns, & Swinson, 1998). The 21 items, all covering negative feelings, were rated on a 4-point scale - 0 (*not at all),* 1 (*sometimes)*, 2 (*often)*, 3 (*usually*) - and represented three subscales: depression, anxiety, and stress. The subscales show good concurrent validity and reliability (Antony et al., 1998). In our sample, Cronbach's alphas were 0.89 for depression, 0.81 for anxiety and 0.87 for stress at pretest. Three outcome predictor variables were computed: maternal depression, maternal anxiety and maternal stress.

Strategy of Analyses

A *t* test and a χ^2-test were performed in IBM SPSS Statistics 23 to assess whether randomization was successful for sex and age. To test non-inferiority, we used a two-sided confidence interval (CI) approach. The idea behind this approach is that if the upper bound of the CI for the difference in mean change in secondary outcomes is below the margin of non-inferiority, MindLight is non-inferior to CBT. Based on a previous indicated anxiety prevention trial (van Starrenburg et al. 2017), the margin of non-inferiority was set at 0.38 SEQ points for social, emotional and academic self-efficacy, at 1.11 SDQ points for internalizing problems, and at 0.90 SDQ points for externalizing symptoms. These differences correspond to 0.5 *SD* of the change in emotional self-efficacy (*M* = -0.28, *SD* = 0.76), internalizing symptoms (*M* = 1.50, *SD* = 2.22), and externalizing symptoms (*M* = 1.10, *SD* = 1.80) at posttest in children in the CBT condition of the van Starrenburg et al. (2017) trial.

To further examine the effectiveness of MindLight on the secondary outcomes (i.e., social, emotional, and academic self-efficacy, internalizing and externalizing problems), Latent Growth Curve Modelling (LGCM) was performed using Mplus 7.2 (Muthén & Muthén, 1998-2012b). First, we estimated the initial model based on the four time points (i.e., pretest, posttest, 3- and 6-months FU) without any predictors or control variables. Second, we tested whether condition predicted initial levels of outcomes (i.e., intercept) and/or rates of change in outcomes (i.e., slope).

For our second aim, predictors (i.e., baseline anxiety symptoms, maternal mental health problems and self-efficacy) of the effectiveness of MindLight and CBT on anxiety symptoms were also assessed with LGCM. The effectiveness on anxiety symptoms was already reported in Schoneveld et al. (2018). For the current analyses, we started with the quadratic growth model of anxiety symptoms found in Schoneveld et al. (2018) and added the outcome predictors measured at pretest (i.e., social, emotional, and academic self-efficacy) next to condition as predictors. In addition, we added maternal depression, anxiety and stress, and baseline anxiety levels as predictors. This was done separately for the model based on child-reported and mother-reported total anxiety symptoms.

To determine model fit, we used the Chi-square an *p*-value, the Comparative Fit Index (CFI, critical value ≥ .95), Tucker Lewis Index (TLI, critical value ≥ .95) and the Root Mean Squared Estimate of Approximation (RMSEA, critical value ≤ .06) (Hu and Bentler, 1999). The default maximum likelihood estimator was used. Attrition analyses were conducted but no systematic relationships were found between baseline covariates and missingness. The model was estimated using all available data.

Results

Descriptive Statistics

Means and *SD*s of all study variables at all-time points separately for condition are shown in Table 1. Randomization was successful. Details of the randomization results are available elsewhere (Schoneveld et al., 2018). In addition, no differences were found on the outcome predictors: baseline anxiety symptoms child report, baseline anxiety symptoms mother report, maternal depression, maternal anxiety, and maternal stress.

Bivariate correlations between secondary outcomes across time points are available in Table 2. The self-efficacy subscales were positively correlated at the same time and over time. Similarly, internalizing and externalizing symptoms were positively correlated within assessments and over time. In addition, Table 3 shows bivariate correlations of maternal mental health problems and anxiety symptoms. Child- and mother-reported anxiety were positively correlated at all time-points, except for child-reported anxiety at pretest and mother-reported anxiety at 6-months follow-up. In addition, mother-reported anxiety was positively correlated with baseline maternal mental health problems at all time-points. Last, maternal depression, anxiety and stress were positively correlated at pretest.

Improvement in Mental Health Outcomes over Time

Non-inferiority. Table 4 presents the change in secondary outcomes and 95% CIs for both intervention programs over the course of the study. It shows that non-inferiority of MindLight to CBT could be demonstrated at posttest, 3-months follow-up and 6-months follow-up for social self-efficacy, emotional self-efficacy, academic self-efficacy and internalizing problems. For externalizing problems, non-inferiority could only be shown at 3-months follow-up. At posttest and 6-months follow-up, the CI lay entirely to the right of zero, indicating significant differences in favor of CBT. The results are visualized in Figure 2 (self-efficacy), Figure 3 (internalizing problems), and Figure 4 (externalizing problems). Results from the non-inferiority analyses of the secondary outcomes in the completers only sample were similar and are available in Appendix A.

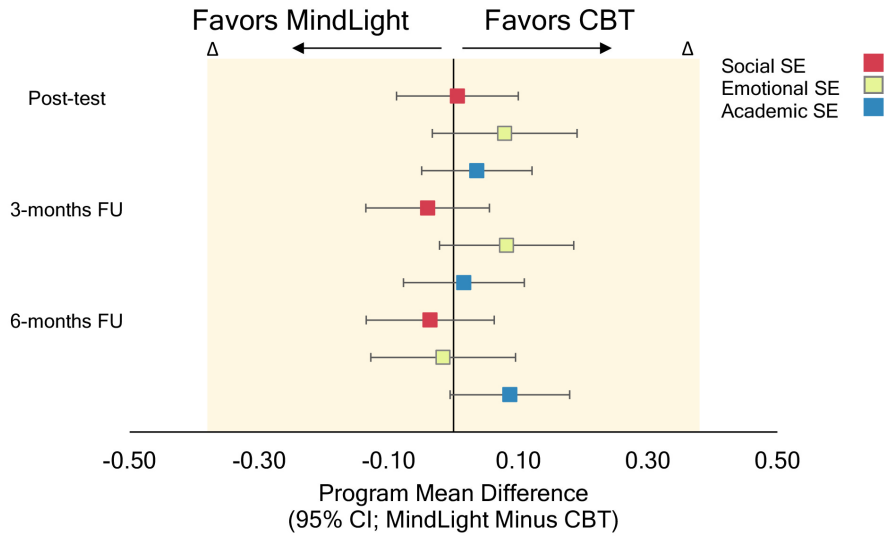

Figure 2. Differences between intervention programs in self-efficacy, in relation to non-inferiority.

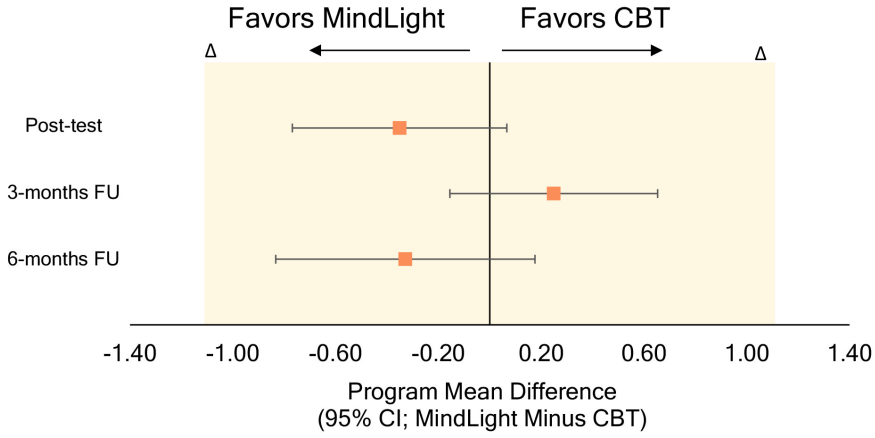

Figure 3. Differences between intervention programs in internalizing problems, in relation to non-inferiority.

Table 1
Means, Standard Deviations, Minimum, Maximum, Skewness, and Kurtosis of Study Variables Separately for Intervention Programs and for Time Point

	MindLight					
Measure	*M*	*SD*	Min.	Max.	SK	KU
			Pretest			
Sex	50[a]	58.1[b]	-	-	-	-
Age	9.87	1.16	7.84	12.65	0.35	-0.62
Anx. child	0.97	0.40	0.24	2.24	0.73	0.80
Anx. m.	0.51	0.26	0.03	1.20	0.54	0.05
Dep. mother	1.17	2.04	0.00	8.37	2.37	5.32
Anx. mother	0.54	1.12	0.00	5.47	2.69	7.68
Stress mother	3.13	3.09	0.00	12.51	0.91	0.29
Social SE	2.34	0.68	0.86	4.00	-0.11	-0.31
Emotional SE	1.84	0.76	0.00	3.29	-0.18	-0.50
Academic SE	2.43	0.74	0.43	4.00	-0.52	-0.07
Int. problems	4.58	3.27	0.00	13.00	0.70	-0.01
Ext. problems	5.42	3.47	0.00	15.00	0.35	-0.24
			Posttest			
Social SE	2.53	0.67	0.86	4.00	0.27	-0.22
Emotional SE	2.10	0.73	0.43	4.00	0.58	0.42
Academic SE	2.57	0.75	0.86	4.00	-0.15	-0.31
Int. problems	3.48	3.18	0.00	12.00	1.04	0.13
Ext. problems	5.09	3.11	0.00	14.00	0.28	-0.33
			3-months follow-up			
Social SE	2.67	0.71	0.51	4.00	-0.57	0.54
Emotional SE	2.25	0.86	0.57	4.00	0.12	-0.59
Academic SE	2.72	0.78	0.43	4.00	-0.63	0.48
Int. problems	3.65	3.43	0.00	13.00	1.12	0.23
Ext. problems	5.09	3.20	0.00	14.00	0.47	0.14
			6-months follow-up			
Social SE	2.73	0.67	1.29	4.00	-0.22	-0.33
Emotional SE	2.37	0.86	0.29	4.00	-0.21	-0.24
Academic SE	2.67	0.75	0.71	4.00	-0.15	-0.40
Int. problems	3.18	3.14	0.00	11.93	1.31	1.16
Ext. problems	4.75	3.33	0.00	15.00	0.50	0.09

Note. Min. = minimum; Max. = maximum; SK = skewness; KU = kurtosis; Anx. = anxiety; m. = mother; Dep. = depression; SE = self-efficacy; Int. = internalizing; Ext. = externalizing.
[a] Not *M*, but *n* girls; [b] Not *SD*, but %.

CBT					
M	*SD*	Min.	Max.	SK	KU
Pretest					
53[a]	60.2[b]	-	-	-	-
10.07	1.16	7.85	12.80	0.33	-0.69
0.99	0.41	0.26	2.24	0.88	0.80
0.50	0.19	0.16	1.05	0.66	0.13
1.04	1.79	0.00	8.37	2.28	4.95
0.57	0.99	0.00	5.47	2.37	7.31
3.10	3.00	0.00	12.51	1.08	1.08
2.28	0.60	0.53	3.57	-0.12	0.15
1.84	0.73	0.29	3.86	-0.22	0.01
2.28	0.63	1.00	3.71	-0.10	-0.40
4.62	3.54	0.00	14.81	1.18	1.32
5.87	4.01	0.00	16.89	0.74	0.33
Posttest					
2.49	0.66	0.57	4.00	-0.46	0.34
2.18	0.76	0.00	4.00	-0.32	0.77
2.56	0.67	1.14	4.00	0.07	-0.40
3.70	3.16	0.00	13.14	0.87	0.11
4.79	3.33	0.00	15.08	1.12	1.72
3-months follow-up					
2.58	0.66	0.51	4.00	-0.49	0.60
2.32	0.73	0.57	4.00	0.06	-0.41
2.60	0.71	0.71	4.00	-0.31	-0.39
3.33	3.01	0.00	13.00	1.11	1.14
5.07	3.75	0.00	15.54	0.95	0.61
6-months follow-up					
2.63	0.58	1.43	4.00	0.18	-0.48
2.33	0.79	0.14	4.00	-0.29	0.10
2.62	0.68	1.00	4.00	-0.10	-0.55
3.27	2.62	0.00	10.00	0.80	-0.27
4.88	3.53	0.00	15.24	0.80	0.75

Table 2
Bivariate Correlations of Secondary Outcomes Across Time Points

Measure	1	2	3	4	5	6	7	8	9
Pretest									
1. SE soc.	-								
2. SE emo.	**.51**	-							
3. SE aca.	**.31**	**.39**	-						
4. Int.	**-.18**	-.14	-.06	-					
5. Ext.	-.10	-.09	**-.36**	**.48**	-				
Posttest									
6. SE soc.	**.55**	**.38**	**.40**	-.09	-.03	-			
7. SE emo.	**.41**	**.52**	**.41**	-.09	-.06	**.60**	-		
8. SE aca.	**.33**	**.27**	**.69**	-.07	**-.22**	**.58**	**.56**	-	
9. Int.	**-.21**	**-.18**	-.15	**.72**	**.41**	**-.18**	**-.20**	-.13	-
10. Ext.	-.06	-.12	**-.27**	**.46**	**.81**	.02	-.06	**-.22**	**.47**
3-months FU									
11. SE soc.	**.57**	**.36**	**.39**	-.14	.03	**.67**	**.47**	**.37**	**-.21**
12. SE emo.	**.32**	**.54**	**.35**	-.08	.16	**.55**	**.69**	**.47**	-.14
13. SE aca.	**.28**	**.24**	**.64**	-.05	-.15	**.48**	**.51**	**.72**	-.10
14. Int.	**-.18**	**-.20**	-.11	**-.75**	**.40**	-.11	-.10	-.08	**.76**
15. Ext.	-.07	-.11	**-.29**	**.41**	**.81**	.00	-.01	-.18	**.42**
6-months FU									
16. SE soc.	**.46**	**.23**	**.20**	-.11	.05	**.62**	**.39**	**.27**	-.13
17. SE emo.	**.27**	**.41**	**.17**	-.03	.05	**.48**	**.59**	**.40**	-.08
18. SE aca.	**.21**	.15	**.63**	.01	**-.18**	**.44**	**.40**	**.72**	-.04
19. Int.	-.17	**-.22**	-.04	**.57**	**.32**	-.07	-.07	.04	**.67**
20. Ext.	-.01	-.10	**-.28**	**.29**	**.76**	.00	.03	**-.21**	**.33**

Note. Correlations in bold are significant with at least $p < .05$. SE soc. = social self-efficacy; SE emo. = emotional self-efficacy; SE aca. = academic self-efficacy; Int. = internalizing problems; Ext. = externalizing problems.

	10	11	12	13	14	15	16	17	18	19
	-									
	.00	-								
	.04	**.65**	-							
	-.18	**.60**	**.61**	-						
	.47	**-.21**	**-.18**	-.06	-					
	.84	.01	.07	-.15	**.46**	-				
	.02	**.72**	**.53**	**.36**	**-.18**	-.07	-			
	.04	**.41**	**.70**	**.35**	-.09	.02	**.58**	-		
	-.17	**.44**	**.50**	**.73**	-.05	**-.18**	**.44**	**.52**	-	
	.40	**-.20**	-.16	.01	**.76**	**.40**	**-.21**	.07	.00	-
	.77	.02	.10	-.18	**.40**	**.85**	.08	.08	**-.22**	**.36**

Table 3
Bivariate Correlations of (Other) Predictors and Anxiety Symptoms Across Time Points

Measure	1	2	3	4	5	6	7	8	9	10
Pretest										
1. Anxiety (child report)	-									
2. Anxiety (mother report)	**.20**	-								
3. Depression mother	-.01	**.26**	-							
4. Anxiety mother	.05	**.22**	**.46**	-						
5. Stress mother	.01	**.31**	**.67**	**.46**	-					
Posttest										
6. Anxiety (child report)	**.61**	**.25**	.08	.10	-.01	-				
7. Anxiety (mother report)	**.18**	**.69**	**.18**	**.24**	**.23**	**.29**	-			
3-months FU										
8. Anxiety (child report)	**.50**	**.20**	.05	.04	-.03	**.72**	**.25**	-		
9. Anxiety (mother report)	**.25**	**.69**	**.19**	**.24**	**.27**	**.37**	**.79**	**.39**	-	
6-months FU										
10. Anxiety (child report)	**.44**	**.20**	-.04	.08	-.04	**.67**	**.19**	**.83**	**.33**	-
11. Anxiety (mother report)	.14	**.50**	.14	**.28**	**.22**	**.24**	**.66**	**.30**	**.76**	**.25**

Note. Correlations in bold are significant with at least $p < .05$.

Latent Growth Curve Modeling. To define the growth function that best reflected children's change in social, emotional and academic self-efficacy, internalizing problems, and externalizing problems, we first fitted a linear growth model with intercept (*i*) and linear slope (*s*) as latent variables for all secondary outcomes separately in the intention-to-treat (ITT) sample. Most model fit indices showed acceptable fit (Appendix B), especially given our small sample size (Chen et al., 2008). The intercept and linear slope component were significant for all secondary outcomes (Table 5). This indicated that 1) children differed in their initial levels of social, emotional and academic self-efficacy, and internalizing and externalizing problems, 2) that their levels of social, emotional and academic self-efficacy increased (positive slope *B*), and that their levels of internalizing and externalizing problems decreased (negative slope *B*) significantly over time. The absence of significant variances of the slope reflects the idea that most children in our sample do change in a similar manner. Second, we added condition in the linear growth function. As expected, we did not find any differences in initial levels and rates of change of the secondary outcomes between conditions (Appendix C). Figure 5 panel A shows the increase in emotional self-efficacy and panel B shows the decrease in internalizing and externalizing problems separate by condition. The patterns in the other self-efficacy models were similar to the one presented in panel A. Results from the LGCM of the secondary outcomes in the completers only sample were similar and are available in Appendix D.

Table 4
Pretest and Change in Secondary Outcomes Over the Study (Intention-to-Treat Sample)

Assessment	MindLight	CBT	Mean difference[a]	*SD*	95% CI
		Social self-efficacy			
Posttest – pretest[b]	0.19	0.20	0.01	0.62	[-0.09, 0.10] [d]
3-months FU – pretest[b]	0.33	0.29	-0.04	0.63	[-0.14, 0.06] [d]
6-months FU – pretest[b]	0.38	0.34	-0.04	0.65	[-0.13, 0.06] [d]
n	82	83			
		Emotional self-efficacy			
Posttest – pretest [b]	0.26	0.34	0.08	0.73	[-0.03, 0.19] [d]
3-months FU – pretest [b]	0.40	0.49	0.08	0.68	[-0.02, 0.19] [d]
6-months FU – pretest [b]	0.54	0.52	-0.02	0.73	[-0.13, 0.10] [d]
n	82	83			
		Academic self-efficacy			
Posttest – pretest [b]	0.18	0.22	0.04	0.56	[-0.05, 0.12] [d]
3-months FU – pretest [b]	0.31	0.33	0.02	0.61	[-0.08, 0.11] [d]
6-months FU – pretest [b]	0.24	0.33	0.09	0.60	[-0.01, 0.18] [d]
n	79	78			
		Internalizing problems			
Posttest – pretest [c]	-1.28	-1.03	-0.25	2.47	[-0.63, 0.13] [d]
3-months FU – pretest [c]	-1.32	-1.46	0.15	2.37	[-0.22, 0.51] [d]
6-months FU – pretest [c]	-1.47	-1.39	-0.08	2.81	[-0.51, 0.35] [d]
N	67	66			
		Externalizing problems			
Posttest – pretest [c]	-0.49	-1.06	0.57	2.17	[0.24, 0.90] [e]
3-months FU – pretest [c]	-0.62	-0.79	0.17	2.22	[-0.17, 0.51] [d]
6-months FU – pretest [c]	-0.62	-1.02	0.40	2.43	[0.03, 0.77] [e]
n	67	66			

Note. CI = confidence interval.
[a] A negative difference is a difference in favor of MindLight. [b] A positive score means an increase in self-efficacy. [c] A negative score means a decrease in problems. [d] The 95% CI of the difference in change in secondary outcome lies entirely between the equivalence margins, indicating equivalence of MindLight and CBT. [e] The 95% CI of the difference in change in secondary outcome lies entirely to the right of zero, indicating significant differences in favor of CBT.

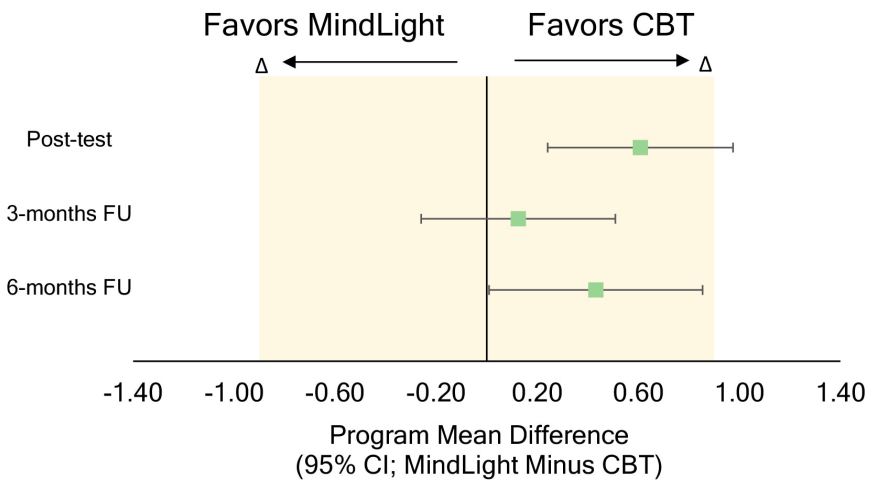

Figure 4. Differences between intervention programs in externalizing problems, in relation to non-inferiority.

For Whom are MindLight and CBT effective?

As described above, we started with the quadratic growth model of anxiety symptoms found in Schoneveld et al. (2018). This model showed that both child- and mother-reported anxiety symptoms decreased quadratically over time (i.e., the rate of the decrease slowed over time) in both the MindLight and CBT group. In the current study, we added social, emotional and academic self-efficacy, levels of maternal depression, anxiety and stress, and baseline anxiety separately as outcome predictors to the quadratic model. None of these predicted the linear nor the quadratic slope component for both child- and mother-reported anxiety symptoms (Table 6). However, social, emotional and academic self-efficacy, and mother-reported baseline anxiety was associated with the intercept of the quadratic growth model of child-reported anxiety. Specifically, children with higher levels of social, emotional and/or academic self-efficacy, and/or lower levels of mother-reported baseline anxiety showed lower initial levels of child-reported anxiety. In addition, levels of maternal depression, anxiety and stress predicted the intercept of the quadratic growth model of mother-reported anxiety: children from mothers with lower levels of depression, anxiety and stress, showed lower initial levels of mother-reported anxiety. Results from the LGCM of the outcome prediction analyses in the completers only sample are similar and available in Appendix E.

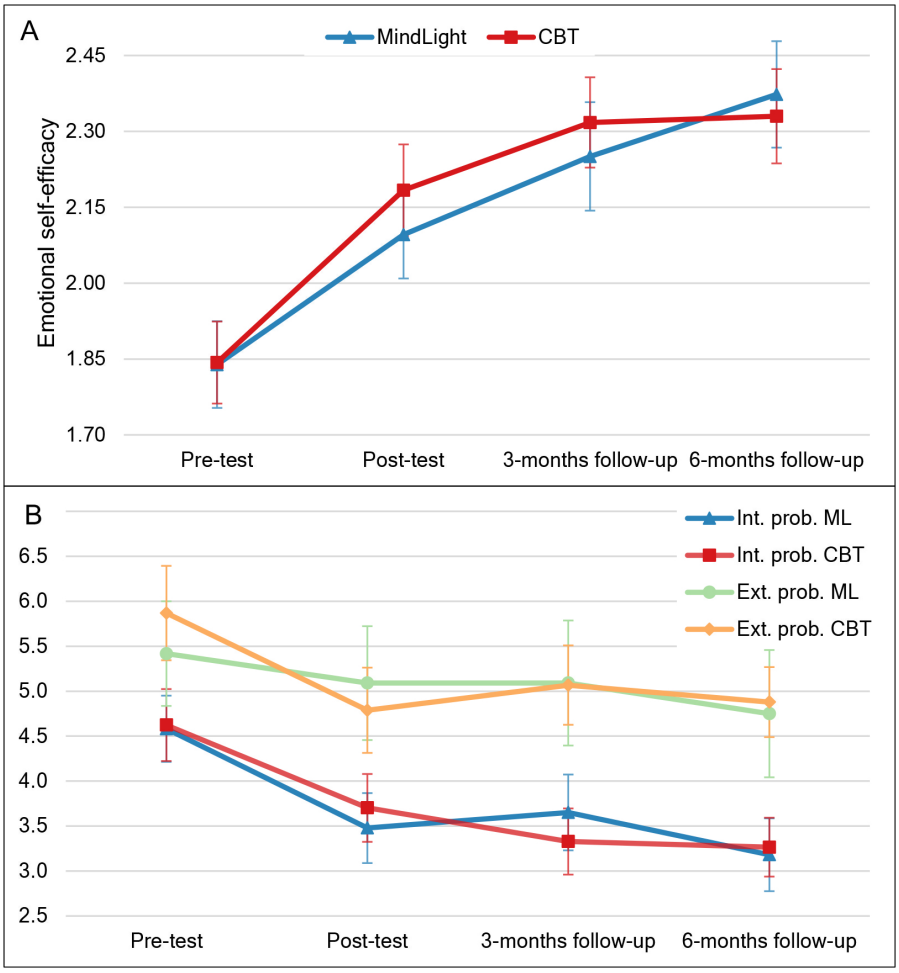

Figure 5. Emotional self-efficacy, internalizing problems (int. prob.) and externalizing problems (ext. prob.) across time by program: ML (MindLight) and CBT. Error bars are standard errors.

Table 5
Linear Growth Model Growth Curve Parameters for Secondary Outcomes, From Pretest to 6-Months Follow-up (Intention-to-treat Sample)

	Means					
	Intercept			Slope		
	B	*SE*	*t*	*B*	*SE*	*t*
Social self-efficacy	2.37	0.05	47.37***	0.50	0.08	6.33***
Emotional self-efficacy	1.92	0.06	33.65***	0.74	0.10	7.54***
Academic self-efficacy	2.42	0.05	45.68***	0.40	0.08	5.39***
Internalizing problems	4.28	0.27	15.73***	-1.84	0.36	-5.11***
Externalizing problems	5.44	0.28	19.41***	-0.94	0.31	-3.08**

Note. SE = standard error.
*** $p < 0.001$; ** $p < .010$, two-tailed tests.

Table 6
Linear Regression Predicting Growth Parameters of Quadratic Growth Model of Anxiety by Mental Health Predictors at Pretest Separate for Child-reported Anxiety and Mother-reported Anxiety (Intention-to-Treat Sample)

	Intercept anxiety		
Predictor	*B*	*SE*	*t*
Anxiety (child report)			
Baseline anxiety (mother report)	0.30	0.15	2.03*
Social self-efficacy	-0.17	0.05	-3.39**
Emotional self-efficacy	-0.23	0.04	-5.91***
Academic self-efficacy	-0.21	0.05	-4.24***
Depression mother	-0.01	0.02	-0.47
Anxiety mother	0.01	0.03	0.35
Stress mother	-0.00	0.01	-0.20
Anxiety (mother report)			
Baseline anxiety (child report)	0.08	0.05	1.62
Social self-efficacy	-0.02	0.03	-0.47
Emotional self-efficacy	-0.03	0.03	-1.07
Academic self-efficacy	-0.02	0.03	-0.61
Depression mother	0.03	0.01	2.86**
Anxiety mother	0.05	0.02	2.85**
Stress mother	0.02	0.01	3.96***

Note. SE = standard error.
*** $p < 0.001$; ** $p < .010$; * $p < .050$, two-tailed tests.

Variances					
Intercept			Slope		
B	*SE*	*t*	*B*	*SE*	*t*
0.26	0.05	5.28***	0.31	0.18	1.69
0.31	0.06	4.87***	0.42	0.29	1.47
0.33	0.05	6.30***	0.12	0.17	0.72
8.98	1.32	6.81***	6.28	3.63	1.73
10.35	1.66	6.23***	2.13	2.26	0.95

Outcome					
Linear slope anxiety			Quadratic slope anxiety		
B	*SE*	*t*	*B*	*SE*	*t*
0.19	0.58	0.33	-0.20	0.74	-0.28
0.01	0.25	0.04	0.13	0.31	0.41
-0.05	0.20	-0.25	0.27	0.26	1.07
0.04	0.21	0.19	0.23	0.25	0.92
0.11	0.07	1.55	-0.17	0.09	-1.96
0.00	0.13	0.02	0.01	0.16	0.08
-0.00	0.05	-0.01	-0.01	0.06	-0.10
0.11	0.18	0.64	-0.11	0.23	-0.49
-0.09	0.10	-0.84	-0.04	0.13	-0.27
-0.12	0.08	-1.48	0.09	0.11	0.83
-0.14	0.10	-1.37	0.18	0.13	1.33
-0.06	0.03	-1.86	0.06	0.04	1.59
-0.04	0.06	-0.60	0.03	0.08	0.35
-0.04	0.02	-1.65	0.03	0.03	1.30

Discussion

This study reported secondary outcomes and outcome predictors of effectiveness of a non-inferiority RCT comparing the applied game MindLight with a CBT-program (Coping Cat; van Starrenburg et al., 2017) for childhood anxiety prevention. Findings were reported for post-intervention, 3- and 6-months follow-up using child- and mother-report.

Improvement in Mental Health Outcomes

The first set of hypotheses were supported in that children in both intervention groups showed improvements in internalizing and externalizing problems, and self-efficacy. The CI approach showed affirmatively that MindLight was non-inferior to CBT over the course of the study for social self-efficacy, emotional self-efficacy, academic self-efficacy and internalizing problems. CBT however showed a larger decrease in externalizing problems at posttest and 6-months follow-up. Importantly, improvements in secondary outcomes were sustained up to six months after intervention completion. Thus, a relatively short intervention, delivered as a game or face-to-face CBT for eight weeks, seems to have a significant and promising impact on more than the targeted anxiety.

The effects on internalizing problems are consistent with prior findings that interventions targeting anxiety also effectively reduce internalizing problems (Donovan & March, 2014) and emotional symptoms (Morgan, Rapee, & Bayer, 2016). The decrease in externalizing problems corresponds with research showing that anxiety and externalizing problems are strongly associated (Priddis et al., 2014). Last, self-efficacy increased in children participating in our study. This finding is in line with improvements in self-efficacy found in school-refusing children following a CBT-program (N. J. King et al., 1998) and now extends these results to applied games. The non-inferiority of MindLight to CBT on internalizing symptoms and self-efficacy suggests that MindLight is as effective as CBT in improving these mental health outcomes. However, CBT was more effective in decreasing externalizing symptoms than MindLight. An explanation could be the (minimal) involvement of parents in CBT, which is recommended in treatment guidelines for externalizing problem behavior (Buitelaar et al., 2013). In sum, these results may suggest that MindLight, an applied game, is as effective as a conventional expert-led group-based CBT prevention program in enhancing self-efficacy and internalizing symptoms beyond reductions in anxiety.

For Whom are MindLight and CBT effective?

The second set of hypotheses were not supported: none of the mental health variables predicted interventions' effectiveness in preventing anxiety symptoms over time. First, we found no differences in the rate of change in anxiety symptoms for children with relatively lower or higher levels of baseline anxiety. This is in contrast to prior research that has demonstrated

that anxiety symptoms at baseline could impact the response to anxiety interventions positively (van Starrenburg et al., 2017) or adversely (Cunningham et al., 2016). Our results seem to suggest that the responsiveness to MindLight and CBT has little to do with the severity of presenting problems children began with. In addition, levels of children's self-efficacy did not predict interventions' effectiveness. A possible explanation is the rather low variance in self-efficacy scores in our sample. Most children rated themselves at the middle "not good, not bad" end of the scale, perhaps because we selected children from the general population. Other prevention studies (e.g., Tak, Kleinjan, Lichtwarck-Aschoff, & Engels, 2014) have also found rather low variance on self-efficacy. This restricted range precludes detecting effects.

Next to child factors, we also examined maternal mental health (i.e., maternal depressive, anxiety and stress symptoms) as possible outcome predictors. In line with our hypothesis, maternal mental health problems did not affect changes in children's anxiety symptoms over time. It is important to note, however, that the prevalence of maternal mental health problems was relatively low in our sample. Considering the important role of maternal mental well-being in children's development (S. H. Goodman et al., 2011; Powdthavee & Vignoles, 2008) more research may be needed. For example, it may be interesting to select children for a prevention program based on whether their mothers are highly stressed versus not and examine differential effects.

Although anxiety symptoms at baseline, self-efficacy and maternal mental health did not predict the *change* in anxiety symptoms, there were some interesting associations between these mental health variables and *initial* levels of anxiety symptoms that warrant further discussion. First, as expected, children that rated themselves as more anxious at baseline also reported lower levels of social, emotional and academic self-efficacy. Second, initial levels of child-reported anxiety were predicted by mother-reported children's anxiety at baseline. This result basically represents cross-informant agreement of baseline anxiety levels, which is generally significant but low (De Los Reyes et al., 2015). Last, higher initial levels of *mother*-reported children's anxiety were predicted by higher maternal depression, anxiety and stress symptoms. This finding suggests that mothers with mental health problems might have a biased perception of their child's emotional well-being (Briggs-Gowan, Carter, & Schwab-Stone, 1996). That is that mothers' rating of their children's anxiety is not so much a reflection of children's actual anxiety level but reflects their own struggles with depression, anxiety and/or stress. In sum, these results suggest that MindLight and CBT can enhance mental health despite difficulties children or their parents may have.

Strengths, Limitations and Future Suggestions

To our knowledge, this is the first study in the emerging field of applied games for mental health that used a non-inferiority randomized controlled design to assess the effectiveness

of an applied game against the standard of anxiety prevention (i.e., CBT). More specifically, we extended our previous work about the effectiveness of MindLight on anxiety symptoms by assessing effects on secondary outcomes and potential outcome predictors, factors that are often neglected in previous research. In addition to the broader range of outcomes, we extended previous studies on anxiety prevention programs by including children's as well as maternal reports. The results that internalizing and externalizing problems decreased according to both children and mothers seems to imply that skills transferred from the program context to everyday life, where mothers were able to observe their children's behavior. Last, we addressed a limitation of applied games research – a focus on short-term outcomes – by assessing children and mothers directly, three and six months after the program. These follow-ups give insight into the immediate, short-term but also longer-term effects of anxiety prevention programs, which informs implementation research. Programs with only short-term benefits might be less favorable than programs that show sustained beneficial effects.

Apart from these strengths, this study has several limitations that need to be addressed in the future. First, the internal consistency statistics for the social self-efficacy subscales were in a questionable range, which may have affected the results related to social self-efficacy. However, when the pattern of these results is compared with the results of the remaining types of self-efficacy, no differences appear. Second, the sample consisted of relatively well-functioning children. Whether the current results hold in a more distressed sample is a question for future research. Third, given the absence of a waitlist control group, passage of time could not be eliminated as an alternative explanation for the change in mental health outcomes.

In addition, future studies might want to investigate program effects on other important (secondary) outcomes. For example, as anxiety problems are related to worse academic performance (Nail et al., 2015), academic functioning indicators such as grades and problem solving skills could be relevant. Furthermore, assessing the effect of anxiety prevention programs on children's social skills might be another important avenue for future research. Social skills start to develop in childhood, are affected by anxiety issues, and at the same time are an important contributing factor in the maintenance and further aggravation of mental health problems (Clarke, Morreale, Field, Hussein, & Barry, 2015). Prior research has shown that increasing children's social skills helps to reduce their behavioral and emotional difficulties (Humphrey, Kalambouka, Wigelsworth, & Lendrum, 2010).

Next to investigating outcomes, future studies may want to extend the range of possible predictors of effectiveness. An important general predictor of program effectiveness is children's motivation to change. Children entering the program more motivated might show a larger decrease in anxiety symptoms than children who are less motivated (Dean, Britt, Bell, Stanley, & Collings, 2016). In addition, choice could be a moderator of program effectiveness.

Given the positive effect of choice and autonomy on intrinsic motivation (Ryan & Deci, 2000), children who choose themselves which program to attend might respond more positively than children who are randomly assigned.

Furthermore, the current study leaves open the question about mechanisms of change. Possible psychological mechanisms worth of investigation in future studies are increased active coping skills (Thorne, Andrews, & Nordstokke, 2013), and decreased maladaptive cognitions (Hogendoorn et al., 2014). Ideally, these mediators should be assessed repeatedly over the course of the intervention, to investigate whether changes in these mediators contribute to decreases in anxiety (Selig & Preacher, 2009). In addition, studying mediators of change in applied games versus conventional prevention programs (i.e., moderated mediation) could be an interesting future direction. MindLight focuses more on relaxation whereas CBT centers on changing cognitions. Thus, contrasting the relative contribution of changes in relaxation and cognitions in anxiety reduction will give insight into program specific mechanisms of change but will also contribute to a broader understanding of what is actually driving changes in anxiety.

Conclusion

The current non-inferiority RCT shows that MindLight was as effective as an established CBT program in affecting a range of mental health indicators (i.e., internalizing problems and self-efficacy) in children with elevated levels of anxiety. Remarkably, the positive effects were sustained in both interventions up to six months and according to child- as well as maternal reports. These are important findings because they demonstrate that learning how to regulate anxiety, by either CBT or an applied game, positively affects other domains of mental health functioning in children. In addition, none of the child mental health or maternal mental health problems predicted the effectiveness of the two interventions. This suggests that effective child-focused interventions such as the ones we examined can be beneficial regardless of the difficulties children have when entering the treatment program and despite potential mental health struggles of their parents. More research into treatment-specific mechanism of change and potential moderators of treatment effects is necessary in order to elucidate which children may benefit most, and why, from which kind of treatment.

Appendix A

Pretest and change in secondary outcomes over the study (completers only sample)

Assessment	MindLight	CBT	Mean difference[a]	*SD*	95% CI
		Social self-efficacy			
Pretest	2.34	2.28			
Posttest – pretest[b]	0.21	0.22	0.01	0.62	[-0.10, 0.11] [d]
3-months FU – pretest[b]	0.31	0.31	-0.01	0.62	[-0.11, 0.10] [d]
6-months FU – pretest[b]	0.39	0.34	-0.05	0.65	[-0.16, 0.06] [d]
n	82	83			
		Emotional self-efficacy			
Pretest	1.84	1.84			
Posttest – pretest [b]	0.26	0.36	0.10	0.73	[-0.03, 0.22] [d]
3-months FU – pretest [b]	0.41	0.50	0.09	0.73	[-0.03, 0.22] [d]
6-months FU – pretest [b]	0.55	0.52	-0.03	0.84	[-0.17, 0.11] [d]
n	82	83			
		Academic self-efficacy			
Pretest	2.43	2.28			
Posttest – pretest [b]	0.19	0.26	0.08	0.55	[-0.02, 0.17] [d]
3-months FU – pretest [b]	0.31	0.34	0.03	0.61	[-0.07, 0.14] [d]
6-months FU – pretest [b]	0.24	0.36	0.12	0.59	[0.01, 0.22] [e]
n	79	78			
		Internalizing problems			
Pretest	4.58	4.62			
Posttest – pretest [c]	-1.28	-0.93	-0.35	2.46	[-0.77, 0.07] [d]
3-months FU – pretest [c]	-1.31	-1.56	0.25	2.34	[-0.16, 0.65] [d]
6-months FU – pretest [c]	-1.68	-1.35	-0.33	2.83	[-0.83, 0.18] [d]
N	67	66			
		Externalizing problems			
Pretest	5.42	5.87			
Posttest – pretest [c]	-0.48	-1.09	0.61	2.17	[0.24, 0.97] [f]
3-months FU – pretest [c]	-0.63	-0.76	0.12	2.23	[-0.26, 0.51] [d]
6-months FU – pretest [c]	-0.63	-1.06	0.43	2.37	[0.01, 0.85] [f]
n	67	66			

Note. CI = confidence interval.

[a] A negative difference is a difference in favor of MindLight. [b] A positive score means an increase in self-efficacy. [c] A negative score means a decrease in problems. [d] The 95% CI of the difference in change in secondary outcome lies entirely between the equivalence margins, indicating equivalence of MindLight and CBT. [e] The 95% CI of the difference in change in secondary outcome lies entirely to the left of zero, indicating significant differences in favor of MindLight. [f] The 95% CI of the difference in change in secondary outcome lies entirely to the right of zero, indicating significant differences in favor of CBT.

Appendix B

Linear growth model fit indices for secondary outcomes, from pretest to 6-months follow-up (intention-to-treat sample)

	χ^2 (*df*)	*p*	RMSEA	CFI	TLI
Social self-efficacy	11.29 (5)	.046	0.09	0.97	0.97
Emotional self-efficacy	13.73 (5)	.017	0.10	0.96	0.95
Academic self-efficacy	15.60 (5)	.008	0.11	0.96	0.95
Internalizing problems	22.09 (5)	<.001	0.14	0.94	0.93
Externalizing problems	12.61 (5)	.027	0.10	0.98	0.98

Note: RMSEA = root mean square error of approximation; CFI = comparative fit index; TLI = Tucker-Lewis Index.

Appendix C

Linear model fit indices and linear regression predicting growth parameters of linear growth model of secondary outcomes by program, from pretest to 6-months follow-up (intention-to-treat sample)

	χ^2(*df*)	*p*	RMSEA	CFI	TLI
Social self-efficacy	11.82 (7)	.107	0.07	0.98	0.97
Emotional self-efficacy	15.08 (7)	.035	0.08	0.96	0.95
Academic self-efficacy	16.33 (7)	.022	0.09	0.97	0.95
Internalizing problems	23.89 (7)	.001	0.12	0.95	0.93
Externalizing problems	15.66 (7)	.028	0.09	0.98	0.97

Note: *** $p < 0.001$; ** $p < .010$, two-tailed tests. RMSEA = root mean square error of approximation; CFI = comparative fit index; TLI = Tucker-Lewis Index; *SE* = standard error.

Appendix D

Linear growth model growth curve parameters for secondary outcomes, from pretest to 6-months follow-up (completers only sample)

	Means					
	Intercept			Slope		
	B	*SE*	*t*	*B*	*SE*	*t*
Social self-efficacy	2.36	0.05	48.86***	0.50	0.08	6.44***
Emotional self-efficacy	1.92	0.06	33.99***	0.73	0.10	7.07***
Academic self-efficacy	2.41	0.05	45.68***	0.42	0.08	5.45***
Internalizing problems	4.36	0.27	16.06***	-2.00	0.35	-5.63***
Externalizing problems	5.43	0.28	19.10***	-1.00	0.31	-3.28**

Note. SE = standard error.
*** $p < 0.001$; ** $p < .010$, two-tailed tests.

Outcome					
Intercept			Linear slope		
B	*SE*	*t*	*B*	*SE*	*t*
0.04	0.098	0.36	0.06	0.151	0.42
-0.05	0.114	-0.43	0.05	0.198	0.23
0.13	0.105	1.25	-0.11	0.141	-0.80
-0.05	0.534	-0.09	0.04	0.691	0.06
-0.09	0.557	-0.17	0.26	0.599	0.44

Variances					
Intercept			Slope		
B	*SE*	*t*	*B*	*SE*	*t*
0.26	0.05	4.87***	0.33	0.19	1.80
0.30	0.07	4.52***	0.49	0.33	1.48
0.34	0.05	6.42***	0.18	0.18	0.99
8.96	1.37	6.54***	7.07	4.00	1.77
10.35	1.75	5.90***	2.44	2.33	1.05

Appendix E

Linear regression predicting growth parameters of quadratic growth model of anxiety by mental health predictors at pretest separate for child-reported anxiety and mother-reported anxiety (completers only sample)

	Intercept anxiety		
Predictor	*B*	*SE*	*t*
Anxiety (child report)			
Baseline anxiety (mother report)	0.35	0.14	2.52*
Social self-efficacy	-0.17	0.05	-3.34**
Emotional self-efficacy	-0.23	0.04	-5.79***
Academic self-efficacy	-0.22	0.05	-4.47***
Depression mother	-0.00	0.02	-0.06
Anxiety mother	0.02	0.03	0.75
Stress mother	0.00	0.01	0.11
Anxiety (mother report)			
Baseline anxiety (child report)	0.09	0.05	1.78
Social self-efficacy	-0.02	0.03	-0.48
Emotional self-efficacy	-0.03	0.03	-1.03
Academic self-efficacy	-0.02	0.03	-0.79
Depression mother	0.03	0.01	2.57*
Anxiety mother	0.05	0.02	2.73**
Stress mother	0.02	0.01	3.64***

Note. SE = standard error.
*** $p < 0.001$; ** $p < .010$; * $p < .050$, two-tailed tests.

Outcome					
Linear slope anxiety			Quadratic slope anxiety		
B	*SE*	*t*	*B*	*SE*	*t*
0.01	0.54	0.01	0.09	0.67	0.13
0.08	0.26	0.31	0.07	0.32	0.22
-0.02	0.20	-0.08	0.23	0.26	0.88
0.09	0.22	0.41	0.17	0.26	0.64
0.10	0.07	1.35	-0.16	0.08	-1.91
-0.01	0.13	-0.10	0.03	0.15	0.23
-0.01	0.05	-0.25	0.01	0.06	0.14
0.06	0.18	0.32	-0.06	0.24	-0.23
-0.06	0.11	-0.59	-0.08	0.15	-0.53
-0.13	0.09	-1.48	0.11	0.12	0.89
-0.14	0.11	-1.25	0.19	0.16	1.19
-0.05	0.03	-1.66	0.05	0.04	1.40
-0.01	0.06	-0.21	0.01	0.07	0.09
-0.03	0.02	-1.25	0.02	0.03	0.88

CHAPTER 5

What keeps them motivated? Children's views on an applied game for anxiety

In press:
Schoneveld, E. A., Lichtwarck-Aschoff, A., & Granic, I. (2018). What keeps them motivated? Children's views on an applied game for anxiety. *Entertainment Computing.* doi:10.1016/j.entcom.2018.12.003

Abstract

Applied games for mental health are an addition to current interventions. To successfully implement applied games, appealing games are needed that motivate youth to play and practice. However, applied games are often not as appealing as commercial games. Children's views on the motivational affordances of an applied game for anxiety (MindLight) were explored to get insight into what makes games appealing. Four focus groups were conducted with children 8-12 years old. Semi-structured interviews were conducted, containing questions about what in-game activities children liked more and less, and what they would add or remove. The children liked the overall look and feel of MindLight. The level of challenge was not optimal for all children as some indicated that the level of outcome uncertainty was high and the feedback was not clear. Children experienced control to some extent. However, the contingency of their achievements upon their skills was low and power seemed not to be experienced intensely for some children. An iterative and youth-informed game development process with end-user involvement might be important. This might eventually lead to applied games that are effective and engaging, and might enhance the implementation potential of applied games.

Applied games for mental health are increasingly gaining attention in intervention and prevention science as a viable addition to current interventions (Lau et al., 2016). Only recently has the effectiveness of those applied games been tested with rigorous designs (Beaumont & Sofronoff, 2008; Fleming, Dixon, Frampton, & Merry, 2012; Holmes, James, Kilford, & Deeprose, 2010; Kato et al., 2008; Merry et al., 2012; Poppelaars et al., 2016; Schoneveld et al., 2018; Schoneveld et al., 2016; Tanaka et al., 2010). MindLight was developed in close collaboration with clinicians, children, game designers and researchers. The primary aim of the game is to train children to regulate their anxiety in the face of increasingly intense fears. Evidence-based practices and techniques were used and built into the game (Bar-Haim et al., 2011; Kendall et al., 2005; Price & Budzynski, 2009). Several randomized controlled trials (RCTs) have now shown that MindLight is effective in reducing anxiety in children (Baranowski et al., 2016; Schoneveld et al., 2018; Schoneveld et al., 2016). A future step is to think about how the game can be implemented outside the research world and brought into the hands of children and their families. In order for implementation to succeed, a version of MindLight is needed that is so appealing that children choose themselves to play it instead of that parents or clinicians need to convince them to play it. In addition, the game should be so engaging that children want to continue playing it.

Generally, applied games are not as appealing as commercial games (Baranowski et al., 2016). Balancing the art and science, the motivational characteristics and the evidence-based techniques, is a challenge that all applied game designers face. Applied games should not only be based on recent knowledge of intervention and prevention science, but should also be fun and engaging.

Previously, it was found that children were equally likely to suggest MindLight or a commercial game to a friend. However, children rated MindLight lower than the commercial game (Schoneveld et al., 2016). These findings suggested to us that the game was not as appealing in some ways as the commercial one and that there is room for improvement. Before the design of MindLight is re-thought and MindLight2.0 is developed, the opinion of the players themselves is important. What did they think about the game? Therefore, the aim of this study was to get insight into children's views on MindLight. These views were collected using focus group interviews. To provide a context for the children's input and to structure their answers, a theoretical framework was used that specifies particular characteristics that foster intrinsic motivation.

A Taxonomy of Intrinsic Motivation

One of the theories that focuses on engagement and motivation is Malone and Lepper's taxonomy of intrinsic motivation, which has shown its merits for studying games (Ciampa, 2014; Malone & Lepper, 1987). Challenge is the first motivational affordance. Applied

games are challenging when they provide an optimal level of difficulty. When tasks are too easy, people become bored. When tasks are too difficult, on the other hand, people may experience performance anxiety (Nakamura & Csikszentmihalyi, 2002). Characteristics of a challenging task are goals, uncertain outcomes, and performance feedback (Abuhamdeh, Csikszentmihalyi, & Jalal, 2014; Dweck, 2017; Mueller & Dweck, 1998). For example, in the puzzle video game Tetris, players need to manipulate tiles to make them disappear by filling a horizontal line (i.e., goal). Whether this goal can be achieved is uncertain, because players do not know which tiles will appear. The performance feedback is the disappearance of horizontal rows.

Control is the second motivational affordance (Amoura, Berjot, Gillet, & Altintas, 2013). A sense of control is strongest when people's successes are dependent upon their skills and abilities (i.e., contingency). Tasks that seem too difficult may undermine feelings of control, thereby diminishing intrinsic motivation. In addition, individuals feel most in control when choice is available, relevant and provided in the right amount (Evans & Boucher, 2015; Ryan, Rigby, & Przybylski, 2006). Last, environments evoke a sense of control when people's actions have powerful effects (Yee, 2006).

MindLight: Game Mechanics for Motivation

First, challenge is provided in MindLight by two types of goals. The main goal of MindLight is saving grandmother. Sub-goals work towards this final goal and include uncovering threatening stimuli (i.e., fear events), finding hidden coins and solving puzzles. The second characteristic of challenge, uncertain outcomes, are presented in game elements that are unpredictable, such as hidden coins, falling pots and attacking monsters. In addition, the outcome of uncovering fear events and solving puzzles is uncertain in the sense that the exact moment a fear event is uncovered or a puzzle is solved is unclear and depends on the players in-game behavior. Performance feedback, the third challenge characteristic, is given continuously; the number of coins found and lives left are displayed on the screen (Figure 1). Furthermore, and importantly, the player wears an EEG (electroencephalogram) headset that measures the player's relaxation and focus levels. These levels are shown in the form of light (i.e., mindlight) or a beam (i.e., mindbeam) respectively. The brightness of the mindlight matches with how relaxed the player is and the curve of the beam matches with how focused the player is. The more relaxed the player is, the brighter the mindlight shines and the more focused the player is, the more straight the mindbeam is (Figure 1).

Second, control is implemented in MindLight through the feedback on players' performance. As described above, the brightness of the mindlight responds to the relaxation levels of players. In other words, the response is contingent upon the mental state of players, which elicits a sense of agency (van Elk, Rutjens, & van der Pligt, 2015). Likewise, the appearance of a coin after

uncovering a fear event is dependent upon the player's relaxation level. In addition, because MindLight is a nonlinear game, players can choose their own route through the game world, a haunted mansion. Players can explore the game world at their own pace and choose their direction, which contributes to a sense of autonomy. Furthermore, chasing away monsters and solving puzzles also give players a sense of power and control. Nobody but players themselves make these game events happen.

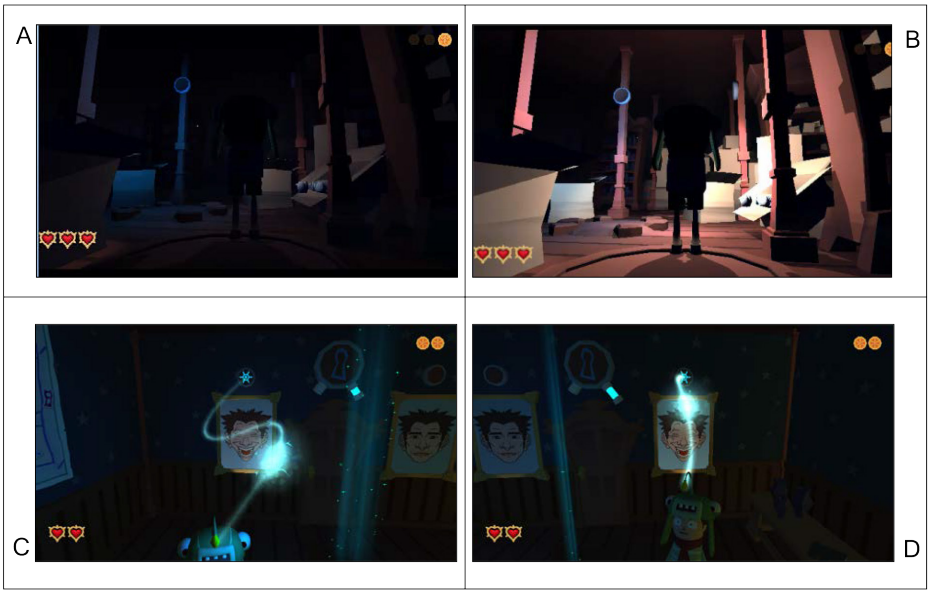

Figure 1. Screenshots of the avatar shining dimmed (A) and bright mindlight (B) and of the avatar having a curved (C) and a straight mindbeam (D). Red hearts represent number of lives left and yellow coins represent number of coins found.

The Current Study

The current study investigated children's views on the motivational characteristics of MindLight. Based on the children's views presented in the results, concrete suggestions and recommendation for improvement of the game are formulated in the discussion. We hereby hope to inspire game designers to make better, more engaging and motivating applied games, thereby maximizing their implementation potential (Fleming et al., 2016).

Material and Methods

Participants and Context of the Study

This study drew upon a sample from an RCT on the effects of MindLight as an indicated prevention program (i.e., including children who already show elevated levels of anxiety) (Schoneveld et al., 2018). Children were randomized between February 2015 and January 2016. The ethics committee of the Faculty of Social Sciences of the Radboud University approved the study (EC2013-0410-139a1). Participating children were initially included in the RCT if they showed elevated levels of anxiety. In total, 13 children (6 girls, 46.15%) participated in the current study. Their mean age was 10.24 (*SD* = 1.24). Children received parental permission to participate in the focus groups. The MindLight play sessions (six in total) of the RCT took place once a week at school, after school hours. Each session lasted about one hour in which multiple children (max. 10) played the game at the same time on an individual laptop. Supervisors gave instructions and were available for questions.

Procedure

The focus groups took place after the RCT's 6-months follow-up assessment (Schoneveld et al., 2018) at school, after school hours. Before the 6-months follow-up assessment, parents were called and asked for permission for participation in the focus groups. Written informed consent was obtained before the focus groups. Focus groups started with an explanation of the goal. Children then made a nameplate and shortly introduced themselves. To refresh their memory, a video of MindLight was shown. Then, children were asked what they remembered about the game. Answers of the children were written down on a flipchart. Next, children were given post-its and wrote down things about MindLight they liked and things they liked less. These post-its were stuck on the flipchart next to the corresponding subjects they had remembered. Children were encouraged to explain why they (dis)liked each specific subject. The conversation was continued with questions about the game world. Specifically, we asked what they thought was the scariest part, and what they would add or remove.

Results and Discussion

Before presenting the children's views on the game's motivational characteristics, the overall game play experience is discussed briefly. Overall, children liked the look of MindLight: "I thought it (MindLight) looked nice (J., 10-year-old boy)." However, MindLight was also frustrating for some: "You try to get relaxed, but if you think 'I want to turn on that lamp', it just will not work (S., 11-year-old boy)." In addition, the artwork seemed to evoke emotional responses. The game was designed specifically to evoke anxiety, in order to provide a training ground for children

to practice regulating these anxious feelings. This goal seemed to be met, according to some children: "The heads (from the puzzles) were the scariest. There is suddenly a head! [Looks straight up and imitates a head in a box.] (J., 10-year-old boy)." Furthermore, sound seemed to have contributed to meeting the anxiety-induction goals: "I thought the screech was scary (N., 9-year-old girl)." Thus, it seems that the children were engaged and that emotions, specifically anxiety, were evoked, an important goal of MindLight and applied games for mental health in general.

Challenge

As described above, the characteristics of an optimal level of challenge are goals, outcome uncertainty, and performance feedback. The introduction video of MindLight told the narrative and provided the main goal of saving grandmother. The first practice rooms showed the sub-goals of finding hidden coins, uncovering fear events and solving puzzles. The majority of children indeed understood the narrative and the accompanying main goal. An 11-year-old boy (S.) explained it: "Trying to get the monsters from her (grandmother) body." In addition, when children were asked what they remembered about what they could do in the game, they mentioned all sub-goals.

Second, hidden coins, falling pots, attacking monsters and attention puzzles are examples of unpredictable game elements that were designed to induce some outcome uncertainty. The level of outcome uncertainty appeared to be sometimes too high, when the game event was too difficult. Specifically, children found some hidden coins too difficult to find, especially the ones in the largest room of the game. In addition, the monsters in the first hallway were experienced as especially difficult by most children, because they follow the avatar and cannot be defeated. Furthermore, some children found the attention puzzles too difficult; they indicated that they had too little time to find the neutral faces.

Third, the mindlight and mindbeam were designed into the game to provide children with explicit feedback on their performance (i.e., level of relaxation and focus respectively). However, it appeared that some children were confused about what it actually was that the mindlight and mindbeam were representing, illustrated by the quote of an 8-year old boy: "Suddenly I was not focused and then it (mindlight) suddenly goes out. But half an hour later, I'm focused and then suddenly it will turn on (B., 8-year-old boy)." Note that this boy actually confuses focus with relaxation as the mindlight represents his relaxation and not his focus level. Other children in contrast seemed to have understood what the feedback was about: "You had to shine for a long time and make sure you did not get scared. If you're very scared and then just stay calm, keep watching, you're not scared, then it goes away by itself (M. 9-year-old boy)."

Control

The characteristics of an optimal level of control are contingency, choice and power. First, contingency is implemented in MindLight through the response of the game events on players' performance; the brightness of the mindlight and the appearance of a coin after uncovering a fear event respond to relaxation levels of players. The contingency of children's successes upon their skills might be experienced as low. "I think that's a bit difficult, because I felt just fine, but the light was not working properly (bright) (L., 12-year-old girl)." "If you think you're concentrating, then that thing (headset) thinks you are not (J., 10-year-old boy)."

Second, players are offered choice by the possibility of choosing their own route through the haunted mansion. The relevance of this choice was evident from children's comments about the order in which they explored the mansion. Some started with what they thought was a difficult part of the game. "Just like eating. If you eat the disgusting food first, you save the best for last (R., 9-year-old boy)." Others choose to begin with easier parts. "I actually looked at the places first. Which one can I do? And which ones are easier? And then the hardest last (S., 11-year-old boy)." Alternatively, children explored the mansion randomly: "I went a little bit all over the place. I actually just went somewhere. Yes, just what I felt like (T., 8-year-old boy)." This illustrates that players differ in their play style and that by offering choice MindLight could suit those individual needs. One girl suggested adding the possibility to choose the difficulty level. "To have multiple settings. For example, if you want fewer monsters, then you can put it on easy (M., 12-year-old girl)." A group of children suggested including a room without coins, monsters and puzzles. A room to just play around and have fun. This can be interpreted as a wish to have the opportunity to leave the haunted rooms and relax without facing fears for a moment.

Third, the acts of chasing away monsters and solving puzzles were designed to give players a sense of power and control. Power seemed not to be experienced intensely, because children suggested adding abilities that make them more powerful. They said that they would like to be able to defeat the monsters with guns or fists. "Actually, I just want to be able to [makes punching motion with fist and says pam] and then they (monsters) leave (R., 9-year-old boy)." In addition, children suggested to add the ability to run, because "now you really have to do this [walks slowly with bent back and hanging arms] (J., 10-year-old boy)."

Recommendations for Applied Game Design

The results about the overall game play experience showed that the children were engaged and that the light, sound and artwork indeed evoked different emotions, such as anxiety and anger. Experiencing negative emotions is important because children need to experience those emotions in order to be able to regulate them, and to practice those regulation skills repeatedly. However, player's engagement might be increased even more by also triggering positive and more complex emotional experiences. Adding an extra room for light-heartedly

play and to have fun might give players the possibility to upregulate positive feelings such as joy and amusement (Nolan & McBride, 2014). In addition, recognition, for example, might be triggered in MindLight2.0 by adding compliments from a voice-over about their effort (Dweck, 2017; Mueller & Dweck, 1998).

With regard to the motivational characteristics, the optimal level of challenge was one of the main themes children talked about in the focus group interviews. To reach this optimal level, the degree of difficulty is especially important; too easy equals boredom, too difficult corresponds to performance anxiety (Nakamura & Csikszentmihalyi, 2002). An optimal level of difficulty may be attained by adapting it to a player's individual performance. For example, when players uncover fear events quickly, the fear events could become scarier, hence more difficult (e.g., adding increasingly creepy sounds and artwork). The same goes for the attention puzzles: their difficulty could increase by including extra threatening faces or by reducing the time that they are visible. Moreover, adjustments to the mindlight and mindbeam mechanics might be made by raising the minimal relaxation and focus value for the brightness of the mindlight and the straightness of the mindbeam respectively. Furthermore, decreasing the level of difficulty may be done by renewing the boxes where players can hide and calm down when the game events are too intense and difficult. In the current version, monsters can attack players while they are opening a box with their mindbeam. Being able to go into a box without monsters attacking could help decrease the experienced level of difficulty. An example of the successful incorporation of an optimal level of difficulty is the applied game HealthSeeker, in which patients with diabetes choose missions to help them change lifestyle. When players progress in the game, the missions get harder, hence more challenging (Kamel Boulos et al., 2015).

In addition to an optimal level of difficulty, performance feedback is an important characteristic of challenge. MindLight's feedback in the form of the mindlight and mindbeam is provided continuously. In the current version, these game mechanics are explained in cut scenes. In addition, in the first rooms of the haunted mansion, players can practice with their mindlight and mindbeam on fear events and puzzles among other things. However, to be more intrinsically motivating, feedback should be more clear, constructive and encouraging as well (Malone & Lepper, 1987). For example, additional instructional videos might tell players what went wrong and invite players to practice some more if needed, to endorse players effort (Dweck, 2017; Mueller & Dweck, 1998). Other well-known game mechanics that could provide performance feedback are points and progress. Currently, the number of lives left and coins found show the players' progress in MindLight. Additionally, the number of rooms illuminated might be another game mechanic to provide feedback and to show players their progress towards the main goal of saving grandmother. Providing feedback is illustrated in the gamified digital health platform Empower. This platform is developed for patients with diabetes and the in-game quiz gives players feedback about their knowledge about health (Kamel Boulos et al., 2015).

Choice was the key characteristic of control that children mentioned in the focus group interviews. The possibility to choose the difficulty level of MindLight might be one way to promote choice. As discussed above, fear events, attention puzzles and the mindlight / mindbeam could be more or less difficult depending on the settings chosen by the player or, more advanced, based on player's real-time performance. Children furthermore suggested adding a floor map to make a choice about where to go first. Such a map is already included in MindLight, but it is not always accessible as it hangs only in one room. Including the option to push a button to pull up a floor map with their current position might provide players with an increased sense of control. In addition, children wanted an option to go to a safe room and just play around. For example, portals to a safe room without fear events and monsters might give players the opportunity to leave their current location whenever they want. They then have the opportunity to play around and up-regulate their positive emotions (Giuliani, McRae, & Gross, 2008). This is of added value to the hiding boxes, where players can mainly down-regulate their negative feelings, since they cannot do anything playfully while being in the box. Lastly, making it possible to personalize the avatar and / or the environment gives players a sense of choice and could enhance their sense of control. SPARX is an example of an applied game that provides choice. In SPARX, adolescents with depression can make personal choices about their avatar, and about when and where to play the game (Cheek et al., 2014).

Next to choice, increasing players' sense of power might also increase feelings of control. Children suggested they would have liked in-game objects (i.e., guns, fists) to defeat monsters. However, we think that extending the ability of the mindlight to defeating monsters, next to chasing them away, could also evoke a sense of empowerment. The sense of power might even be bigger when players conquer the monsters themselves, with their mindlight, than when they conquer the monsters with an object, given the dependence of the monster's defeat upon their own state of mind rather than an impersonal object. In addition, being able to adapt the avatar's pace could contribute to player's sense of control. In the current version of MindLight, players can only walk. Adding the ability to move stealthily or sprint at any pace give players more control over the avatar and its environment. This could be dependent on players' real-time performance: the more relaxed they are, the faster they could run, for example. Combined with the ability to defeat monsters, players might feel in control and powerful, ready to rule the game and real world. An example of increasing players' sense of power can be found in the applied game HealthSeeker, that offers feedback through empowering messages (e.g., "You can do this now") (Kamel Boulos et al., 2015).

Limitations

The current study showed that challenge and control were important motivational characteristics for children playing MindLight. However, limitations of this study should be noted when interpreting the results. First, the focus groups took place six months after children played MindLight for the last time. To refresh children's memory, a video of MindLight was shown at the beginning of the focus group. We cannot exclude, however, the possibility that children's comments about their game play experience were biased towards what they actually remembered of the game experience. To get a more immediate reaction of children playing MindLight, other methods, such as think aloud protocols in which children comment about their thoughts and feeling while playing a game, are better suited. We refrained from these types of methods, because the current study was part of a larger RCT. Asking children to reflect on the game while playing it might have influenced the results of the RCT. A second limitation is that children might have been giving socially acceptable opinions to please the interviewer or other children in the group. Alternatively, children might have felt that they had to agree with statements of other children due to peer pressure. By setting the rule that 'what is said in the room, stays in the room', we attempted to create an open ambiance in which children would feel secure to express their opinion.

Youth-informed Game Development

Applied game designers face a unique challenge: balancing intrinsically motivating game mechanics with knowledge from intervention and prevention science. This paper illustrated a potential way to handle this challenge: iterating the design process with end-users. End-users should be involved at different stages of the development process: from brainstorm via minimal viable product to prototype and alpha, beta and stable releases. Focus groups are one way to involve children and different methods are cognitive walkthrough, action analysis, think aloud, observation, standardized usability questionnaires and physiological measures, such as eye-tracking, galvanic skin response and electrocardiography (Holzinger, 2005; Law, Kickmeier-Rust, Albert, & Holzinger, 2008; J. R. Lewis, 2014). Using mixed methods to involve children will be most valuable, given the complexity of game environments (Law et al., 2008). Furthermore, the domains that end-users should comment on are as diverse as the interface, the emotional experience, game mechanics and infinite other elements of a game. Other dimensions could be measured for a more complete picture of children's experience, such as technical, affective, cognitive and social dimensions of an applied game (Law et al., 2008). This paper showed the importance of involving end-users in the process of applied game design continuously. Incorporating youth's perspective into the development process will lead to applied games that are relevant to youth. To game play experiences that feel respected, empowered, and inspired and to games that are engaging to play. Eventually, this might enhance the implementation potential of applied games.

CHAPTER 6

General discussion

The current thesis examined the efficacy and motivational characteristics of the applied game MindLight, which was developed for children with anxiety problems. In this research, we aimed to address shortcomings in existing applied game studies by using rigorous research designs. The results of our efficacy studies are reviewed in part one of this general discussion, while the results of our examination of MindLight's motivational characteristics in order to gain insight into how children experienced the game are reviewed in part two. The general discussion ends with reflections on the implementation of applied games and a general conclusion.

Efficacy of MindLight

Summary of main results. Chapters 2, 3, and 4 of the current thesis presented the results of two RCTs: one in which MindLight was compared with a commercial video game (RCT 1); the other in which it was compared with cognitive behavioral therapy (CBT; RCT 2). In RCT 1, anxiety symptoms were measured prior to and immediately after a period of gameplay (i.e., on MindLight or the commercial video game Max and the Magic Marker), and then again three months later. Both MindLight and Max and the Magic Marker (hereafter shortened to Max) were effective in reducing levels of child- and parent-reported anxiety symptoms in a sample of 136 anxious children aged between seven and 13 years. A decrease in child- and parent-reported anxiety symptoms was also found in RCT 2. Chapter 3 described the efficacy of MindLight and CBT, from pretest to six-months follow-up, in a sample of 174 children (seven to 12 years old) with elevated levels of anxiety. In addition to anxiety symptoms, mother-reported internalizing and externalizing problems and child-reported self-efficacy were included as secondary outcomes in RCT 2. The results showed that both MindLight and CBT were effective in reducing mother-reported internalizing and externalizing problems and increasing child-reported self-efficacy, as described in Chapter 4. Overall, MindLight seems to be effective in improving a range of mental health outcomes, including anxiety, self-efficacy, and internalizing and externalizing problems in children with anxiety problems.

In addition to primary and secondary outcomes, possible predictors of these outcomes were examined to investigate whether personal characteristics were associated with larger improvements. We examined sex, age, expectations, weekly game time, baseline anxiety, self-efficacy, and maternal mental health problems as possible predictors of the programs' efficacy. Results showed that sex, age, expectations, baseline anxiety, self-efficacy, and maternal mental health problems failed to predict MindLight's, Max's, or CBT's efficacy on anxiety symptoms. The interaction between condition and weekly game time did, however, predict the quadratic slope component of personalized anxiety. This indicates that the anxiety slowed down the most for children who 1) played MindLight (RCT 2) and 2) played games during their spare time the most. In sum, the children's characteristics, as well as their own and their mothers' mental health, failed to explain differences between the children in terms of their response to the anxiety prevention programs examined here. The results with regard to the efficacy of MindLight will now be discussed in light of existing research.

Discussion of main results. The effect sizes of the changes in anxiety symptoms in the MindLight groups ranged from small to large. At the lower end, for example, the decrease in mother-reported anxiety symptoms in RCT1 from pretest to three-months follow-up showed an effect size of -0.26; while at the higher end, the reduction in child-reported total anxiety symptoms in RCT2 from pretest to six-months follow-up had an effect size of -1.07. These effect sizes are in line with recent meta-analyses of prevention programs for anxious children (Lawrence, Rooke, & Creswell, 2017; Mychailyszyn et al., 2012; Rasing, Creemers, Janssens, & Scholte, 2017; Stockings et al., 2016; Werner-Seidler, Perry, Calear, Newby, & Christensen, 2017). For example, a recent systematic review of reviews found no significant reductions in anxiety symptoms following indicated prevention programs for young people (Stockings et al., 2016). However, a small effect size was found directly following prevention programs and at 12-months follow-up in two recent meta-analyses (Lawrence et al., 2017; Werner-Seidler et al., 2017). Elsewhere, another meta-analysis (Mychailyszyn et al., 2012) found a moderate decrease in anxiety symptoms in youths receiving indicated prevention programs. Conversely, mixed results were found in a meta-analytic review of prevention programs based on CBT; no effect was found directly after the programs or 12 months later, but a small effect was apparent at three- to six-months follow-up (Rasing et al., 2017). Taken together, the evidence confirms that conventional prevention programs that target young people already experiencing anxiety symptoms show similar decreases to those in the MindLight group.

Remarkably, we found changes in mental health outcomes in MindLight groups not only in the children's reports of their own anxiety and self-efficacy, but also in the parents' reports of their children's anxiety and internalizing and externalizing symptoms. Typically, different subjects tend to show only low agreement on such reports, especially for internalizing symptoms (De Los Reyes et al., 2015). The fact that we found cross-reporter similarities therefore seems to suggest a robust effect. In addition, these similarities imply that learning how to regulate anxiety was transferred from the prevention program to everyday life, as parents were able to observe changes in their children's behavior. In addition, improvements in mental health were sustained for up to six months after the programs were terminated. Furthermore, despite the primary focus on anxiety, self-efficacy and internalizing and externalizing symptoms also improved. These results appear to suggest that targeting anxiety has spill-over effects into other areas of emotional functioning (Girard et al., 2013).

The fact that the children's mental health improved could lead to the conclusion that MindLight works. However, as Max and CBT also showed decreases in symptoms, all three programs seem to have worked. This situation is an example of the Dodo bird effect: psychotherapies are equally efficacious (Wampold et al., 1997). In order to understand why all three programs improved mental health, factors that are similar and factors that are different between the programs are discussed next. One explanation may be in the inclusion of specific therapeutic

techniques that decrease mental health problems. For example, exposing anxious children to fearful situations, as occurs in MindLight and CBT, could lead to a reduction in anxiety for most children (Kendall et al., 2005).

In addition to treatment-specific mediators, non-specific factors may have led to an improvement in anxiety and secondary outcomes. Examples of such factors are expectations, the child–trainer relationship, and motivation to change. Given that expectations influence intervention effects generally, we equalized children's expectations about the efficacy of the prevention programs by presenting them with a short description of the programs and their goals (Boot et al., 2013). This information was also provided to parents when we invited them to participate. However, by equalizing their expectations we may have primed children and parents to expect a reduction in anxiety, which might have led to the change in mental health outcomes.

Second, the child–trainer relationship may have been an important factor in the prevention program outcomes, as all programs were supervised by trainers. With their interpersonal skills, the trainers (i.e., master's students in psychology or professional mental health practitioners) were able to establish good relationships with the children. These relationships may have contributed to the changes in mental health symptoms and self-efficacy reported in a number of studies (e.g., Laska, Gurman, & Wampold, 2014). Furthermore, expectations and relationship quality may have reinforced each other. Positive expectations about the efficacy of the prevention programs may have been associated with a better relationship, and a better relationship in turn may have been related to larger improvements (McClintock, Anderson, & Petrarca, 2015; Murphy & Hutton, 2018).

Third, besides expectations and the child-trainer relationship, motivation to change may partly explain the decrease in mental health symptoms and increase in self-efficacy. Our selection procedure may have resulted in a relatively homogeneous group of children and parents motivated to change. We first screened all children on anxiety symptoms and those with elevated levels of anxiety symptoms were invited to participate. It is likely that the children participating in our studies were highly motivated. The least motivated children probably rejected our invitation to participate. On top of this selection procedure, supervisors motivated the children to play the game and to participate in the exercises. Thus, in turn, the children may have been more susceptible to the skills taught in the programs. Hence, they might show a larger improvement in mental health outcomes than less motivated children would (G. King, Currie, & Petersen, 2014).

In addition to non-specific factors, game-related factors might explain the beneficial effects of Max and MindLight. The games may have general training properties that could influence anxiety symptoms and secondary outcomes. First, games designers are experts in motivating players to continue playing, after successes and—more surprisingly—after failures. Games are

a training ground for perseverance: a sustained effort to achieve a goal even when hindered by difficulties or failure (Malone & Lepper, 1987). Children who persevere in the face of failure are more likely to have a growth mindset and to believe that their abilities are not fixed but can be developed through hard work (Dweck, 2017). This flexible belief system makes them more resilient when they face challenges such as, for example, anxious situations (Johnson, Panagioti, Bass, Ramsey, & Harrison, 2017). The games in our studies may have boosted the children's growth mindset and perseverance, which in turn may have had a positive effect on their ability to approach anxious situations and as a result they may have felt less anxious, showed fewer externalizing behaviors, and experienced more self-efficacy (Schleider & Weisz, 2018).

Second, Max and MindLight could be seen as a series of behavioral experiments. Such experiments are used in clinical practice to test the plausibility of cognitions. For example, people who believe that worrying is uncontrollable are asked to postpone their worrying to a specific time. When they succeed in postponing their worrying thoughts, it proves that worrying is not completely uncontrollable (Van der Heiden, 2011). In our studies, the gameplay may have functioned like behavioral experiments testing the plausibility of children's cognitions about anxious situations. For example, children might believe that they are not capable of overcoming difficult situations. In both games, they are constantly challenged to conquer obstacles (e.g., rivers in Max and monsters in MindLight). Their belief that they cannot overcome difficult situations becomes less plausible when they succeed. Hence, the cognitions of the children in this study may have been challenged, leading them to feel more self-efficacious. This sense of self-efficacy may, in turn, have made them more willing to face challenging and anxious situations and to cope with feelings of anxiety in their daily lives

Third, Max may have helped the children to regulate their emotions. After gameplay, they may have been able to release their stress and/or tension and feel more relaxed (Olson, 2010). Playing the game may also have distracted the children from their problems, as shown in a recent meta-analysis of distraction in medical procedures (Birnie et al., 2014) and a study about distraction by a game (Dahlquist et al., 2010). The game used in our study may have brought about a decrease in negative emotions by similarly distracting the children.

Strengths. The current thesis's main strength is its research design: an RCT. Specifically, randomly assigning children to either the MindLight or control group minimized the risk of selection bias. The groups were similar with respect to observed (e.g., inclusion and exclusion criteria) and unobserved (those present by chance) characteristics. Consequently, the likelihood of a biased estimate of efficacy was minimized (Odgaard-Jensen et al., 2011). In addition, we examined the wider efficacy of MindLight by including both primary and secondary outcomes. This range of outcomes, which is broader than that used in other RCTs of applied games, builds up our knowledge base on the efficacy of MindLight on other domains associated with

anxiety. We encourage applied games researchers too, to broaden their scope of outcomes and investigate the "spreading" effect of applied games on mental health. Furthermore, we included relatively long follow-ups (i.e., up to six months) to capture the longer-term efficacy of MindLight after the children had stopped playing the game.

Another strength of the current thesis is the control groups used. Specifically, the effect of MindLight was compared using active, rather than wait-list, control groups (i.e., Max and CBT). With this design, the effect of attention, motivation, behavioral activation, and expectations on improvements could be accounted for (Baranowski et al., 2016). In addition, by using active control groups we moved forward and went beyond the countless studies finding a superiority effect over a wait-list control group. Besides being active the program used the control group in our first RCT (i.e., Max) was also engaging, having won numerous awards on that basis. By making sure that the game would be appealing to children, we were able to equalize both groups in terms of engagement and thus to rigorously test the efficacy of MindLight. Furthermore, the program used with the control group in our second RCT was a first-line, evidence-based treatment for childhood anxiety (i.e., CBT). In sum, with this study design, we filled a research gap by comparing the effect of an applied game on anxiety symptoms in children with other active and engaging programs.

In addition to our research design, the samples too are a strength. Compared with other applied games studies, our samples (n = 136 and n = 174) are relatively large. Furthermore, both the children themselves and their parents reported on children's anxiety symptoms and other mental health outcomes. With this multisource approach, we were able to cross-validate our results.

Limitations and future suggestions. One important limitation of the current thesis is its lack of a multimethod approach. All data was collected through questionnaires. Because anxiety symptoms are experienced internally, self-report questionnaires are considered to be more reliable than teacher or parent reports (Hourigan et al., 2011; Lagattuta et al., 2012; Lahikainen et al., 2006). However, children and parents might nevertheless have given socially desirable answers to the questions, which may have biased the reporting of symptoms. Future studies could tackle this bias by measuring anxiety symptoms using multiple measures. These measures could include observations, such as of a speech task (Buske-Kirschbaum et al., 1997), or implicit measures (Egloff & Schmukle, 2002).

In addition, while RCTs are valid research designs for evaluating efficacy, the way the RCTs were conducted in the current thesis precludes us from drawing conclusions about effectiveness: the effect of MindLight in a real-world setting. Effectiveness could be an important topic for future research (Higa-McMillan, Francis, Rith-Najarian, & Chorpita, 2016; McMain, Newman, Segal, & DeRubeis, 2015) investigating, for example, the effect of MindLight when children are free to choose where and when they play the game.

Future research could, furthermore, focus on the cost-effectiveness of MindLight. Specifically, what are the costs of its implementation and its effectiveness compared with conventional prevention programs? A systematic review of studies on adult samples shows that internet-based CBT was more cost-effective than conventional CBT (Hedman, Ljotsson, & Lindefors, 2012). Whether this is also the case for e-health interventions for children is unclear (Arnberg, Linton, Hultcrantz, Heintz, & Jonsson, 2014). In addition, dose responsiveness could be a topic for future research on MindLight. In the current thesis, the dose was fixed by our research protocol. Future studies could vary the number and/or length of the play sessions and examine the effect on anxiety change (Shafran & Bennett, 2017). These studies could shed light on a possible optimal MindLight dose, taking into account the optimum re-playability and engagement appeal of the game.

Finally, RCTs are not the most useful research methods for investigating mechanisms of change (Maric, Wiers, & Prins, 2012); dismantling studies which can elegantly test the effect of specific parts of an intervention, are. A MindLight dismantling study could compare the full version of the game with a dismantled version, from which one component of MindLight (e.g., neurofeedback, exposure, or attention-bias modification) is removed. With this kind of research design, more insight could be gained about the processes of change because the effect of specific intervention components on outcomes could be tested.

Motivational characteristics of MindLight

Summary of main results. In addition to the efficacy of MindLight, the current thesis also aimed to investigate its motivational characteristics to gain insight into how children experience the game. These insights could be relevant for implementation efforts and the development of the next version of MindLight. The children's ratings of MindLight, Max, and CBT are reported in Chapters 2 (MindLight and Max) and 3 (MindLight and CBT). Figures 1 (RCT 1) and 2 (RCT 2) visualize these ratings, with significant differences represented by stars at the end of bars. Overall, most ratings were equal between groups. Specifically, Figure 1 shows that the children who played MindLight and children those who played Max rated their program equally relevant and difficult at both the posttest and the three-month follow-up stages. The children also agreed on the games' appeal to others at posttest, and on anxiety-inducement and flow at the three-months follow-up. Differences between groups were found for personal appeal at posttest and three-months follow-up. The children who played Max liked their game better than those who played MindLight did. At posttest only, MindLight was rated as more anxiety-inducting and less likely to induce feelings of flow compared with Max. Lastly, children in the MindLight group rated their game as less appealing to others than did children in the Max group at three-months follow-up. In addition, Figure 2 (RCT 2) shows that children who played MindLight and children who receive CBT rated their program equally anxiety-inducing, difficult, and appealing to them and to others at posttest, three-months

follow-up and six-months follow-up. The only difference between the MindLight and CBT groups was on relevance: children in the CBT group rated their program as more relevant than children in the MindLight group did at posttest and three-months follow-up, but not at six-months follow-up. In summary, MindLight was as engaging as the commercial video game Max on appeal to others, difficulty, and relevance, but not on appeal to self, flow, and anxiety-inducing. In comparison with CBT, the ratings of children playing MindLight were similar to the ratings of children receiving CBT, except that CBT was rated as more relevant than MindLight to daily life.

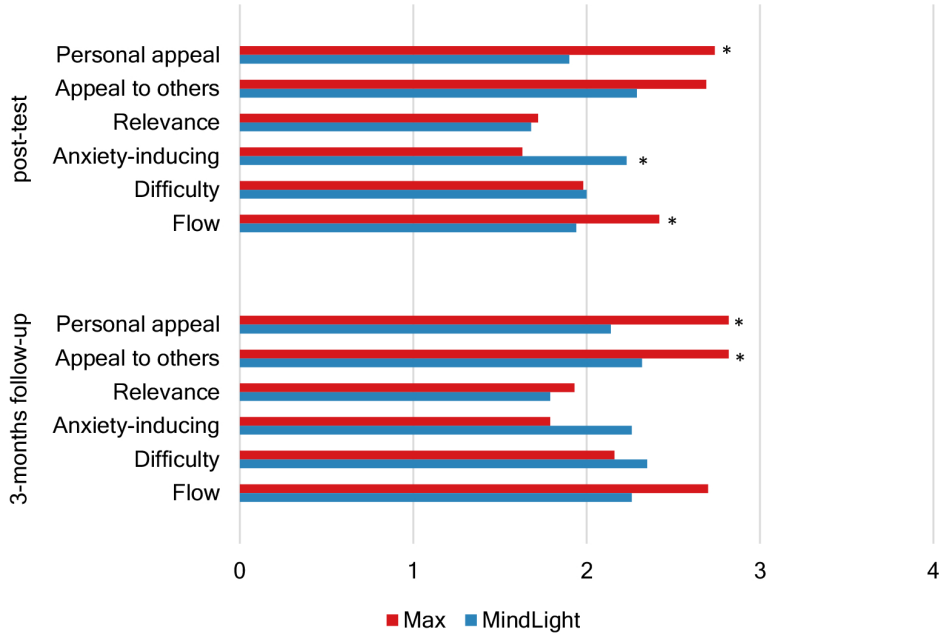

Figure 1. Children's ratings of Max and MindLight at posttest and three-months follow-up (RCT 1). Stars represent significant differences between Max and MindLight.

Besides being asked to rate their program in a questionnaire, the children were also interviewed in focus groups about their experiences of MindLight. The results described in Chapter 5 showed that, in line with their ratings, the children liked the overall look and feel of the game. They also thought that MindLight was — as intended — scary. Challenge and control were the most important motivational characteristics for them. For some, the game events were too difficult and hence too challenging. For example, some hidden coins were too difficult to find. Control and power were not, however, experienced equally intensely by all the children playing MindLight. Some indicated that they would have liked abilities that made them more powerful,

such as guns or fists. Others were confused by the feedback mechanism on their state of relaxation and focus, represented in the form of mindlight and mindbeam. All in all, the current version of MindLight has potential, but adjustments may make the game more adaptable and engaging to more children.

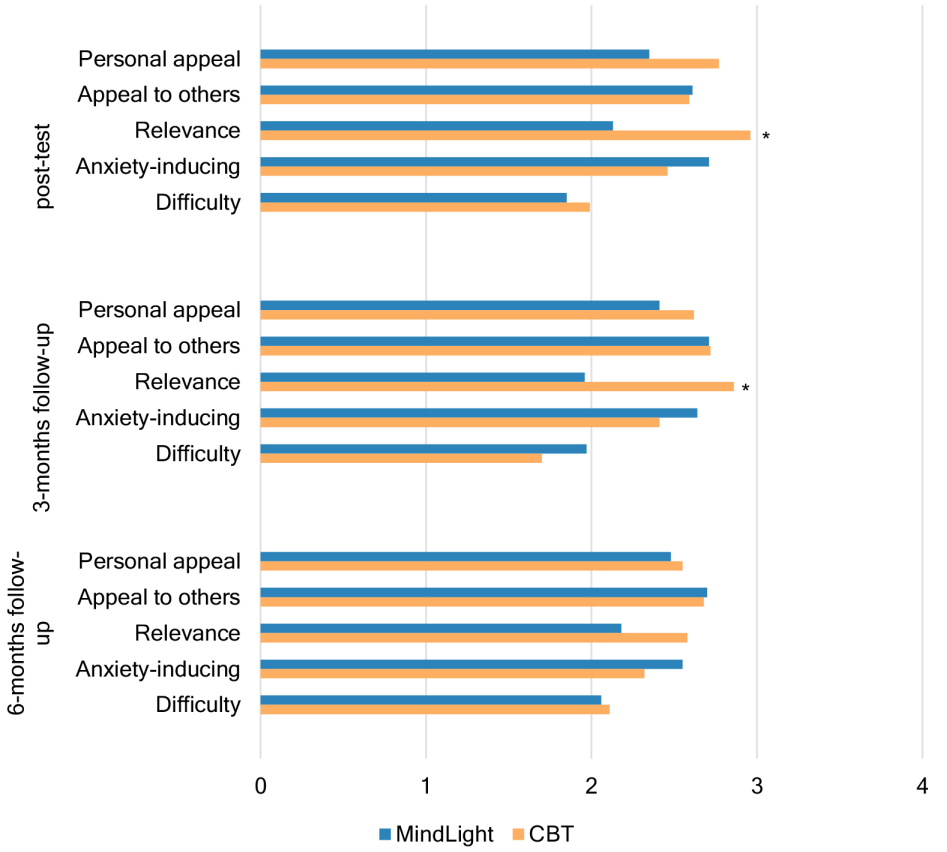

Figure 2. Children's rating of MindLight and CBT at posttest, three- and six-months follow-up (RCT 2).

Discussion of main results. When interpreting the means of the ratings, it was apparent that they did not fall on either extremity of the scale. That is, the children did not display the most negative or most positive attitudes possible towards the programs. This suggests that they were neither one hundred percent enthusiastic about nor one hundred percent disinterested in MindLight. It is possible that the research context repressed their likeability for the game. First, the research protocol guided many aspects of the context: which children were in which group, which program they received, where the program took place, and when the program sessions

were scheduled to run. The advantage of a research protocol is clear: it reduces noise in the data. However, a disadvantage is the reduction in the autonomy of the participating children, who had no say in who, what, where and when they received the program. This limited autonomy may have detracted from their intrinsic motivation and pleasure. Self-determination theory supports this explanation. Research validating this theory shows that the need for autonomy does indeed predict gameplay enjoyment (Ryan et al., 2006). Also, because the children played the game individually, the need for social interaction may have been violated to some extent. Consequently, this may have decreased their motivation to play (Ryan & Deci, 2000). Hence, taken together, the overall research context may have tempered their attitude towards MindLight.

In addition, the freedom of artists and designers to create products that are intrinsically motivating and fun may be impeded by the scientific principles that serve as the basis and starting point of applied games development. Conversely, giving artists and designers the freedom to create what they value based on artistic principles, may compromise the efficacy of known evidence-based principles. The attention puzzles in MindLight are an example of the balance between scientific and artistic principles. Some children indicated that these puzzles took too long to finish. Had the balance been prioritized in favor of scientific principles the puzzles would have lasted even longer, as most attention bias modification programs last at least a couple of minutes. This balance between scientific and artistic principles may have resulted in a game that is not comparable to the commercial games children are used to playing. However, do applied games need to be comparable to commercial games, produced by major publishers with tens of millions of dollars budgets, to have an impact on children's mental health? The studies in the current thesis suggest that applied games can co-exist with commercial games.

Future suggestions: MindLight2.0. In accordance with the challenges faced when balancing scientific and artistic principles, we propose to intensify collaboration between representatives of science and art: researchers and games developers. Integrating research with the design process is one way of doing this. In the case of MindLight1.0, the design and development processes were completed before the research took place. These two processes could, instead, evolve at the same time. For example, when minimal viable game elements are ready, researchers could study children's experiences with these elements using several research methods: focus groups, think aloud, observation, and standardized usability questionnaires (J. R. Lewis, 2014). On the basis of the results, the elements could then be improved and prototypes developed. This design and research circle could be repeated and the elements combined to build alpha and beta versions of MindLight2.0. Once all parties are content, more time-consuming studies could be conducted that aim to test the efficacy and effectiveness of MindLight2.0. This proposed design and research circle has the advantage of enabling design and research to keep up with each other, so that MindLight2.0 does not appear dated by the time its efficacy results are published (Baker, Gustafson, & Shah, 2014).

During this development process, no compromises should be made on the quality of the research methods used. Data collection within the game itself might be an additional way of automatically and unobtrusively collecting data. While playing MindLight, children's activities are recorded and stored locally on the computer in log-files. These files give information on numerous different player actions: which coins they found, which fear events they solved, which light they lit, and which attention puzzles they solved are just a few examples. This data could be a rich source of insight into mechanisms of change, different play trajectories and motivational factors, and how they relate to changes in outcome (Wols, Lichtwarck-Aschoff, Schoneveld, & Granic, 2018).

In addition to researchers and game developers, children should be involved throughout the development process from as early a stage as possible. A participatory design approach is currently used in only half of applied games for anxiety and/or depression (Dekker & Williams, 2017). However, it is important to think about how best to involve children so that they can contribute maximally (DeSmet et al., 2016). One meta-analysis of participatory design in applied games found that involving users as co-designers for game levels and challenges was more effective than not involving them was (DeSmet et al., 2016). However, user involvement in designing character and game-world aesthetic components has been found to be counterproductive (DeSmet et al., 2016). The role of the children themselves as valuable informants was discussed in Chapter 5 of the current thesis, in which their suggestions for MindLight2.0 were presented.

One of those suggestions was the ability to personalize the avatar. In MindLight1.0, all children play with the same avatar. Giving them the opportunity to adapt their avatar may make them feel more connected to it. This could, in turn, increase their feelings of autonomy and potentially their motivation to play the game (Birk, Atkins, Bowey, & Mandryk, 2016). Besides the avatar, other game elements could potentially also be open to personalization. For example, children could indicate which monsters they fear most so that those particular ones were only introduced at the end of the game. A more advanced type of personalization would be game changes based on in-game play behavior (M. J. Lee & Ferwerda, 2017; Orji, Mandryk, & Vassileva, 2017). For example, when children start to lose their lives more frequently, MindLight's difficulty level could be decreased by reducing the number of monsters or making them easier to chase away. Alternatively, when children's focus values measured by the MindWave fall below a certain threshold, the difficulty of attention puzzles could be reduced, making them easier to solve. Conversely, when children show a tendency to avoid the monsters, the monsters could chase the avatar more. By integrating such personalization options into MindLight2.0, it is likely that children would be optimally challenged and gain maximum learning experiences. Whether MindLight would also be more effective then, should be examined in future research.

Lastly, the form and social nature of the game could be considered in the development process of MindLight2.0. While the look and feel of MindLight might be appealing, the PC game format may be less of a fit with children now than it was a couple of years ago, as PCs are used less and less and smartphones and tablets are used increasingly (Kennisnet, 2017). In addition, children prefer to play games with others (Lenhart et al., 2008). Currently, MindLight is a single-player game, designed to be played individually. By making MindLight2.0 a multi-player game that could be played simultaneously with friends and family, it could match more with children's preferences. However, since research shows mixed results about the effect of parental involvement in anxiety prevention programs (Manassis et al., 2014), the added value of a multi-player option is questionable. In sum, the needs of all parties—children, researchers, and game developers—should be considered and ranked, in order to arrive at an informed decision concerning the future development of MindLight2.0.

Implementations

We live in a time of many cutbacks, where less and less money is available. At the same time, we see increasing interest in the mental health of children and ill health prevention. Easy-to-implement programs fit into this era. Given MindLight's promising results, as presented in the current thesis, this and other applied games could be an alternative delivery model for therapeutic techniques. Cost-effectiveness studies could investigate whether applied games for children are indeed more cost-effective than conventional programs (Arnberg et al., 2014), as has been found for adult samples (Hedman et al., 2012). However, possible barriers should be taken into account and are considered next, together with recommendations. As the studies from the current thesis were conducted in the Netherlands, we focus on the barriers present in Dutch society (Raad voor Volksgezondheid en Samenleving, 2017).

First, children are more likely to prefer a known program and to resist a new alternative, even though that alternative may offer potential benefits (i.e., status quo bias; Raad voor Volksgezondheid en Samenleving, 2017; Samuelson & Zeckhauser, 1988; Zhang, Guo, Wu, Lai, & Vogel, 2017). In addition, when they start an applied game children often find it easy to stop (law of attrition; Eysenbach, 2005), especially in less monitored settings outside of school (Neil, Batterham, Christensen, Bennett, & Griffiths, 2009). To tackle children's resistance and attrition, their needs and wishes should be central to the development and implementation process (Dekker & Williams, 2017). When a participatory design approach is used, the chances are high that their possible resistance will be taken care of at an early stage in the design process. In addition to children, professionals in the prevention setting (e.g., teachers)—who could give valuable information on implementation and issues that may arise from their point of view—should be involved (Granja, Janssen, & Johansen, 2018). They might then be more eager to experience the results of their invested time and energy by implementing the applied games in their organizations (Swinkels et al., 2018).

Second, organizations are not inclined to implement e-health programs because financing is focused on the short-term certainty of benefits. However, investments in hardware, software, and training are needed before (uncertain) benefits can arise. Thus, organizations choose the financially safest route, that of known programs (Granja et al., 2018). Furthermore, the "not-invented-here syndrome" reinforces taking the safest route as people tend to avoid innovations that are developed or funded outside of their own organization (Raad voor Volksgezondheid en Samenleving, 2017). However, applied games and other e-health programs might prove to be cheaper mental health program interventions than those delivered by trained psychologists (Hedman et al., 2012). The financial arguments of organizations against implementing the former might thus be contradicted by cost-effectiveness studies. Should e-health programs indeed turn out to be more cost-effective, organizations may be more inclined to invest in the requirements necessary for implementing them effectively, such as hardware, software, and training. In addition, collaboration between organizations, the Ministry of Health, Welfare and Sport and the Ministry of Economic Affairs and Climate could bring about a more conducive financing process that could stimulate the implementation of e-health programs. Recently, a step in the right direction has been made with the Health Deal, introduced by the ministries and major health care organizations in the Netherlands (Ministry of Health Welfare and Sport & Ministry of Economic Affairs and Climate, 2018), which aims to stimulate health through prevention via e-health programs.

Another way of overcoming financing barriers might be by commercializing applied games outside of the collective financing system of healthcare. Commercialization might be a "dirty word" to professionals, but its advantages could outweigh the disadvantages of the current system. For example, companies, schools, and mental healthcare institutions could develop sustainable business models (Oderanti & Li, 2018). They could choose to invest money in e-health programs and reimburse their costs through the profits realized. Furthermore, the profits could be used to improve the applied games in order to keep them up to date and functional. This way, applied games could be granted a longer lifespan and might therefore stand a better chance of changing mental health.

Conclusion

The current thesis is among the first to examine the efficacy and motivational characteristics of an applied game for children with elevated levels of anxiety. Overall, the results presented show that MindLight may be an effective anxiety prevention program, improving anxiety, self-efficacy, and internalizing and externalizing problems in children with anxiety problems. This applied game can enhance mental health outcomes regardless of the potential mental health difficulties or struggles that children or their parents may have at the beginning of the program. Given these promising results, MindLight could be an alternative to conventional anxiety prevention programs. Extending the toolbox of effective interventions for children with anxiety problems

will give them the opportunity to choose the delivery model that suits them best. MindLight may be a competitor of conventional programs because the participating children were engaged while playing the game. At the same time, the children also had suggestions for improving it, through MindLight2.0. Both involving them and integrating research with design processes may be a valuable approach for future applied games development. Together, children, games developers, professional mental health practitioners, and researchers can harness the potential of applied games for mental health and improve the lives of today's children and tomorrow's adolescents.

APPENDIX

References

References

Abuhamdeh, S., Csikszentmihalyi, M., & Jalal, B. (2014). Enjoying the possibility of defeat: Outcome uncertainty, suspense, and intrinsic motivation. *Motivation and Emotion, 39*(1), 1-10. doi:10.1007/s11031-014-9425-2

Aldao, A. (2013). The future of emotion regulation research: Capturing context. *Perspectives on Psychological Science, 8*(2), 155-172. doi:10.1177/1745691612459518

Aldao, A., Nolen-Hoeksema, S., & Schweizer, S. (2010). Emotion-regulation strategies across psychopathology: A meta-analytic review. *Clinical Psychology Review, 30*(2), 217-237. doi:10.1016/j.cpr.2009.11.004

All, A., Castellar, E. P. N., & Van Looy, J. (2016). Assessing the effectiveness of digital game-based learning: Best practices. *Computers & Education, 92-93*, 90-103. doi:10.1016/j.compedu.2015.10.007

American Psychiatric Association. (2013). *The diagnostic and statistical manual of mental disorders: DSM 5*. Washington, D.C: American Psychiatric Association.

Amoura, C., Berjot, S., Gillet, N., & Altintas, E. (2013). Desire for control, perception of control: Their impact on autonomous motivation and psychological adjustment. *Motivation and Emotion, 38*(3), 323-335. doi:10.1007/s11031-013-9379-9

Andrade, L. H., Alonso, J., Mneimneh, Z., Wells, J. E., Al-Hamzawi, A., Borges, G., . . . Kessler, R. C. (2014). Barriers to mental health treatment: Results from the WHO World Mental Health surveys. *Psychological Medicine, 44*(6), 1303-1317. doi:10.1017/S0033291713001943

Antony, M. M., Bieling, P. J., Cox, B. J., Enns, M. W., & Swinson, R. P. (1998). Psychometric properties of the 42-item and 21-item versions of the Depression Anxiety Stress Scales in clinical groups and a community sample. *Psychological Assessment, 10*(2), 176-181. doi:10.1037//1040-3590.10.2.176

Arnberg, F. K., Linton, S. J., Hultcrantz, M., Heintz, E., & Jonsson, U. (2014). Internet-delivered psychological treatments for mood and anxiety disorders: A systematic review of their efficacy, safety, and cost-effectiveness. *PloS one, 9*(5), e98118. doi:10.1371/journal.pone.0098118

Asparouhov, T., & Muthén, B. O. (2010, August 14). Weighted least squares estimation with missing data. Retrieved from http://www.statmodel.com/download/GstrucMissingRevision.pdf

Asselmann, E., & Beesdo-Baum, K. (2015). Predictors of the course of anxiety disorders in adolescents and young adults. *Current Psychiatry Reports, 17*(2), 1-8. doi:10.1007/s11920-014-0543-z

Baker, T. B., Gustafson, D. H., & Shah, D. (2014). How can research keep up with eHealth? Ten strategies for increasing the timeliness and usefulness of eHealth research. *Journal of Medical Internet Research, 16*(2), e36. doi:10.2196/jmir.2925

Bar-Haim, Y. (2010). Research review: Attention bias modification (ABM): A novel treatment for anxiety disorders. *Journal of Child Psychology and Psychiatry, 51*(8), 859-870. doi:10.1111/j.1469-7610.2010.02251.x

Bar-Haim, Y., Morag, I., & Glickman, S. (2011). Training anxious children to disengage attention from threat: A randomized controlled trial. *Journal of Child Psychology and Psychiatry, 52*(8), 861-869. doi:10.1111/j.1469-7610.2011.02368.x

Baranowski, T., Blumberg, F., Buday, R., DeSmet, A., Fiellin, L. E., Green, C. S., . . . Young, K. (2016). Games for health for children - Current status and needed research. *Games for Health Journal, 5*(1), 1-12. doi:10.1089/g4h.2015.0026

Baranowski, T., Buday, R., Thompson, D. I., & Baranowski, J. (2008). Playing for real - Video games and stories for health-related behavior change. *American Journal of Preventive Medicine, 34*(1), 74-82. doi:10.1016/j.amepre.2007.09.027

Beaumont, R., & Sofronoff, K. (2008). A multi-component social skills intervention for children with Asperger syndrome: The Junior Detective Training Program. *Journal of Child Psychology and Psychiatry, 49*(7), 743-753. doi:10.1111/j.1469-7610.2008.01920.x

Beesdo, K., Knappe, S., & Pine, D. S. (2009). Anxiety and anxiety disorders in children and adolescents: Developmental issues and implications for DSM-V. *Psychiatric Clinics of North America, 32*(3), 483-524. doi:10.1016/j.psc.2009.06.002

Beidas, R. S., Mychailyszyn, M. P., Podell, J. L., & Kendall, P. C. (2013). Brief cognitive-behavioral therapy for anxious youth: The inner workings. *Cognitive and Behavioral Practice, 20*(2), 134-146. doi:10.1016/j.cbpra.2012.07.004

Bell, E. C., Marcus, D. K., & Goodlad, J. K. (2013). Are the parts as good as the whole? A meta-analysis of component treatment studies. *Journal of Consulting and Clinical Psychology, 81*(4), 722-736. doi:10.1037/a0033004

Birk, M. V., Atkins, C., Bowey, J. T., & Mandryk, R. L. (2016). Fostering intrinsic motivation through avatar identification in digital games. Proceedings of CHI, USA, 2982-2995. doi:10.1145/2858036.2858062

Birnie, K. A., Noel, M., Parker, J. A., Chambers, C. T., Uman, L. S., Kisely, S. R., & McGrath, P. J. (2014). Systematic review and meta-analysis of distraction and hypnosis for needle-related pain and distress in children and adolescents. *Journal of Pediatric Psychology, 39*(8), 783-808. doi:10.1093/jpepsy/jsu029

Boettcher, H., Brake, C. A., & Barlow, D. H. (2016). Origins and outlook of interoceptive exposure. *Journal of Behavior Therapy and Experimental Psychiatry, 53*, 41-51. doi:10.1016/j.jbtep.2015.10.009

Boot, W. R., Simons, D. J., Stothart, C., & Stutts, C. (2013). The pervasive problem with placebos in psychology: Why active control groups are not sufficient to rule out placebo effects. *Perspectives on Psychological Science, 8*(4), 445-454. doi:10.1177/1745691613491271

Briggs-Gowan, M. J., Carter, A. S., & Schwab-Stone, M. (1996). Discrepancies among mother, child, and teacher reports: Examining the contributions of maternal depression and anxiety. *Journal of Abnormal Child Psychology, 24*(6), 749-765. doi:10.1007/bf01664738

Brown-Jacobsen, A. M., Wallace, D. P., & Whiteside, S. P. H. (2011). Multimethod, multi-informant agreement, and positive predictive value in the identification of child anxiety disorders using the SCAS and ADIS-C. *Assessment, 18*(3), 382-392. doi:10.1177/1073191110375792

Buitelaar, J. K., Smeets, K. C., Herpers, P., Scheepers, F., Glennon, J., & Rommelse, N. N. J. (2013). Conduct disorders. *European Child & Adolescent Psychiatry, 22*(S1), S49-S54. doi:10.1007/s00787-012-0361-y

Buske-Kirschbaum, A., Jobst, S., Wustmans, A., Kirschbaum, C., Rauh, W., & Hellhammer, D. (1997). Attenuated free cortisol response to psychosocial stress in children with atopic dermatitis. *Psychosomatic Medicine, 59*(4), 419-426.

Chandra, A., & Minkovitz, C. S. (2006). Factors that influence mental health stigma among 8th grade adolescents. *Journal of Youth and Adolescence, 36*(6), 763-774. doi:10.1007/s10964-006-9091-0

Cheek, C., Bridgman, H., Fleming, T., Cummings, E., Ellis, L., Lucassen, M. F., . . . Skinner, T. (2014). Views of young people in rural australia on SPARX, a fantasy world developed for New Zealand youth with depression. *JMIR Serious Games, 2*(1), e3. doi:10.2196/games.3183

Chen, F. N., Curran, P. J., Bollen, K. A., Kirby, J., & Paxton, P. (2008). An empirical evaluation of the use of fixed cutoff points in RMSEA test statistic in structural equation models. *Sociological Methods & Research, 36*(4), 462-494. doi:10.1177/0049124108314720

Chorpita, B. F., Brown, T. A., & Barlow, D. H. (1998). Perceived control as a mediator of family environment in etiological models of childhood anxiety. *Behavior Therapy, 29*(3), 457 - 476. doi:10.1016/S0005-7894(98)80043-9.

Christensen, H., Griffiths, K. M., & Jorm, A. F. (2004). Delivering interventions for depression by using the internet: Randomised controlled trial. *British Medical Journal, 328*(7434), 265-268A. doi:10.1136/bmj.37945.566632.EE

Ciampa, K. (2014). Learning in a mobile age: An investigation of student motivation. *Journal of Computer Assisted Learning, 30*(1), 82-96. doi:10.1111/jcal.12036

Clarke, A. M., Morreale, S., Field, C. A., Hussein, Y., & Barry, M. M. (2015, February). *What works in enhancing social and emotional skills development during childhood and adolescence? A review of the evidence on the effectiveness of school-based and out-of-school programmes in the UK*. Retrieved from http://hdl.handle.net/10379/4981

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Collins, K. A., Westra, H. A., Dozois, D. J. A., & Burns, D. D. (2004). Gaps in accessing treatment for anxiety and depression: Challenges for the delivery of care. *Clinical Psychology Review, 24*(5), 583-616. doi:10.1016/j.cpr.2004.06.001

Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers & Education, 59*(2), 661-686. doi:10.1016/j.compedu.2012.03.004

Corrigan, P. (2004). How stigma interferes with mental health care. *American Psychologist, 59*(7), 614-625. doi:10.1037/0003-066X.59.7.614

Cunningham, N. R., Jagpal, A., Tran, S. T., Kashikar-Zuck, S., Goldschneider, K. R., Coghill, R. C., & Lynch-Jordan, A. M. (2016). Anxiety adversely impacts response to cognitive behavioral therapy in children with chronic pain. *The Journal of Pediatrics, 171*, 227-233. doi:10.1016/j.jpeds.2016.01.018

Dadds, M. R., Holland, D. E., Laurens, K. R., Mullins, M., Barrett, P. M., & Spence, S. H. (1999). Early intervention and prevention of anxiety disorders in children: Results at 2-year follow-up. *Journal of Consulting and Clinical Psychology, 67*(1), 145-150. doi:10.1037//0022-006x.67.1.145

Dahlquist, L. M., Weiss, K. E., Law, E. F., Sil, S., Herbert, L. J., Horn, S. B., . . . Ackerman, C. S. (2010). Effects of videogame distraction and a virtual reality type head-mounted display helmet on cold pressor pain in young elementary school-aged children. *Journal of Pediatric Psychology, 35*(6), 617-625. doi:10.1093/jpepsy/jsp082

de Haan, A. M., Boon, A. E., de Jong, J., Hoeve, M., & Vermeiren, R. (2013). A meta-analytic review on treatment dropout in child and adolescent outpatient mental health care. *Clinical Psychology Review, 33*(5), 698-711. doi:10.1016/j.cpr.2013.04.005

De Los Reyes, A., Augenstein, T. M., Wang, M., Thomas, S. A., Drabick, D. A., Burgers, D. E., & Rabinowitz, J. (2015). The validity of the multi-informant approach to assessing child and adolescent mental health. *Psychological Bulletin, 141*(4), 858-900. doi:10.1037/a0038498

Dean, S., Britt, E., Bell, E., Stanley, J., & Collings, S. (2016). Motivational interviewing to enhance adolescent mental health treatment engagement: A randomized clinical trial. *Psychological Medicine, 46*(9), 1961-1969. doi:10.1017/S0033291716000568

Dekker, M. R., & Williams, A. D. (2017). The use of user-centered participatory design in serious games for anxiety and depression. *Games for Health Journal, 6*(6), 327-333. doi:10.1089/g4h.2017.0058

DeSmet, A., Thompson, D., Baranowski, T., Palmeira, A., Verloigne, M., & De Bourdeaudhuij, I. (2016). Is participatory design associated with the effectiveness of serious digital games for healthy lifestyle promotion? A meta-analysis. *Journal of Medical Internet Research, 18*(4), e94. doi:10.2196/jmir.4444

Donovan, C. L., & March, S. (2014). Online CBT for preschool anxiety disorders: A randomised control trial. *Behavior Research and Therapy, 58*, 24-35. doi:10.1016/j.brat.2014.05.001

Dovis, S., Van der Oord, S., Wiers, R. W., & Prins, P. J. (2015). Improving executive functioning in children with ADHD: Training multiple executive functions within the context of a computer game. A randomized double-blind placebo controlled trial. *PloS one, 10*(4), e0121651. doi:10.1371/journal.pone.0121651

Dudeney, J., Sharpe, L., & Hunt, C. (2015). Attentional bias towards threatening stimuli in children with anxiety: A meta-analysis. *Clinical Psychology Review, 40*, 66-75. doi:10.1016/j.cpr.2015.05.007

Duncan, S. C., Duncan, T. E., & Strycker, L. A. (2006). Alcohol use from ages 9 to 16: A cohort-sequential latent growth model. *Drug and Alcohol Dependence, 81*(1), 71-81. doi:10.1016/j.drugalcdep.2005.06.001

Dweck, C. S. (2017). The journey to children's mindsets - and beyond. *Child Development Perspectives, 11*(2), 139-144. doi:10.1111/cdep.12225

Egloff, B., & Schmukle, S. C. (2002). Predictive validity of an implicit association test for assessing anxiety. *Journal of Personality and Social Psychology, 83*(6), 1441-1455. doi:10.1037//0022-3514.83.6.1441

Entertainment Software Association (2017, April). Essential facts about the computer and video game industry. Retrieved from http://www.theesa.com/wp-content/uploads/2017/09/EF2017_Design_FinalDigital.pdf

Essau, C. A. (2003). Comorbidity of anxiety disorders in adolescents. *Depression and Anxiety, 18*(1), 1-6. doi:10.1002/da.10107

Evans, M., & Boucher, A. R. (2015). Optimizing the power of choice: Supporting student autonomy to foster motivation and engagement in learning. *Mind, Brain, and Education, 9*(2), 87-91. doi:10.1111/mbe.12073

Eysenbach, G. (2005). The law of attrition. *Journal of Medical Internet Research, 7*(1), e11. doi:10.2196/jmir.7.1.e11

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion, 7*(2), 336-353. doi:10.1037/1528-3542.7.2.336

Fairburn, C. G., & Patel, V. (2017). The impact of digital technology on psychological treatments and their dissemination. *Behavior Research and Therapy, 88*, 19-25. doi:10.1016/j.brat.2016.08.012

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175-191. doi:10.3758/bf03193146

Ferguson, C. J., & Olson, C. K. (2013). Friends, fun, frustration and fantasy: Child motivations for video game play. *Motivation and Emotion, 37*(1), 154-164. doi:10.1007/s11031-012-9284-7

Feske, U., & Chambless, D. L. (1995). Cognitive-behavioral versus exposure only treatment for social phobia: A meta-analysis. *Behavior Therapy, 26*(4), 695-720. doi:10.1016/s0005-7894(05)80040-1

Fisak, B., Jr., & Grills-Taquechel, A. E. (2007). Parental modeling, reinforcement, and information transfer: Risk factors in the development of child anxiety? *Clinical Child and Family Psychology Review, 10*(3), 213-231. doi:10.1007/s10567-007-0020-x

Fisak, B., Jr., Richard, D., & Mann, A. (2011). The prevention of child and adolescent anxiety: A meta-analytic review. *Prevention Science, 12*(3), 255-268. doi:10.1007/s11121-011-0210-0

Fish, M. T. (2011). *A randomized controlled study of the effectiveness of casual video games in reducing symptoms of anxiety* (Master's thesis). Retrieved from the Scholarship. (http://thescholarship.ecu.edu/bitstream/handle/10342/3575/Fish_ecu_0600M_10411.pdf?sequenc)

Flannery-Schroeder, E., Choudhury, M. S., & Kendall, P. C. (2005). Group and individual cognitive-behavioral treatments for youth with anxiety disorders: 1-year follow-up. *Cognitive Therapy and Research, 29*(2), 253-259. doi:10.1007/s10608-005-3168-z

Flannery-Schroeder, E., & Kendall, P. C. (2000). Group and individual cognitive-behavioral treatments for youth with anxiety disorders: A randomized clinical trial. *Cognitive Therapy and Research, 24*(3), 251-278. doi:10.1023/a:1005500219286

Fleming, T. M., Bavin, L., Stasiak, K., Hermansson-Webb, E., Merry, S. N., Cheek, C., . . . Hetrick, S. (2017). Serious games and gamification for mental health: Current status and promising directions. *Frontiers in Psychiatry, 7:215*. doi:10.3389/fpsyt.2016.00215

Fleming, T. M., de Beurs, D., Khazaal, Y., Gaggioli, A., Riva, G., Botella, C., . . . Riper, H. (2016). Maximizing the impact of e-therapy and serious gaming: Time for a paradigm shift. *Frontiers in Psychiatry, 7:65*. doi:10.3389/fpsyt.2016.00065

Fleming, T. M., Dixon, R., Frampton, C., & Merry, S. (2012). A pragmatic randomized controlled trial of computerized CBT (SPARX) for symptoms of depression among adolescents excluded from mainstream education. *Behavioral and Cognitive Psychotherapy, 40*, 529-541. doi:10.1017/S1352465811000695

Fraire, M. G., & Ollendick, T. H. (2013). Anxiety and oppositional defiant disorder: A transdiagnostic conceptualization. *Clinical Psychology Review, 33*(2), 229-240. doi:10.1016/j.cpr.2012.11.004

Furukawa, T. A., Noma, H., Caldwell, D. M., Honyashiki, M., Shinohara, K., Imai, H., . . . Churchill, R. (2014). Waiting list may be a nocebo condition in psychotherapy trials: A contribution from network meta-analysis. *Acta Psychiatrica Scandinavica, 130*(3), 181-192. doi:10.1111/acps.12275

Garber, J., Brunwasser, S. M., Zerr, A. A., Schwartz, K. T. G., Sova, K., & Weersing, V. R. (2016). Treatment and prevention of depression and anxiety in youth: Test of cross-over effects. *Depression and Anxiety, 33*(10), 939-959. doi:10.1002/da.22519

Gehring, N. D., McGrath, P., Wozney, L., Soleimani, A., Bennett, K., Hartling, L., . . . Newton, A. S. (2017). Pediatric eMental healthcare technologies: A systematic review of implementation foci in research studies, and government and organizational documents. *Implementation Science, 12:76*. doi:10.1186/s13012-017-0608-6

Gershoff, E. T. (2002). Corporal punishment by parents and associated child behaviors and experiences: A meta-analytic and theoretical review. *Psychological Bulletin, 128*(4), 539-579. doi:10.1037/0033-2909.128.4.539

Girard, C., Ecalle, J., & Magnan, A. (2013). Serious games as new educational tools: How effective are they? A meta-analysis of recent studies. *Journal of Computer Assisted Learning, 29*(3), 207-219. doi:10.1111/j.1365-2729.2012.00489.x

Giuliani, N. R., McRae, K., & Gross, J. J. (2008). The up- and down-regulation of amusement: Experiential, behavioral, and autonomic consequences. *Emotion, 8*(5), 714-719. doi:10.1037/a0013236

Glenn, D., Golinelli, D., Rose, R. D., Roy-Byrne, P., Stein, M. B., Sullivan, G., . . . Craske, M. G. (2013). Who gets the most out of cognitive-behavioral therapy for anxiety disorders?: The role of treatment dose and patient engagement. *Journal of Consulting and Clinical Psychology, 81*(4), 639-649. doi:10.1037/a0033403

Goodman, A., Lamping, D. L., & Ploubidis, G. B. (2010). When to use broader internalising and externalising subscales instead of the hypothesised five subscales on the strengths and difficulties questionnaire (SDQ): Data from British parents, teachers and children. *Journal of Abnormal Child Psychology, 38*(8), 1179-1191. doi:10.1007/s10802-010-9434-x

Goodman, R. (1997). The strengths and difficulties questionnaire: A research note. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 38*(5), 581-586. doi:10.1111/j.1469-7610.1997.tb01545.x

Goodman, S. H., Rouse, M. H., Connell, A. M., Broth, M. R., Hall, C. M., & Heyward, D. (2011). Maternal depression and child psychopathology: A meta-analytic review. *Clinical Child and Family Psychology Review, 14*(1), 1-27. doi:10.1007/s10567-010-0080-1

Graham, J. W. (2009). Missing data analysis: Making it work in the real world. *Annual Review of Psychology, 60*, 549-576. doi:10.1146/annurev.psych.58.110405.085530

Granic, I. (2014). The role of anxiety in the development, maintenance, and treatment of childhood aggression. *Development and Psychopathology, 26*, 1515-1530. doi:10.1017/S0954579414001175

Granic, I., Lobel, A., & Engels, R. C. M. E. (2014). The benefits of playing video games. *American Psychologist, 69*(1), 66-78. doi:10.1037/a0034857

Granja, C., Janssen, W., & Johansen, M. A. (2018). Factors determining the success and failure of eHealth interventions: Systematic review of the literature. *Journal of Medical Internet Research, 20*(5), e10235. doi:10.2196/10235

Green, A. C., Hunt, C., & Stain, H. J. (2012). The delay between symptom onset and seeking professional treatment for anxiety and depressive disorders in a rural Australian sample. *Social Psychiatry and Psychiatric Epidemiology, 47*(9), 1475-1487. doi:10.1007/s00127-011-0453-x

Grist, R., Porter, J., & Stallard, P. (2017). Mental health mobile apps for preadolescents and adolescents: A systematic review. *Journal of Medical Internet Research, 19*(5), e176. doi:10.2196/jmir.7332

Gulliver, A., Griffiths, K. M., & Christensen, H. (2010). Perceived barriers and facilitators to mental health help-seeking in young people: A systematic review. *Bmc Psychiatry, 10:113*. doi:10.1186/1471-244x-10-113

Hadwin, J. A., & Richards, H. J. (2016). Working memory training and CBT reduces anxiety symptoms and attentional biases to threat: A preliminary study. *Frontiers in Psychology, 7:47*. doi:10.3389/fpsyg.2016.00047

Hakamata, Y., Lissek, S., Bar-Haim, Y., Britton, J. C., Fox, N. A., Leibenluft, E., . . . Pine, D. S. (2010). Attention bias modification treatment: A meta-analysis toward the establishment of novel treatment for anxiety. *Biological Psychiatry, 68*(11), 982-990. doi:10.1016/j.biopsych.2010.07.021

Hedman, E., Ljotsson, B., & Lindefors, N. (2012). Cognitive behavior therapy via the Internet: A systematic review of applications, clinical efficacy and cost-effectiveness. *Expert Review of Pharmacoeconomics & Outcomes Research, 12*(6), 745-764. doi:10.1586/erp.12.67

Herzog, W., & Boomsma, A. (2009). Small-sample robust estimators of noncentrality-based and incremental model fit. *Structural Equation Modeling-a Multidisciplinary Journal, 16*(1), 1-27. doi:10.1080/10705510802561279

Higa-McMillan, C. K., Francis, S. E., Rith-Najarian, L., & Chorpita, B. F. (2016). Evidence base update: 50 years of research on treatment for child and adolescent anxiety. *Journal of Clinical Child & Adolescent Psychology, 45*(2), 91-113. doi:10.1080/15374416.2015.1046177

Hirshfeld-Becker, D. R., & Biederman, J. (2002). Rationale and principles for early intervention with young children at risk for anxiety disorders. *Clinical Child and Family Psychology Review, 5*(3), 161-172. doi:10.1023/a:1019687531040

Hogendoorn, S. M., Prins, P. J., Boer, F., Vervoort, L., Wolters, L. H., Moorlag, H., . . . de Haan, E. (2014). Mediators of cognitive behavioral therapy for anxiety-disordered children and adolescents: Cognition, perceived control, and coping. *Journal of Clinical Child & Adolescent Psychology, 43*(3), 486-500. doi:10.1080/15374416.2013.807736

Hoglund, W. L. G., & Chisholm, C. A. (2014). Reciprocating risks of peer problems and aggression for children's internalizing problems. *Developmental Psychology, 50*(2), 586-599. doi:10.1037/a0033617

Hollis, C., Falconer, C. J., Martin, J. L., Whittington, C., Stockton, S., Glazebrook, C., & Davies, E. B. (2017). Annual research review: Digital health interventions for children and young people with mental health problems - a systematic and meta-review. *Journal of Child Psychology and Psychiatry, 58*(4), 474. doi:10.1111/jcpp.12663

Holmes, E. A., James, E. L., Kilford, E. J., & Deeprose, C. (2010). Key steps in developing a cognitive vaccine against traumatic flashbacks: Visuospatial Tetris versus verbal pub quiz. *PloS one, 5*(11), e13706. doi:10.1371/journal.pone.0013706

Holzinger, A. (2005). Usability engineering methods for software developers. *Communications of the ACM, 48*(1), 71-74. doi:10.1145/1039539.1039541

Hourigan, S. E., Goodman, K. L., & Southam-Gerow, M. A. (2011). Discrepancies in parents' and children's reports of child emotion regulation. *Journal of Experimental Child Psychology, 110*(2), 198-212. doi:10.1016/j.jecp.2011.03.002

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling-a Multidisciplinary Journal, 6*(1), 1-55. doi:10.1080/10705519909540118

Hudson, J. L., & Kendall, P. C. (2002). Showing you can do it: Homework in therapy for children and adolescents with anxiety disorders. *Journal of Clinical Psychology, 58*(5), 525-534. doi:10.1002/jclp.10030

Humphrey, N., Kalambouka, A., Wigelsworth, M., & Lendrum, A. (2010). Going for goals: An evaluation of a short, social–emotional intervention for primary school children. *School Psychology International, 31*(3), 250-270. doi:10.1177/0143034309352578

James, A. C., James, G., Cowdrey, F. A., Soler, A., & Choke, A. (2015). Cognitive behavioral therapy for anxiety disorders in children and adolescents. *Cochrane Database of Systematic Reviews*(2). doi:10.1002/14651858.CD004690.pub4

James, E. L., Bonsall, M. B., Hoppitt, L., Tunbridge, E. M., Geddes, J. R., Milton, A. L., & Holmes, E. A. (2015). Computer game play reduces intrusive memories of experimental trauma via reconsolidation-update mechanisms. *Psychological science, 26*(8), 1201-1215. doi:10.1177/0956797615583071

Jameson, E., Trevena, J., & Swain, N. (2011). Electronic gaming as pain distraction. *Pain Research & Management, 16*(1), 27-32.

Johansson, O., Michel, T., Andersson, G., & Paxling, B. (2015). Experiences of non-adherence to Internet-delivered cognitive behavior therapy: A qualitative study. *Internet Interventions, 2*(2), 137-142. doi:10.1016/j.invent.2015.02.006

Johnson, J., Panagioti, M., Bass, J., Ramsey, L., & Harrison, R. (2017). Resilience to emotional distress in response to failure, error or mistakes: A systematic review. *Clinical Psychology Review, 52*, 19-42. doi:10.1016/j.cpr.2016.11.007

Johnstone, S. J., Blackman, R., & Bruggemann, J. M. (2012). EEG from a single-channel dry-sensor recording device. *Clinical Eeg and Neuroscience, 43*(2), 112-120. doi:10.1177/1550059411435857

Jones, E., Jarvis, P., Lewis, J. A., & Ebbutt, A. F. (1996). Trials to assess equivalence: The importance of rigorous methods. *British Medical Journal, 313*(7048), 36-39. doi:10.1136/bmj.313.7048.36

Kamel Boulos, M. N., Gammon, S., Dixon, M. C., MacRury, S. M., Fergusson, M. J., Miranda Rodrigues, F., . . . Yang, S. P. (2015). Digital games for type 1 and type 2 diabetes: Underpinning theory with three illustrative examples. *JMIR Serious Games, 3*(1), e3. doi:10.2196/games.3930

Kane, R. L., Wang, J., & Garrard, J. (2007). Reporting in randomized clinical trials improved after adoption of the CONSORT statement. *Journal of Clinical Epidemiology, 60*(3), 241-249. doi:10.1016/j.jclinepi.2006.06.016

Kataoka, S. H., Zhang, L., & Wells, K. B. (2002). Unmet need for mental health care among US children: Variation by ethnicity and insurance status. *American Journal of Psychiatry, 159*(9), 1548-1555. doi:10.1176/appi.ajp.159.9.1548

Kato, P. M., Cole, S. W., Bradlyn, A. S., & Pollock, B. H. (2008). A video game improves behavioral outcomes in adolescents and young adults with cancer: A randomized trial. *Pediatrics, 122*(2), E305-E317. doi:10.1542/peds.2007-3134

Kazdin, A. E. (2015). Technology-based interventions and reducing the burdens of mental illness: Perspectives and comments on the special series. *Cognitive and Behavioral Practice, 22*(3), 359-366. doi:10.1016/j.cbpra.2015.04.004

Kazdin, A. E., & Blase, S. L. (2011). Rebooting psychotherapy research and practice to reduce the burden of mental illness. *Perspectives on Psychological Science, 6*(1), 21-37. doi:10.1177/1745691610393527

Kazdin, A. E., & Rabbitt, S. M. (2013). Novel models for delivering mental health services and reducing the burdens of mental illness. *Clinical Psychological Science, 1*(2), 170-191. doi:10.1177/2167702612463566

Kendall, P. C. (2011). *Child and adolescent therapy: Cognitive-behavioral procedures*. New York, NY: Guilford Press.

Kendall, P. C., Flannery-Schroeder, E., Panichelli-Mindel, S. M., Southam-Gerow, M., Henin, A., & Warman, M. (1997). Therapy for youths with anxiety disorders: A second randomized clinical trial. *Journal of Consulting and Clinical Psychology, 65*(3), 366-380. doi:10.1037/0022-006x.65.3.366

Kendall, P. C., & Hedtke, K. A. (2006). *Cognitive-behavioral therapy for anxious children: Therapist manual*. Ardmore, PA: Workbook Publishing.

Kendall, P. C., Hudson, J. L., Gosch, E., Flannery-Schroeder, E., & Suveg, C. (2008). Cognitive-behavioral therapy for anxiety disordered youth: A randomized clinical trial evaluating child and family modalities. *Journal of Consulting and Clinical Psychology, 76*(2), 282-297. doi:10.1037/0022-006x.76.2.282

Kendall, P. C., Robin, J. A., Hedtke, K. A., Suveg, C., Flannery-Schroeder, E., & Gosch, E. (2005). Considering CBT with anxious youth? Think exposures. *Cognitive and Behavioral Practice, 12*(1), 136-148. doi:10.1016/s1077-7229(05)80048-3

Kendall, P. C., Safford, S., Flannery-Schroeder, E., & Webb, A. (2004). Child anxiety treatment: Outcomes in adolescence and impact on substance use and depression at 7.4-year follow-up. *Journal of Consulting and Clinical Psychology, 72*(2), 276-287. doi:10.1037/0022-006X.72.2.276

Kennisnet (2017). Monitor jeugd en media 2017 [report]. Retrieved from https://www.kennisnet.nl/fileadmin/kennisnet/publicatie/jeugd_media/Kennisnet_Monitor_Jeugd_en_Media_2017.pdf

Kessler, R. C., Avenevoli, S., Costello, E. J., Georgiades, K., Green, J. G., Gruber, M. J., . . . Merikangas, K. R. (2012). Prevalence, persistence, and sociodemographic correlates of DSM-IV disorders in the National Comorbidity Survey Replication Adolescent Supplement. *Archives of General Psychiatry, 69*(4), 372-380. doi:10.1001/archgenpsychiatry.2011.160

Kidwell, K. M., Van Dyk, T. R., Guenther, K. D., & Nelson, T. D. (2016). Anger and children's health: Differentiating role of inward versus outward expressed anger on sleep, medical service utilization, and mental health. *Childrens Health Care, 45*(3), 342-358. doi:10.1080/02739615.2015.1038680

Kiluk, B. D., Sugarman, D. E., Nich, C., Gibbons, C. J., Martino, S., Rounsaville, B. J., & Carroll, K. M. (2011). A methodological analysis of randomized clinical trials of computer-assisted therapies for psychiatric disorders: Toward improved standards for an emerging field. *American Journal of Psychiatry, 168*(8), 790-799. doi:10.1176/appi.ajp.2011.10101443

King, G., Currie, M., & Petersen, P. (2014). Child and parent engagement in the mental health intervention process: A motivational framework. *Child and Adolescent Mental Health, 19*(1), 2-8. doi:10.1111/camh.12015

King, N. J., Hamilton, D. I., & Ollendick, T. H. (1988). *Children's phobias: A behavioral perspective*: John Wiley & Sons, Inc.

King, N. J., Tonge, B. J., Heyne, D., Pritchard, M., Rollings, S., Young, D., . . . Ollendick, T. H. (1998). Cognitive-behavioral treatment of school-refusing children: A controlled evaluation. *Journal of the American Academy of Child and Adolescent Psychiatry, 37*(4), 395-403. doi:10.1097/00004583-199804000-00017

Knowles, S. E., Toms, G., Sanders, C., Bee, P., Lovell, K., Rennick-Egglestone, S., . . . Bower, P. (2014). Qualitative meta-synthesis of user experience of computerised therapy for depression and anxiety. *PloS one, 9*(1), e84323. doi:10.1371/journal.pone.0084323

Kraemer, H. C., & Blasey, C. M. (2004). Centring in regression analyses: A strategy to prevent errors in statistical inference. *International journal of methods in psychiatric research, 13*(3), 141-151.

Lagattuta, K. H., Sayfan, L., & Bamford, C. (2012). Do you know how I feel? Parents underestimate worry and overestimate optimism compared to child self-report. *Journal of Experimental Child Psychology, 113*(2), 211-232. doi:10.1016/j.jecp.2012.04.001

Lahikainen, A. R., Kraav, I., Kirmanen, T., & Taimalu, M. (2006). Child-parent agreement in the assessment of young children's fears: A comparative perspective. *Journal of Cross-Cultural Psychology, 37*(1), 100-119. doi:10.1177/0022022105282298

Lang, P. J., McTeague, L. M., & Bradley, M. M. (2016). RDoC, DSM, and the reflex physiology of fear: A bio-dimensional analysis of the anxiety disorders spectrum. *Psychophysiology, 53*(3), 336-347. doi:10.1111/psyp.12462

Laska, K. M., Gurman, A. S., & Wampold, B. E. (2014). Expanding the lens of evidence-based practice in psychotherapy: A common factors perspective. *Psychotherapy, 51*(4), 467-481. doi:10.1037/a0034332

Lau, H. M., Smit, J. H., Fleming, T. M., & Riper, H. (2016). Serious games for mental health: Are they accessible, feasible, and effective? A systematic review and meta-analysis. *Frontiers in Psychiatry, 7:209*. doi:10.3389/fpsyt.2016.00209

Lavigne, J. V., Hopkins, J., Gouze, K. R., & Bryant, F. B. (2015). Bidirectional influences of anxiety and depression in young children. *Journal of Abnormal Child Psychology, 43*(1), 163-176. doi:10.1007/s10802-014-9884-7

Law, E. L. C., Kickmeier-Rust, M. D., Albert, D., & Holzinger, A. (2008). Challenges in the development and evaluation of immersive digital educational games. In A. Holzinger (Ed.), *HCI and Usability for Education and Work. USAB 2008. Lecture Notes in Computer Science* (Vol. 5298). Berlin, Heidelberg: Springer.

Lawrence, P. J., Rooke, S. M., & Creswell, C. (2017). Review: Prevention of anxiety among at-risk children and adolescents - a systematic review and meta-analysis. *Child and Adolescent Mental Health, 22*(3), 118-130. doi:10.1111/camh.12226

Lee, K., Noda, Y., Nakano, Y., Ogawa, S., Kinoshita, Y., Funayama, T., & Furukawa, T. A. (2006). Interoceptive hypersensitivity and interoceptive exposure in patients with panic disorder: Specificity and effectiveness. *Bmc Psychiatry, 6:32*. doi:10.1186/1471-244X-6-32

Lee, M. J., & Ferwerda, B. (2017). Personalizing online educational tools. Proceedings of HUMANIZE ACM Workshop on Theory-Informed User Modeling for Tailoring and Personalizing Interfaces, Cyprus, 27-30. doi: 10.1145/3039677.3039680

Lenhart, A., Kahne, J., Middaugh, E., Macgill, A. R., Evans, C., & Vitak, J. (2008, September 16). Teen, video games, and civics: Teens' gaming experiences are diverse and include significant social interaction and civic engagement [report]. Retrieved from http://www.pewinternet.org/2008/09/16/teens-video-games-and-civics/

Lewis, C. C., Simons, A. D., & Kim, H. K. (2012). The role of early symptom trajectories and pretreatment variables in predicting treatment response to cognitive behavioral therapy. *Journal of Consulting and Clinical Psychology, 80*(4), 525-534. doi:10.1037/a0029131

Lewis, C. C., Simons, A. D., Silva, S. G., Rohde, P., Small, D. M., Murakami, J. L., . . . March, J. S. (2009). The role of readiness to change in response to treatment of adolescent depression. *Journal of Consulting and Clinical Psychology, 77*(3), 422-428. doi:10.1037/a0014154

Lewis, J. R. (2014). Usability: Lessons learned ... and yet to be learned. *International Journal of Human-Computer Interaction, 30*(9), 663-684. doi:10.1080/10447318.2014.930311

Liu, C., Agrawal, P., Sarkar, N., & Chen, S. (2009). Dynamic difficulty adjustment in computer games through real-time anxiety-based affective feedback. *International Journal of Human-Computer Interaction, 25*(6), 506-529. doi:10.1080/10447310902963944

Lubke, G. H., Miller, P. J., Verhulst, B., Bartels, M., van Beijsterveldt, T., Willemsen, G., . . . Middeldorp, C. M. (2016). A powerful phenotype for gene-finding studies derived from trajectory analyses of symptoms of anxiety and depression between age seven and 18. *American Journal of Medical Genetics Part B, 171*(7), 948-957. doi:10.1002/ajmg.b.32375

Macleod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology, 95*(1), 15-20. doi:10.1037//0021-843x.95.1.15

Malone, T. W., & Lepper, M. R. (1987). Making learning fun: A taxonomy of intrinsic motivations for learning. In R. E. Snow & M. J. Farr (Eds.), *Aptitude, learning, and instruction: Vol. 3. Conative and affective process analyses* (pp. 223-253). Hillsdale, NJ: Lawrence Erlbaum Associates.

Manassis, K., Lee, T. C., Bennett, K., Zhao, X. Y., Mendlowitz, S., Duda, S., . . . Wood, J. J. (2014). Types of parental involvement in CBT with anxious youth: A preliminary meta-analysis. *Journal of Consulting and Clinical Psychology, 82*(6), 1163-1172. doi:10.1037/a0036969

Maric, M., Wiers, R. W., & Prins, P. J. M. (2012). Ten ways to improve the use of statistical mediation analysis in the practice of child and adolescent treatment research. *Clinical Child and Family Psychology Review, 15*, 177-191. doi:10.1007/s10567-012-0114-y

Mathews, B. L., Koehn, A. J., Abtahi, M. M., & Kerns, K. A. (2016). Emotional competence and anxiety in childhood and adolescence: A meta-analytic review. *Clinical Child and Family Psychology Review, 19*(2), 162-184. doi:10.1007/s10567-016-0204-3

McClintock, A. S., Anderson, T., & Petrarca, A. (2015). Treatment expectations, alliance, session positivity, and outcome: An investigation of a three-path mediation model. *Journal of Clinical Psychology, 71*(1), 41-49. doi:10.1002/jclp.22119

McGonigal, J. (2011). *Reality is broken: Why games make us better and how they can change the world*. New York, NY: Penguin Press.

McMain, S., Newman, M. G., Segal, Z. V., & DeRubeis, R. J. (2015). Cognitive behavioral therapy: Current status and future research directions. *Psychotherapy Research, 25*(3), 321-329. doi:10.1080/10503307.2014.1002440

Merry, S. N., Stasiak, K., Shepherd, M., Frampton, C., Fleming, T., & Lucassen, M. F. G. (2012). The effectiveness of SPARX, a computerised self help intervention for adolescents seeking help for depression: Randomised controlled non-inferiority trial. *British Medical Journal, 344*, e2598. doi:10.1136/bmj.e2598

Ministry of Health Welfare and Sport, & Ministry of Economic Affairs and Climate (2018). Health Deal Stimulering gezondheid door persoonlijke preventie via e-health [agreement]. Retrieved from https://www.rvo.nl/sites/default/files/2018/03/Overeenkomst_Health_Deal_Stimulering_gezondheid_door_persoonlijke_preventie_via_e-health.pdf

Morgan, A. J., Rapee, R. M., & Bayer, J. K. (2016). Prevention and early intervention of anxiety problems in young children: A pilot evaluation of Cool Little Kids Online. *Internet Interventions, 4*, 105-112. doi:10.1016/j.invent.2016.05.001

Mrazek, P. J., & Haggerty, R. J. (1994). *Reducing risks for mental disorders: Frontiers for preventive intervention research*. Washington, DC: National Academies Press.

Mueller, C. M., & Dweck, C. S. (1998). Praise for intelligence can undermine children's motivation and performance. *Journal of Personality and Social Psychology, 75*(1), 33-52. doi:10.1037/0022-3514.75.1.33

Mukolo, A., & Heflinger, C. A. (2011). Factors Associated with Attributions About Child Health Conditions and Social Distance Preference. *Community Mental Health Journal, 47*(3), 286-299. doi:10.1007/s10597-010-9325-1

Muris, P. (2001). A brief questionnaire for measuring self-efficacy in youths. *Journal of Psychopathology and Behavioral Assessment, 23*(3), 145-149. doi:10.1023/a:1010961119608

Muris, P. (2006). The pathogenesis of childhood anxiety disorders: Considerations from a developmental psychopathology perspective. *International Journal of Behavioral Development, 30*(1), 5-11. doi:10.1177/0165025406059967

Muris, P., Merckelbach, H., Mayer, B., & Prins, E. (2000). How serious are common childhood fears? *Behavior Research and Therapy, 38*(3), 217-228. doi:10.1016/s0005-7967(98)00204-6

Muris, P., Merckelbach, H., Schmidt, T., & Mayer, B. (1999). The revised version of the Screen for Child Anxiety Related Emotional Disorders (SCARED-R): Factor structure in normal children. *Personality and Individual Differences, 26*(1), 99-112. doi:10.1016/S0191-8869(98)00130-5

Muris, P., Schmidt, H., & Merckelbach, H. (2000). Correlations among two self-report questionnaires for measuring DSM-defined anxiety disorder symptoms in children: The Screen for Child Anxiety Related Emotional Disorders and the Spence Children's Anxiety Scale. *Personality and Individual Differences, 28*(2), 333-346. doi:10.1016/s0191-8869(99)00102-6

Murphy, R., & Hutton, P. (2018). Practitioner Review: Therapist variability, patient-reported therapeutic alliance, and clinical outcomes in adolescents undergoing mental health treatment - a systematic review and meta-analysis. *Journal of Child Psychology and Psychiatry, 59*(1), 5-19. doi:10.1111/jcpp.12767

Muthén, L. K., & Muthén, B. O. (1998-2012a). *Mplus User's Guide* (6th ed.). Los Angeles, CA: Muthén & Muthén.

Muthén, L. K., & Muthén, B. O. (1998-2012b). *Mplus User's Guide.* (7th ed.). Los Angeles, CA: Muthén & Muthén.

Mychailyszyn, M. P., Brodman, D. M., Read, K. L., & Kendall, P. C. (2012). Cognitive-behavioral school-based interventions for anxious and depressed youth: A meta-analysis of outcomes. *Clinical Psychology-Science and Practice, 19*(2), 129-153. doi:10.1111/j.1468-2850.2012.01279.x

Nail, J. E., Christofferson, J., Ginsburg, G. S., Drake, K., Kendall, P. C., McCracken, J. T., . . . Sakolsky, D. (2015). Academic impairment and impact of treatments among youth with anxiety disorders. *Child & Youth Care Forum, 44*(3), 327-342. doi:10.1007/s10566-014-9290-x

Nakamura, J., & Csikszentmihalyi, M. (2002). The concept of flow. In C. R. Snyder & S. J. Lopez (Eds.), *Handbook of positive psychology* (pp. 89-105). New York, NY: Oxford University Press.

Nathan, P. E., & Gorman, J. M. (2007). *A guide to treatments that work.* New York, NY: Oxford University Press.

Nauta, M. H., Scholing, A., Rapee, R. M., Abbott, M., Spence, S. H., & Waters, A. (2004). A parent-report measure of children's anxiety: Psychometric properties and comparison with child-report in a clinic and normal sample. *Behavior Research and Therapy, 42*(7), 813-839. doi:10.1016/s0005-7967(03)00200-6

Neil, A. L., Batterham, P., Christensen, H., Bennett, K., & Griffiths, K. M. (2009). Predictors of adherence by adolescents to a cognitive behavior therapy website in school and community-based settings. *Journal of Medical Internet Research, 11*(1), e6. doi:10.2196/jmir.1050

Niditch, L. A., & Varela, R. E. (2012). Perceptions of parenting, emotional self-efficacy, and anxiety in youth: Test of a mediational model. *Child Youth Care Forum, 41*, 21-35. doi:10.1007/s10566-011-9150-x

Nolan, J., & McBride, M. (2014). Beyond gamification: Reconceptualizing game-based learning in early childhood environments. *Information, Communication & Society, 17*(5), 594-608. doi:10.1080/1369118x.2013.808365

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on Psychological Science, 3*(5), 400-424. doi:10.1111/j.1745-6924.2008.00088.x

O'Neal, L. J., & Cotten, S. R. (2016). Promotive factors and psychosocial adjustment among Urban youth. *Child Youth Care Forum, 45*, 947-961. doi:10.1007/s10566-016-9364-z

O'Neil, H. F., Wainess, R., & Baker, E. L. (2005). Classification of learning outcomes: Evidence from the computer games literature. *The Curriculum Journal, 16*(4), 455-474.

Oderanti, F. O., & Li, F. (2018). Commercialization of eHealth innovations in the market of the UK healthcare sector: A framework for a sustainable business model. *Psychology & Marketing, 35*(2), 120-137. doi:10.1002/mar.21074

Odgaard-Jensen, J., Vist, G. E., Timmer, A., Kunz, R., Akl, E. A., Schunemann, H., . . . Oxman, A. D. (2011). Randomisation to protect against selection bias in healthcare trials. *Cochrane Database of Systematic Reviews*(4), MR000012. doi:10.1002/14651858.MR000012.pub3

Olson, C. K. (2010). Children's motivations for video game play in the context of normal development. *Review of General Psychology, 14*(2), 180-187. doi:10.1037/a0018984

Orji, R., Mandryk, R. L., & Vassileva, J. (2017). Improving the efficacy of games for change using personalization models. *ACM Transactions on Computer-Human Interaction, 24*(5), 1-22. doi:10.1145/3119929

Owens, M., Stevenson, J., Hadwin, J. A., & Norgate, R. (2012). Anxiety and depression in academic performance: An exploration of the mediating factors of worry and working memory. *School Psychology International, 33*(4), 433-449. doi:10.1177/0143034311427433

Pardee, C. S., Colder, C. R., & Bowker, J. C. (2014). Dynamic associations among alcohol use and anxiety symptoms in early adolescence. *Psychology of Addictive Behaviors, 28*(4), 1246-1252. doi:10.1037/a0038372

Piaggio, G., Elbourne, D. R., Pocock, S. J., Evans, S. J. W., Altman, D. G., & CONSORT Group. (2012). Reporting of noninferiority and equivalence randomized trials extension of the CONSORT 2010 statement. *Journal of the American Medical Association, 308*(24), 2594-2604. doi:10.1001/jama.2012.87802

Poppelaars, M., Tak, Y. R., Lichtwarck-Aschoff, A., Engels, R. C., Lobel, A., Merry, S. N., . . . Granic, I. (2016). A randomized controlled trial comparing two cognitive-behavioral programs for adolescent girls with subclinical depression: A school-based program (Op Volle Kracht) and a computerized program (SPARX). *Behavior Research and Therapy, 80*, 33-42. doi:10.1016/j.brat.2016.03.005

Powdthavee, N., & Vignoles, A. (2008). Mental health of parents and life satisfaction of children: A within-family analysis of intergenerational transmission of well-being. *Social Indicators Research, 88*(3), 397-422. doi:10.1007/s11205-007-9223-2

Price, J., & Budzynski, T. (2009). Anxiety, EEG patterns, and neurofeedback. In T. Budzynski, H. Kogan Budzynski, J. R. Evans, & A. Abarbanel (Eds.), *Introduction to quantitative EEG and neurofeedback: Advanced theory and applications* (pp. 453-470): Academic Press.

Priddis, L. E., Landy, S., Moroney, D., & Kane, R. (2014). An exploratory study of aggression in school-age children: Underlying factors and implications for treatment. *Australian Journal of Guidance and Counselling, 24*(1), 18-35. doi:10.1017/jgc.2013.12

Primack, B. A., Carroll, M. V., McNamara, M., Klem, M. L., King, B., Rich, M., . . . Nayak, S. (2012). Role of video games in improving health-related outcomes: A systematic review. *American Journal of Preventive Medicine, 42*(6), 630-638. doi:10.1016/j.amepre.2012.02.023

Raad voor Volksgezondheid en Samenleving (2017). Implementatie van e-health vraagt om durf en ruimte [Publication 17-01, advisory letter]. Retrieved from https://www.raadrvs.nl/uploads/docs/Briefadvies_over_de_implementatie_van_e-health.pdf

Ramsawh, H. J., & Chavira, D. A. (2016). Association of childhood anxiety disorders and quality of life in a primary care sample. *Journal of Developmental and Behavioral Pediatrics, 37*(4), 269-276. doi:10.1097/DBP.0000000000000296

Rapee, R. M. (2002). The development and modification of temperamental risk for anxiety disorders: Prevention of a lifetime of anxiety? *Biological Psychiatry, 52*, 947–957. doi:10.1016/S0006-3223(02)01572-X

Rasing, S. P. A., Creemers, D. H. M., Janssens, J., & Scholte, R. H. J. (2017). Depression and anxiety prevention based on cognitive behavioral therapy for at-risk adolescents: A meta-analytic review. *Frontiers in Psychology, 8*:1066. doi:10.3389/fpsyg.2017.01066

Rasing, S. P. A., Creemers, D. H. M., Vermulst, A. A., Janssens, J., Engels, R., & Scholte, R. H. J. (2018). Outcomes of a randomized controlled trial on the effectiveness of depression and anxiety prevention for adolescents with a high familial risk. *International Journal of Environmental Research and Public Health, 15*(7), 1457. doi:10.3390/ijerph15071457

Reinholdt-Dunne, M. L., Mogg, K., & Bradley, B. P. (2013). Attention control: Relationships between self-report and behavioral measures, and symptoms of anxiety and depression. *Cognition and Emotion, 27*(3), 430-440. doi:10.1080/02699931.2012.715081

Rickwood, D. J., Deane, F. P., & Wilson, C. J. (2007). When and how do young people seek professional help for mental health problems? *The Medical Journal of Australia, 187*(7), S35-S39.

Rideout, V. J., Foehr, U. G., & Roberts, D. F. (2010, January). Generation M2: Media in the lives of 8-to 18-year-olds [report]. Retrieved from https://kaiserfamilyfoundation.files.wordpress.com/2013/04/8010.pdf

Rijkeboer, M. M., & Van den Hout, M. A. (2014). Nieuwe inzichten over exposure. *Gedragstherapie, 47*(1), 2-19.

Ritterfeld, U., Cody, M., & Vorderer, P. (2009). *Serious games: Mechanisms and effects*. New York, NY: Routledge.

Russoniello, C. V., O'Brien, K., & Parks, J. M. (2009). EEG, HRV, and psychological correlates while playing Bejeweled II: A randomized controlled study. *Annual Review of CyberTherapy and Telemedicine, 7*, 189-192.

Russoniello, C. V., O'Brien, K., & Parks, J. M. (2009). The effectiveness of casual video games in improving mood and decreasing stress. *Journal of Cyber Therapy and Rehabilitation, 2*(1), 53-66.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*(1), 68-78. doi:10.1037//0003-066x.55.1.68

Ryan, R. M., Rigby, C. S., & Przybylski, A. (2006). The motivational pull of video games: A self-determination theory approach. *Motivation and Emotion, 30*(4), 347-363. doi:10.1007/s11031-006-9051-8

Salloum, A., Johnco, C., Lewin, A. B., McBride, N. M., & Storch, E. A. (2016). Barriers to access and participation in community mental health treatment for anxious children. *Journal of Affective Disorders, 196*, 54-61. doi:10.1016/j.jad.2016.02.026

Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. *Journal of Risk and Uncertainty, 1*, 7-59. doi:10.1007/BF00055564

Schafer, J. L. (1997). *Analysis of incomplete multivariate data*. London: Chapman & Hall/CRC.

Schleider, J., & Weisz, J. (2018). A single-session growth mindset intervention for adolescent anxiety and depression: 9-month outcomes of a randomized trial. *Journal of Child Psychology and Psychiatry, 59*(2), 160-170. doi:10.1111/jcpp.12811

Scholten, H., & Granic, I. (2018). *Using principles of design thinking to address limitations of digital mental health interventions for youth.* Manuscript in preparation.

Scholten, H., Malmberg, M., Lobel, A., Engels, R. C., & Granic, I. (2016). A randomized controlled trial to test the effectiveness of an immersive 3D video game for anxiety prevention among adolescents. *PloS one, 11*(1), e0147763. doi:10.1371/journal.pone.0147763

Schoneveld, E. A., Lichtwarck-Aschoff, A., & Granic, I. (2018). Preventing childhood anxiety disorders: Is an applied game as effective as a cognitive behavioral therapy-based program? *Prevention Science, 19*(2), 220-232. doi:10.1007/s11121-017-0843-8

Schoneveld, E. A., Malmberg, M., Lichtwarck-Aschoff, A., Verheijen, G. P., Engels, R. C. M. E., & Granic, I. (2016). A neurofeedback video game (*MindLight*) to prevent anxiety in children: A randomized controlled trial. *Computers in Human Behavior, 63*, 321-333. doi:10.1016/j.chb.2016.05.005

Schulz, K. F., Altman, D. G., Moher, D., & CONSORT Group. (2010). CONSORT 2010 Statement: Updated guidelines for reporting parallel group randomised trials. *Plos Medicine, 7*(3), e1000251. doi:10.1371/journal.pmed.1000251

Schuurmans, A. A. T., Nijhof, K. S., Engels, R. C. M. E., & Granic, I. (2017). Using a videogame intervention to reduce anxiety and externalizing problems among youth in residential care: An initial randomized controlled trial. *Journal of Psychopathology and Behavioral Assessment*. *40*(2), 344-354. doi:10.1007/s10862-017-9638-2

Selig, J. P., & Preacher, K. J. (2009). Mediation models for longitudinal data in developmental research. *Research in Human Development, 6*(2-3), 144-164. doi:10.1080/15427600902911247

Shafran, R., & Bennett, S. D. (2017). Commentary: All that glisters is not gold - reflections on Hollis et al. 2017. *Journal of Child Psychology and Psychiatry, 58*(4), 504-506. doi:10.1111/jcpp.12715

Sheeran, P., Maki, A., Montanaro, E., Avishai-Yitshak, A., Bryan, A., Klein, W. M., . . . Rothman, A. J. (2016). The impact of changing attitudes, norms, and self-efficacy on health-related intentions and behavior: A meta-analysis. *Health Psychology, 35*(11), 1178-1188. doi:10.1037/hea0000387

Shute, V. J., Ventura, M., & Ke, F. (2015). The power of play: The effects of Portal 2 and Lumosity on cognitive and noncognitive skills. *Computers & Education, 80*, 58-67. doi:10.1016/j.compedu.2014.08.013

Slone, M., Meir, Y., & Tarrasch, R. (2013). Individual differences in referral for help for severe emotional difficulties in adolescence. *Children and Youth Services Review, 35*(11), 1854-1861. doi:10.1016/j.childyouth.2013.08.011

Spence, S. H. (1997). Structure of anxiety symptoms among children: A confirmatory factor-analytic study. *Journal of Abnormal Psychology, 106*(2), 280-297. doi:10.1037//0021-843x.106.2.280

Spence, S. H. (1998). A measure of anxiety symptoms among children. *Behavior Research and Therapy, 36*(5), 545-566. doi:10.1016/s0005-7967(98)00034-5

Spence, S. H. (2013, December 10). T-Scores. Retrieved from https://www.scaswebsite.com/index.php?p=1_9

Stice, E., Rohde, P., Seeley, J. R., & Gau, J. M. (2010). Testing mediators of intervention effects in randomized controlled trials: An evaluation of three depression prevention programs. *Journal of Consulting and Clinical Psychology, 78*(2), 273-280. doi:10.1037/a0018396

Stockings, E. A., Degenhardt, L., Dobbins, T., Lee, Y. Y., Erskine, H. E., Whiteford, H. A., & Patton, G. (2016). Preventing depression and anxiety in young people: A review of the joint efficacy of universal, selective and indicated prevention. *Psychological Medicine, 46*(1), 11-26. doi:10.1017/S0033291715001725

Stone, L. L., Otten, R., Engels, R. C. M. E., Vermulst, A. A., & Janssens, J. M. A. M. (2010). Psychometric properties of the parent and teacher versions of the Strengths and Difficulties Questionnaire for 4- to 12-year-olds: A review. *Clinical Child and Family Psychology Review, 13*(3), 254-274. doi:10.1007/s10567-010-0071-2

Swinkels, I. C. S., Huygens, M. W. J., Schoenmakers, T. M., Oude Nijeweme-D'Hollosy, W., van Velsen, L., Vermeulen, J., . . . de Witte, L. (2018). Lessons learned from a living lab on the broad adoption of eHealth in primary health care. *Journal of Medical Internet Research, 20*(3), e83. doi:10.2196/jmir.9110

Tak, Y. R., Kleinjan, M., Lichtwarck-Aschoff, A., & Engels, R. C. M. E. (2014). Secondary outcomes of a school-based universal resiliency training for adolescents: A cluster randomized controlled trial. *Bmc Public Health, 14:1177*. doi:10.1186/1471-2458-14-1171

Tanaka, J. W., Wolf, J. M., Klaiman, C., Koenig, K., Cockburn, J., Herlihy, L., . . . Schultz, R. T. (2010). Using computerized games to teach face recognition skills to children with autism spectrum disorder: The Let's Face It! program. *Journal of Child Psychology and Psychiatry, 51*(8), 944-952. doi:10.1111/j.1469-7610.2010.02258.x

Taylor, S., Abramowitz, J. S., & McKay, D. (2012). Non-adherence and non-response in the treatment of anxiety disorders. *Journal of Anxiety Disorders, 26*(5), 583-589. doi:10.1016/j.janxdis.2012.02.010

Teubert, D., & Pinquart, M. (2011). A meta-analytic review on the prevention of symptoms of anxiety in children and adolescents. *Journal of Anxiety Disorders, 25*(8), 1046-1059. doi:10.1016/j.janxdis.2011.07.001

Thorne, K. J., Andrews, J. J., & Nordstokke, D. (2013). Relations among children's coping strategies and anxiety: The mediating role of coping efficacy. *The Journal of General Psychology, 140*(3), 204-223. doi:10.1080/00221309.2013.792235

Van der Heiden, C. (2011). Protocollaire behandeling van patiënten met een gegeneraliseerde angststoornis. In G. P. J. Keijsers, A. Van Minnen, & C. A. L. Hoogduin (Eds.), *Protocollaire behandelingen voor volwassenen met psychische klachten 1*. Amsterdam, Netherlands: Uitgeverij Boom.

van Elk, M., Rutjens, B. T., & van der Pligt, J. (2015). The development of the illusion of control and sense of agency in 7- to-12-year old children and adults. *Cognition, 145*, 1-12. doi:10.1016/j.cognition.2015.08.004

van Starrenburg, M. L. A., Kuijpers, R. C., Kleinjan, M., Hutschemaekers, G. J., & Engels, R. C. (2017). Effectiveness of a cognitive behavioral therapy-based indicated prevention program for children with elevated anxiety levels: A randomized controlled trial. *Prevention Science, 18*(1), 31-39. doi:10.1007/s11121-016-0725-5

Vandervord Nixon, R. D., Sterk, J., & Pearce, A. (2012). A randomized trial of cognitive behavior therapy and cognitive therapy for children with posttraumatic stress disorder following single-incident trauma. *Journal of Abnormal Child Psychology, 40*(3), 327-337. doi:10.1007/s10802-011-9566-7

Vogel, J. J., Vogel, D. S., Cannon-Bowers, J., Bowers, C. A., Muse, K., & Wright, M. (2006). Computer gaming and interactive simulations for learning: A meta-analysis. *Journal of Educational Computing Research, 34*(3), 229-243.

Wampold, B. E., Mondin, G. W., Moody, M., Stich, F., Benson, K., & Ahn, H. (1997). A meta-analysis of outcome studies comparing bona fide psychotherapies: Empirically, "all must have prizes". *Psychological Bulletin, 122*(3), 203-215. doi:10.1037/0033-2909.122.3.203

Weems, C. F., & Scheeringa, M. S. (2013). Maternal depression and treatment gains following a cognitive behavioral intervention for posttraumatic stress in preschool children. *Journal of Anxiety Disorders, 27*, 140-146. doi:10.1016/j.janxdis.2012.11.003

Weerdmeester, J., Cima, M., Granic, I., Hashemian, Y., & Gotsis, M. (2016). A feasibility study on the effectiveness of a full-body videogame intervention for decreasing attention deficit hyperactivity disorder symptoms. *Games for Health Journal, 5*(4), 258-269. doi:10.1089/g4h.2015.0103

Weisz, J. R., & Kazdin, A. E. (2010). *Evidence-based psychotherapies for children and adolescents*. New York, NY: Guilford Press.

Wells, K., Klap, R., Koike, A., & Sherbourne, C. (2001). Ethnic disparities in unmet need for alcoholism, drug abuse, and mental health care. *American Journal of Psychiatry, 158*(12), 2027-2032. doi:10.1176/appi.ajp.158.12.2027

Werner-Seidler, A., Perry, Y., Calear, A. L., Newby, J. M., & Christensen, H. (2017). School-based depression and anxiety prevention programs for young people: A systematic review and meta-analysis. *Clinical Psychology Review, 51*, 30-47. doi:10.1016/j.cpr.2016.10.005

White, K. S., Payne, L. A., Gorman, J. M., Shear, M. K., Woods, S. W., Saksa, J. R., & Barlow, D. H. (2013). Does maintenance CBT contribute to long-term treatment response of panic disorder with or without agoraphobia? A randomized controlled clinical trial. *Journal of Consulting and Clinical Psychology, 81*(1), 47-57. doi:10.1037/a0030666

Whiteside, S. P. H., Ale, C. M., Young, B., Dammann, J. E., Tiede, M. S., & Biggs, B. K. (2015). The feasibility of improving CBT for childhood anxiety disorders through a dismantling study. *Behavior Research and Therapy, 73*, 83-89. doi:10.1016/j.brat.2015.07.011

Whiteside, S. P. H., & Brown, A. M. (2008). Exploring the utility of the Spence Children's Anxiety Scales parent- and child-report forms in a North American sample. *Journal of Anxiety Disorders, 22*(8), 1440-1446. doi:10.1016/j.janxdis.2008.02.006

Wijnhoven, L. A. M. W., Creemers, D. H. M., Engels, R. C. M. E., & Granic, I. (2015). The effect of the video game Mindlight on anxiety symptoms in children with an Autism Spectrum Disorder. *Bmc Psychiatry, 15:138*. doi:10.1186/s12888-015-0522-x

Wijnhoven, L. A. M. W., Creemers, D. H. M., Vermulst, A., Engels, R. C. M. E., & Granic, I. (2017). *Randomized controlled trial testing the effect of the video game 'Mindlight' on anxiety of children with an autism spectrum disorder*, Manuscript in preparation.

Wols, A., Lichtwarck-Aschoff, A., Schoneveld, E. A., & Granic, I. (2018). In-game play behaviors during an applied video game for anxiety prevention predict successful intervention outcomes. *Journal of Psychopathology and Behavioral Assessment*. doi:10.1007/s10862-018-9684-4

Woodward, L. J., & Fergusson, D. M. (2001). Life course outcomes of young people with anxiety disorders in adolescence. *Journal of the American Academy of Child and Adolescent Psychiatry, 40*(9), 1086-1093. doi:10.1097/00004583-200109000-00018

World Health Organization (2012). Making health services adolescent friendly: Developing national quality standards for adolescent-friendly health services [report]. Retrieved from http://apps.who.int/iris/bitstream/10665/75217/1/9789241503594_eng.pdf

Yee, N. (2006). Motivations for play in online games. *Cyberpsychology & Behavior, 9*(6), 772-775. doi:10.1089/cpb.2006.9.772

Zhang, X., Guo, X., Wu, Y., Lai, K.-h., & Vogel, D. (2017). Exploring the inhibitors of online health service use intention: A status quo bias perspective. *Information & Management, 54*(8), 987-997. doi:10.1016/j.im.2017.02.001

APPENDIX

Nederlandse samenvatting

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Angststoornissen zijn de meest voorkomende psychische problemen in de kindertijd. Eén op de vijf kinderen heeft last van verhoogde angstklachten. Angstsymptomen en de bijkomende negatieve gevolgen zoals depressieve klachten, verminderde sociale contacten en slechtere schoolprestaties pleiten voor effectieve preventieprogramma's. Om de last die kinderen ervaren van angstsymptomen te verminderen, is het belangrijk dat preventieprogramma's toegankelijk en aantrekkelijk zijn. Applied games bieden een middel om evidence-based preventieve technieken aan te reiken en ze zijn tegelijkertijd toegankelijk en aantrekkelijk. Onderzoek laat de potentie van applied games zien. Inhoudelijk zijn applied games echter beperkt en er zijn beperkingen in het onderzoek naar deze games. De studies beschreven in het huidige proefschrift hadden tot doel deze beperkingen aan te pakken. Specifiek zijn hierbij de werkzaamheid en motiverende kenmerken van de applied game MindLight voor kinderen met angstproblemen onderzocht.

MindLight

In hoofdstuk 2, 3 en 4 van dit proefschrift wordt het onderzoek naar de werkzaamheid van MindLight als angstpreventieprogramma beschreven. MindLight is ontwikkeld door een team van onderzoekers - met expertise op het gebied van ontwikkelingspsychopathologie en werkzame interventies - en professionele game-ontwikkelaars. Dit team werkte samen met clinici en kinderen, wat resulteerde in een aantrekkelijk en boeiend computerspel met evidence-based technieken. MindLight heeft tot doel kinderen met angstklachten te leren om hun angstgevoelens beter te kunnen reguleren. Zo ontstond er een gamewereld die (enige) angst oproept, zodat kinderen konden oefenen om weer rustiger te worden.

Het verhaal van MindLight begint met een jongetje genaamd Arty die door zijn ouders bij zijn oma wordt achtergelaten. Kwaadaardige krachten hebben echter bezitgenomen van oma en haar huis, dat veranderd is in een donker en eng huis. Het is Arty's taak om zijn oma te redden door het huis weer licht te maken. In zijn slaapkamer vindt Arty een muts met een lamp eraan, die licht (d.w.z., mindlight) schijnt. Door Arty en de lichtgevende muts te besturen met een spelcomputer controller gaan kinderen op zoek naar verborgen munten, waarmee ze aandachtspuzzels ontgrendelen. Als deze puzzels opgelost zijn, wordt een kamer weer licht. Volg de link in de voetnoot voor een video.[1]

In het spel zijn evidence-based technieken vertaald naar game elementen. De eerste evidence-based techniek in MindLight is exposure (d.w.z., blootstelling), het meest gevalideerde element van conventionele angstbehandelingen. In MindLight worden kinderen voortdurend blootgesteld aan de angstaanjagende gamewereld, met zijn donkere kamers en aanvallende

1 https://youtu.be/buNaErarLts

monsters. Om het spel te kunnen vervolgen, moeten kinderen naar deze monsters toe lopen met Arty, in plaats van deze te vermijden. Als ze met de mindlight in de ogen van de monsters schijnen, gaan ze opzij. Verder moeten kinderen de mindlight gebruiken om angstaanjagende objecten te onthullen. Deze objecten blijken vervolgens normale objecten te zijn en bevatten de verborgen munten. Hoe rustiger kinderen blijven, hoe feller de mindlight schijnt en hoe beter het lukt om de monsters te verslaan en de objecten te onthullen. Kinderen ervaren door deze herhaaldelijke blootstelling uiteindelijk dat de angstaanjagende omgeving veilig is en dat het angstgevoel dragelijk is.

De tweede evidence-based techniek in MindLight is aandachtsbias modificatie (ABM), een techniek dat tot doel heeft een hyperaandacht op mogelijke bedreigingen te verminderen. In MindLight moeten kinderen herhaaldelijk snel hun aandacht richten op lachende gezichten tussen verschillende angstaanjagende gezichten. Wanneer zij zo'n aandachtpuzzel oplossen, worden kinderen beloond met een verlichte kamer en het verdwijnen van monsters.

De laatste evidence-based techniek is neurofeedback, waarbij kinderen een real-time visuele voorstelling krijgen van hun hersengolven. Tijdens het spelen van MindLight dragen kinderen een headset, die de hersengolven meet en omzet in ontspanning- en focuswaarden. Deze waarden worden vervolgens gebruikt als input voor respectievelijk 'mindlight' en 'mindbeam'. Hoe meer ontspannen kinderen zijn, hoe meer licht hun muts schijnt. Mindbeam is een straal tussen de muts en de gezichten van de aandachtspuzzels. Hoe meer gefocust kinderen zijn, hoe sneller ze de puzzels oplossen. Deze drie technieken vormen samen met het verhaal de applied game MindLight.

Werkzaamheid van MindLight

In dit proefschrift worden twee studies naar de werkzaamheid van MindLight beschreven. Beide studies hebben een gelijke opzet, zoals te lezen in hoofdstuk 2 (studie 1) en hoofdstuk 4 (studie 2). In totaal werden per studie meer dan 750 kinderen uit groep 5 tot en met 8 (7 – 13 jaar oud) gescreend op verhoogde angstklachten met een vragenlijst die kinderen zelf hadden ingevuld. Kinderen met verhoogde angstklachten werden uitgenodigd om deel te nemen aan de studie. Uiteindelijk zijn respectievelijk 136 en 174 geselecteerde kinderen willekeurig ingedeeld in de MindLightgroep of de controlegroep. Kinderen in de controlegroep speelden het commerciële computerspel Max and the Magic Marker (studie 1) of namen deel aan een angstpreventieprogramma gebaseerd op cognitieve gedragstherapie (CGT; studie 2). CGT is de meeste effectieve therapie voor kinderen met angstklachten. De bijeenkomsten van alle kinderen waren op school, na schooltijd. In de eerste studie waren er vijf bijeenkomsten van één uur, twee keer per week. In de tweede studie waren de bijeenkomsten één keer per week. Kinderen in de MindLightgroep hadden zes bijeenkomsten van één uur. Kinderen in de CGT-groep hadden twee bijeenkomsten van anderhalf uur en zes bijeenkomsten van één

uur. Hiernaast hebben alle kinderen en hun ouders vragenlijsten ingevuld voorafgaand, na afloop, en op 3 en 6 (alleen studie 2) maanden na afloop van MindLight, Max of CGT. In deze vragenlijsten werd gevraagd naar angstklachten (beide studies), internaliserende problemen (zoals emotionele symptomen en problemen in de sociale relatie met gelijken), externaliserende problemen (zoals gedragsproblemen, hyperactiviteit en aandacht tekort), en zelfeffectiviteit (alleen studie 2; nauw gerelateerd aan zelfvertrouwen).

Uit de resultaten bleek dat de angstklachten van kinderen afnamen over tijd (zie hoofdstuk 2 en 3). Dit geldt voor zowel de angstklachten gerapporteerd door kinderen zelf als door hun ouders. De afname van angstklachten was bij alle kinderen even groot; er was geen verschil in afname tussen de MindLight- en de controlegroepen. Er is daarnaast onderzocht of MindLight meer werkzaam is voor specifieke groepen jongeren. MindLight was echter even werkzaam voor zowel jongens als meisjes, en voor jongere en oudere kinderen, voor kinderen die veel computerspellen speelden en weinig, en voor kinderen die hoge en minder hoge verwachtingen hadden (zie hoofdstuk 2 en 3). De resultaten met betrekking tot internaliserende problemen, externaliserende problemen en zelfeffectiviteit worden besproken in hoofdstuk 4. Internaliserend en externaliserende problemen, gerapporteerd door moeders, bleken te zijn afgenomen over tijd en zelfeffectiviteit was toegenomen. De afname in problemen en de toename in zelfeffectiviteit waren in de MindLightgroep even groot als in de CGT-groep. Daarnaast is onderzocht of de mentale gezondheid van moeders of kinderen de werkzaamheid van MindLight beïnvloed. Dit bleek niet het geval te zijn. Internaliserende problemen, externaliserende problemen, mentale gezondheid van moeders, en angst en zelfeffectiviteit van kinderen waren niet gerelateerd aan de afname in angstklachten.

Verwacht werd dat MindLight meer werkzaam zou zijn dan Max en even werkzaam zou zijn als CGT. Een verklaring voor het uitgebleven verschil tussen de groepen kan liggen in de verwachtingen van de kinderen en hun ouders met betrekking tot het effect van de programma's. Omdat verwachtingen een rol zouden kunnen spelen in de effecten van preventieprogramma's, zijn de verwachtingen gelijk gemaakt aan het begin van het onderzoek. Hierdoor zouden kinderen *geprimed* kunnen zijn met een angstreductie verwachting, wat geleid kan hebben tot de gerapporteerde afname in angstklachten. Daarnaast zou motivatie voor verandering een verklaring kunnen zijn voor de afname van angst in beide groepen. De kinderen in de studie zijn mogelijk gemotiveerd om MindLight en Max te spelen en om aan CGT deel te nemen, omdat ze geloofden dat ze zich daardoor beter zouden voelen. Als ze inderdaad deze verbetering in stemming ervoeren, zou hun vertrouwen in het reguleren van hun eigen angst versterkt kunnen zijn.

Naast deze non-specifieke factoren – verwachtingen en motivatie – zouden specifieke factoren gerelateerd aan computerspellen een rol kunnen spelen in de verbeteringen in zowel de MindLight als Max groep. Ten eerste trainen computerspellen veerkracht bij mislukking.

Game ontwikkelaars verleiden spelers om een uitdaging telkens opnieuw aan te gaan. Dit zou de kinderen in de studie een gevoel van macht en controle gegeven kunnen hebben. Vervolgens zou dit samen kunnen hangen met de afname in angstklachten. Ten tweede zorgen computerspellen voor korte-termijn afleiding, bijvoorbeeld als kinderen aan het piekeren zijn. MindLight en Max zouden voor een onderbreking in dit piekeren gezorgd kunnen hebben en vervolgens in een minder angstige stemming.

Motiverende Kenmerken van MindLight

Naast de werkzaamheid van MindLight zijn ook de motiverende kenmerken van de game onderzocht om inzicht te krijgen in hoe kinderen MindLight ervaren hebben. We hebben deze kenmerken onderzocht met vragenlijsten (zie hoofdstuk 2 en 3) en groepsinterviews (zie hoofdstuk 5). Op de vragenlijst konden de kinderen MindLight beoordelen op verschillende aspecten. Een vergelijking van de beoordeling van MindLight met de beoordeling van Max en CGT laat zien dat MindLight qua moeilijkheid gelijk scoorde met Max en CGT. Verder gaven kinderen aan MindLight als even relevant als Max ervaren te hebben en even interessant en angstaanjagend als CGT. Daarnaast werd MindLight als minder interessant beoordeeld dan Max. Resultaten met betrekking tot de vergelijking van MindLight met Max op de aspecten interessant voor anderen, angstaanjagendheid en flow verschilden per meetmoment. Het enige verschil tussen MindLight en CGT is gevonden op het aspect relevantie. Op de nameting en 3-maanden follow-up beoordeelden kinderen CGT als relevanter, maar dit verschil verdween 6 maanden na de laatste bijeenkomst.

De resultaten van de groepsinterviews waren in overeenstemming met de beoordeling uit de vragenlijst. Kinderen gaven aan dat ze de *look and feel* van MindLight leuk vonden en zeiden dat de game angstaanjagend was, zoals de bedoeling was. Uitdaging en controle waren de meest belangrijke motiverende kenmerken voor de kinderen. Op basis van theorie wordt gesteld dat doelen, onzekerheid over een uitkomst en feedback bijdragen aan een optimaal niveau van uitdaging. De meeste kinderen hadden het doel van MindLight helder. Onzekerheid over een uitkomst bleek bij moeilijke opdrachten te groot te zijn. Zo gaven kinderen bijvoorbeeld aan dat sommige munten te moeilijk te vinden waren. Daarnaast vonden sommige kinderen het feedbackmechanisme in combinatie met hun staat van ontspanning en concentratie verwarrend. Het was niet voor alle kinderen duidelijk dat hun staat van ontspanning gevisualiseerd werd in de vorm van licht en hun staat van concentratie in de vorm van een straal.

Uit onderzoek blijkt dat congruentie, keuze en macht belangrijk zijn voor een optimaal niveau van het gevoel van controle. Kinderen ervoeren niet altijd congruentie tussen hun gedrag en de uitkomt. Een jongen gaf bijvoorbeeld aan dat het schijnen van zijn mindlight niet altijd leidde tot het verdwijnen van een monster. De mogelijkheid om zelf de route door het huis te bepalen zorgde ervoor dat kinderen routes namen die pasten bij hun behoeften. Een jongen maakte

de vergelijking met eten: "Als je het vieste eerst opeet, bewaar je het lekkerste voor het laatste." Verder leken kinderen in beperkte mate het gevoel van power te ervaren, wat bleek uit hun suggesties om elementen toe te voegen aan de game die de avatar machtiger maken, zoals de mogelijkheid om te rennen, stompen en schieten.

Deze resultaten met betrekking tot de motiverende kenmerken van MindLight laten ten eerste zien dat kinderen het spel leuk vonden en verschillende emoties ervoeren. Door meer luchtige speelmomenten toe te voegen, zoals bijvoorbeeld het stuiteren van een grote bal in een lichte kamer zonder monsters, zouden kinderen een ontspanningsmoment kunnen hebben. Op dit moment licht de nadruk binnen het spel minder op het ervaren van positieve emoties. Ten tweede was het optimale niveau van uitdaging één van de belangrijkste thema's. Een manier om dit niveau te optimaliseren is het aanpassen van de opdrachten in MindLight aan de individuele prestatie van de speler. Als een speler bijvoorbeeld angstaanjagende objecten snel onthult, zouden deze objecten nog angstaanjagender gemaakt kunnen worden door bijvoorbeeld geluid en *artwork* aan te passen. Als laatste was keuze het belangrijkste kenmerk van controle. Keuzemogelijkheden met betrekking tot bijvoorbeeld moeilijkheidsgraad en het uiterlijk van de avatar zouden uitgebreid kunnen worden. Deze aanpassingen op het gebied van uitdaging en controle zouden de betrokkenheid van de spelers met MindLight en het effect van het spel kunnen verhogen.

Conclusie

Het huidige proefschrift is één van de eersten die onderzoek doet naar de werkzaamheid en motiverende kenmerken van een applied game voor kinderen met verhoogde angstklachten. De resultaten laten zien dat MindLight een effectief angstpreventieprogramma kan zijn. Na het spelen verbetert angst, zelfeffectiviteit, en internaliserende en externaliserende problemen. Deze game kan de mentale gezondheid van kinderen verbeteren, ongeacht de potentiële mentale gezondheidsproblemen die kinderen of hun ouders aan het begin van het programma kunnen hebben. Gezien deze veelbelovende resultaten zou MindLight een alternatief kunnen zijn voor conventionele angstpreventieprogramma's. Door de *toolbox* met effectieve interventies voor kinderen met angstproblemen uit te breiden, krijgen zij de mogelijkheid om het programma te kiezen dat het beste bij hen past. Kinderen vonden MindLight leuk en waren betrokken. Tegelijkertijd hadden de kinderen ook suggesties voor verbeteringen. Zowel het betrekken van kinderen als het integreren van onderzoeken met ontwerpprocessen kan een waardevolle benadering zijn voor toekomstige game ontwikkelaars. Kinderen, game ontwikkelaars, geestelijke gezondheidszorg professionals en onderzoekers kunnen samen het potentieel van applied games voor geestelijke gezondheidszorg benutten en het leven van kinderen van vandaag en adolescenten van morgen verbeteren.

APPENDIX

Dankwoord

Dankwoord

Ik heb de finish bereikt! De Vierdaagse loop je niet alleen. Bedankt voor jullie steun tijdens deze honderdzestig kilometer.

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APPENDIX

Curriculum Vitae

Curriculum Vitae

Elke Schoneveld was born June 5th 1989 and grew up in Harfsen, the Netherlands. She completed her secondary education at Staring College Lochem. In 2007, she started her Bachelor Psychology at Radboud University in Nijmegen. Between her Bachelor and Master, Elke went to Glasgow University, Scotland, for five months to study Psychology. In 2013, she completed the Research Master Behavioural Science and started her PhD project on the applied game MindLight for children with anxiety problems at the Behavioural Science Institute, Radboud University. During the first year of her PhD project, she completed her Master in Mental Health Psychology with an internship as child psychologist at an outpatient clinic (Radboud Ambulatorium). She combined research with this clinical work during the second year of her PhD project. In her PhD project, she coordinated the data collection and evaluation of the applied game MindLight. In two randomized controlled trials, she investigated the efficacy of MindLight as indicated prevention program for children with elevated levels of anxiety. With focus group interviews, she examined the motivational characteristics of MindLight. She presented her results on several national and international conferences, including Schoolpsychologencongres, Jeugd in Onderzoek congres, Games for Health Europe, Special Topic Meeting on Technology and Media in Children's Development of the Society for Research in Child Development (SRCD), European Association for Behavioural and Cognitive Therapies (EABCT), and International Convention of Psychological Science (ICPS). Furthermore, she published her work in international journals, including Computers in Human Behavior and Prevention Science. Next to doing research, she has supervised several Master students with their thesis, and was a teacher in a course on psychological research. At the moment, she is a teacher at the University of Amsterdam in courses on clinical topics and academic skills and she works as a psychologist in an outpatient clinic for adults with psychological problems (Indigo Gelderland).

APPENDIX

Publications

Publications

Publications included in the current thesis

Schoneveld, E. A., Malmberg, M., Lichtwarck-Aschoff, A., Verheijen, G. P., Engels, R. C., & Granic, I. (2016). A neurofeedback video game (MindLight) to prevent anxiety in children: A randomized controlled trial. *Computers in Human Behavior*, *63*, 321-333. doi: 10.1016/j.chb.2016.05.005

Schoneveld, E. A., Lichtwarck-Aschoff, A., & Granic, I. (2018). Preventing childhood anxiety disorders: is an applied game as effective as a cognitive behavioral therapy-based program?. *Prevention Science, 19*(2), 220-232. doi: 10.1007/s11121-017-0843-8

Schoneveld, E. A., Lichtwarck-Aschoff, A., & Granic, I. (2018). What keeps them motivated? Children's views on an applied game for anxiety. *Entertainment Computing*. doi:10.1016/j.entcom.2018.12.003

Manuscripts submitted for publication

Schoneveld, E. A., Lichtwarck-Aschoff, A., Otten, R., & Granic, I. Mental health outcomes of an applied game for children with elevated anxiety symptoms: A randomized controlled non-inferiority trial. *Journal of Child and Family Studies.*

Other publications

van Den Broek, N., Deutz, M. H., Schoneveld, E. A., Burk, W. J., & Cillessen, A. H. (2016). Behavioral correlates of prioritizing popularity in adolescence. *Journal of Youth and Adolescence, 45*(12), 2444-2454. doi: 10.1007/s10964-015-0352-7

Wols, A., Lichtwarck-Aschoff, A., Schoneveld, E. A., & Granic, I. (2018). In-game play behaviours during an applied video game for anxiety prevention predict successful intervention outcomes. *Journal of Psychopathology and Behavioral Assessment*, 40: 65. doi: 10.1007/s10862-018-9684-4