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Cognitive Bias Modification for adolescents with substance use problems – Can serious games help?

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ABSTRACT

Background and Objectives: Excessive use of psychoactive substances and resulting disorders are a major societal problem, and the most prevalent mental disorder in young men. Recent reviews have concluded that Cognitive Bias Modification (CBM) shows promise as an intervention method in this field. As adolescence is a critical formative period, successful early intervention may be key in preventing later substance use disorders that are difficult to treat. One issue with adolescents, however, is that they often lack the motivation to change their behavior, and to engage in multisession cognitive training programs. The upcoming use of *serious games for health* may provide a solution to this motivational challenge.

Methods: As the use of game-elements in CBM is fairly new, there are very few published studies in this field. This review therefore focuses on currently available evidence from similar fields, such as cognitive training, as well as several ongoing CBM gamification projects, to illustrate the general principles.

Results: A number of steps in the gamification process are identified, starting with the original, evidence-based CBM task, towards full integration in a game. While more data is needed, some steps seem better suited for CBM gamification than others. Based on the current evidence, several recommendations are made.

Limitations: As the field is still in its infancy, further research is needed before firm conclusions can be drawn.

Conclusions: Gamified CBM may be a promising way to reach at risk youth, but the term “game” should be used with caution. Suggestions are made for future research.

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1. Introduction

Alcohol- and drug misuse among adolescents pose a major societal problem. They predict school dropout and academic under-performance (Singleton, 2007; Wood, Sher, & McGowan, 2000) and, as they are relatively likely to escalate into more problematic use (Thatcher & Clark, 2008), may ultimately lead to later addiction problems. There are indications that young binge drinkers (i.e., adolescents who consume large amounts of alcohol, e.g., more than five drinks, within a short time period) are likely to develop atypical reactions to alcohol, which is reflected in their enhanced cue-reactivity (e.g., Tapert et al., 2003) and reduced ability to perform in executive cognitive tasks (Duka et al., 2004; Maurage et al., 2012). Similar neuroadaptations have been found for other popular substances in youth such as cannabis (e.g., Cousijn et al., 2012;

2013). As such, successful intervention during adolescence may help to prevent cognitive decline and substance use disorders later on. Several interventions exist that aim to persuade adolescents to abstain from or regulate their substance use. We can distinguish between explicit and implicit interventions. For example, explicit warning messages about the dangers of substance use are applied frequently (e.g., Drug Abuse Resistance Education, DARE), although their efficacy has been refuted on multiple occasions (e.g., Werch & Owen, 2002). Motivational interviewing (Miller & Rollnick, 2002) is another explicit, but more personalized technique, which has shown support in young adults (for review, see Larimer & Crouce, 2007), although its efficacy in adolescents has been questioned (e.g., Thush et al., 2009), showing mixed results (for review, see Barnett, Sussman, Smith, Rohrbach, & Spruijt-Metz, 2012). An alternative, more implicit intervention is cognitive training (introduced below).

Many adolescents do not consider their alcohol use as problematic or harmful (Johnston, O'malley, Bachman, & Schulenberg, 2012). For example, Wiers, van de Luitgaarden, van den

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Wildenberg, and Smulders (2005) found that while 74% of their pre-screened sample of 96 late adolescents met diagnostic criteria for likely alcohol problems, only one of them actually self-indicated to have an alcohol problem. This lack of awareness may exist because adolescents tend to perceive more positive than negative effects of their alcohol use (National Institute on Alcohol Abuse and Alcoholism, 2005). As such, adolescents' motivation to change is often low and explicitly confronting them with their substance use may not be the most efficient way to prevent serious problems. Inspired by dual process models of addiction (e.g., Deutsch & Strack, 2006; Wiers et al., 2007), several varieties of cognitive training have been developed. These models posit that prolonged use of addictive substances leads to two important sets of cognitive changes. First there are several distinct impulsive or motivational reactions (biases) towards substances, such as attentional bias (e.g., Field et al., 2007; Schoenmakers et al., 2010), automatic memory associations (e.g., Houben, Havermans, Nederkoorn, & Jansen, 2012; Stacy, 1997) and approach bias (Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011; Wiers, Rinck, Dictus, & Van den Wildenberg, 2009). Second, it was posited that cognitive control processes that regulate these impulsive reactions, such as response inhibition (Houben & Wiers, 2009; Peeters et al., 2012) and working memory capacity (Grenard et al., 2008; Thush et al., 2008), may become weakened through prolonged use and eventually fail to fulfill their regulatory function. However, a recent review has shown that there is stronger support for enhanced motivational reactions to stimulus cues than for impaired control functions as a result of adolescent substance use (Wiers, Boelema, Nikolaou, & Gladwin, in press). Meanwhile, there is evidence that premorbid weak control functions are predictive of later substance use escalation (De Wit, 2009; Verdejo-Garcia, Lawrence, & Clark, 2008), and the underlying mechanism may be that these individuals have more trouble in controlling their enhanced implicit motivational processes (Peeters et al., 2013; Wiers, Gladwin, Hofmann, Salemink, & Ridderinkhof, 2013; Wiers et al., in press). The resulting imbalance between these stronger impulsive and relatively weak control processes can then lead to the development of addictive behaviors. Restoring balance may slow down this development, and eventually lead to a decline of substance use. In order to do so, Cognitive Bias Modification (CBM) techniques can be used to change these biased automatic, impulsive reactions by providing more time to make decisions regarding the use of a substance (Wiers et al., 2013). Additionally, cognitive control over the impulses may be strengthened through executive function training (for review, see Klingberg, 2010), and has shown promise in addiction (Houben, Wiers, & Jansen, 2011).

CBM is a collection of different training techniques aimed at changing relatively fast or impulsive reactions to disorder-relevant stimuli (Koster, Fox, & MacLeod, 2009). For example, heavy alcohol users often show selective attention (Field et al., 2007) or approach tendencies (Wiers et al., 2009) towards alcohol-related cues, resulting in cognitive biases. CBM is often applied through computer based reaction time tasks that aim to modify the bias through extensive practice, rather than explicit instruction (Koster et al., 2009). The efficacy of CBM remains subject of debate (Emmelkamp, 2012), but there certainly are indications that these processes can successfully be retrained, with positive clinical effects in addiction and related disorders (for review, see Wiers et al., 2013). In anxiety, Clarke, Notebaert, and Macleod (2014) noted that out of 29 reviewed studies on CBM-Attention (CBM-A), 26 showed a clear link between achieved bias modification and observed change in emotional vulnerability: either both were observed ($n = 16$), or both were absent ($n = 10$). Hence, effects on behavior can only be expected when a change of bias has occurred.

Although CBM seems to be a promising new technique, the repetitive nature of the training tasks often makes them inherently boring (Beard & Weisberg, 2012). Moreover, subjects often have a hard time believing that a simple computer task such as CBM training can really help them control their substance use (Beard & Weisberg, 2012). Therefore, an intrinsic motivation to change may be necessary for participants to follow through with the full training program. Most CBM studies trained adult patients, who often have a long history of substance use problems, and tend to be motivated to change their habits. Adolescents rarely have this insight, nor do they have a strong motivation to change their behaviors. And even when they do recognize that they have a problem, they may still need to be motivated to do the full training. Gladwin, Figner, Crone, and Wiers (2011) identified several ways to tackle this problem, one of which is to introduce game-elements. The products of such combinations are sometimes called *serious games for health*. In the next part of this review, an overview is given of several ways of including game-elements to improve adolescents' motivation to train using CBM techniques.

1.1. Serious games for health

To understand how applying serious gaming techniques may help motivate adolescents to complete CBM training, let us first look at what constitutes a *serious game*. Unfortunately, despite the recent surge in the number of studies about serious games, there is no consensus yet on what defining elements should comprise a serious game (Bedwell, Pavlas, Heyne, Lazzara, & Salas, 2012). One reason might be the very diverse application of gaming techniques for serious purposes. Granic, Lobel, and Engels (2014) provide a comprehensive review of the many types of serious games and their use in fields such as education, medicine and mental health. They conclude that, although very promising, there are still relatively few serious games specifically aimed at improving mental health. A quick online search on the term "serious games" also reveals that many diverse techniques are used, such as virtual reality and motion capture techniques, to increase physical exercise and activities through gaming (also known as *exergaming*), as well as online games and lab-based games. To narrow down this wide field of serious games towards identifying the useful elements for CBM training, we make several distinctions in the ways gaming techniques can be applied to intervention techniques, such as CBM.

First, there is the focus of the game-development. As a serious game ideally is a combination of a serious component (e.g., a training) and a fun component (i.e., a game), the development of a serious game will usually start from one of these two positions. Coming from the game perspective, one can start with a so called "Off The Shelf" (OTS) game, which often is commercially developed and primarily meant for entertainment, and use it for serious purposes, such as cognitive training. Several studies have looked at the effects of prolonged gaming on cognitive abilities (for review, see Granic et al., 2014), and there is growing support for the notion that, contrary to popular belief in recent years, gaming may also have positive effects. However, when examining OTS entertainment games in more detail, it is hard to disentangle which aspect of the game is responsible for the desired training effect. This may limit the scientific use of OTS entertainment games for developing specific training games (e.g. CBM). Alternatively, one may start with a training procedure or training concept and introduce game-elements to make it more fun and motivating. For example, Merry et al. (2012) developed an intervention game called SPARX, based on cognitive behavioral therapy (CBT) principles. This game, aimed at adolescents seeking help for depression, proved to be as effective in treating depression as a therapist-administered CBT program. As the field of CBM already possesses a relatively strong

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