Prevention in addiction: Using serious games to (re)train cognition in Dutch adolescents

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Prevention in Addiction: Using Serious Games to (re)train Cognition in Dutch Adolescents

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Abstract. Excessive use of psychoactive substances during adolescence poses a serious health risk. It can lead to cognitive impairment, as well as addictive problems later in life. Dual process models of addiction suggest that to counter this development, the overdeveloped automatic reactions to drug-related cues should be tempered and cognitive control functions should be strengthened. Recently, several training paradigms have been developed to (re)train these processes. While effective in long time users, most adolescents lack a motivation to train. To motivate them we have developed several serious games that incorporate these evidence-based training paradigms. This paper will present some of them and describe how they work.

Keywords: Serious games · Cognitive training · Cognitive bias modification · Motivation · Adolescents · Substance use

1 Introduction

Adolescents and young adults are known for their experimental and sometimes reckless behavior when it comes to using psychoactive substances. However, especially at that age, misuse of alcohol and drugs can lead to significant problems, such as school dropout [1] and ultimately to later addiction problems. Regular prevention and treatment programs tend to focus on explicit drug education, but only to limited success [2]. An alternative, more implicit approach comes from Dual Process models of addiction (e.g., [3,4]). These propose that the development and maintenance of addiction problems involves an imbalance between two cognitive systems. On the one hand there are several overdeveloped automatic reactions towards the substance, such as biased attention [5] and approach [6] tendencies; on the other hand heavy users tend to have weaker cognitive control abilities, such as working memory [7] and inhibition [8], which then fail to regulate these automatic tendencies. To restore balance, training cognitive control and modifying the biased tendencies (through Cognitive Bias Modification, CBM) have been effective ways to decrease symptoms in long time heavy users [9]. An intrinsic motivation to change problematic behavior may play an important role in these trainings, something younger users often lack, because they do not see their substance use as problematic in the first place [10]. Moreover, the training paradigms used are often long and repetitive and a specific motivation to train

may also be needed to attain a positive effect. To increase adolescents' motivation to train, one approach is to include game elements in the evidence-based training tasks [11]. Our team has developed several serious games, which will be presented below.

2   Serious Games and Implicit Training

In order to adapt some of the evidence-based implicit training tasks often used for cognitive (re)training, one must consider the delicate nature of these paradigms. Most of them are structured as repeated stimulus-response exercises and tend to be very sensitive to slight structural changes (e.g., changing the display duration of a cue from 500 to 2000 ms may give very different results; [12]). As such, there is a risk that adding game elements to such paradigms may eventually render the task ineffective. Boendermaker, Prins, and Wiers [13] have recently proposed a model that features several different techniques to go about turning a typical CBM task into a serious game (see Figure 1). In this paper we will highlight two of these techniques (Step 2 & 4) and provide examples of some of the games we have developed that fit with these steps.
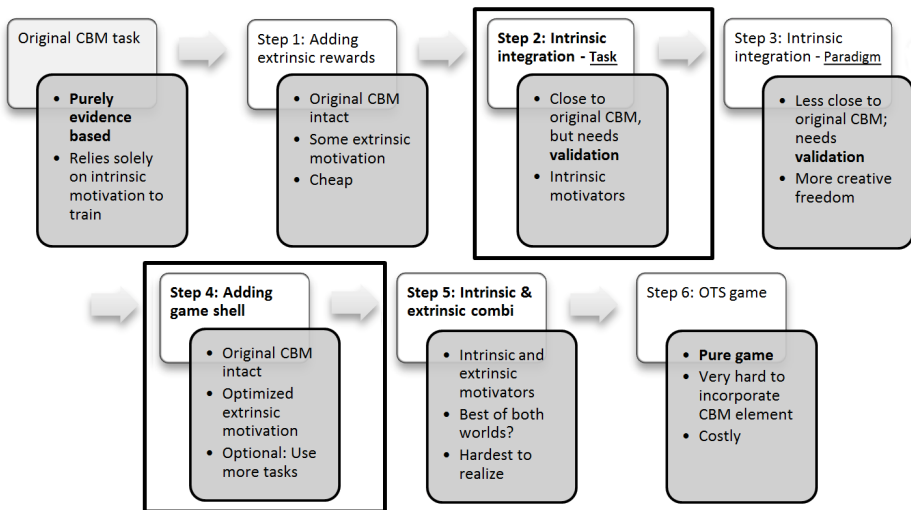
Fig. 1. Gamification model. Six gamification steps from evidence-based paradigm (CBM) to commercial "off the shelf" (OTS) games. Adapted from "Cognitive Bias Modification for Adolescents with Substance Use Problems – Can Serious Games Help?" by W. J. Boendermaker, P. J. M. Prins, and R. W. Wiers, 2015, Journal of Behavior Therapy and Experimental Psychiatry. doi:10.1016/j.jbtep.2015.03.008. Copyright 2015 by Elsevier Ltd. Reprinted with permission.

The first technique (Step 4 in the model) involves adding game elements around the original training task, like a shell, while leaving the task itself relatively unchanged. This has the obvious benefit of minimizing the chance of rendering the training

ineffective, but it also leaves the relatively boring task intact, motivating the user primarily by providing points for good task performance (e.g., based on speed and accuracy), which can then be spent afterwards in the game environment. A possible drawback to this approach is that while potentially motivating as a whole, the fun part remains separated from the training task. Such motivators are sometimes called extrinsic and are viewed as inferior to intrinsic motivators. An example of this type of serious game training is the CityBuilder game [14], featured in Figure 2. In this game, players can train different cognitive aspects, such as working memory and attention. The original training task is presented on top of the game, as shown in the right figure (task instructions are in Dutch). In doing so they receive points for speed and accuracy, which can later be spent buying a variety of objects to build a custom city. The game also includes social features, as well as daily achievements. One advantage of this game type is that it can incorporate several different training tasks.

Fig. 2. Shell game. Game screen on the left; Embedded training task on overlaying the game screen on the right.

Another technique is to make changes to the original training task itself, increasing the motivation to train through the use of intrinsic motivators, making it more fun to perform the task itself (Step 2 in the model). As some key elements of the paradigm may get lost in this process, these games will have to be revalidated. An example of this type of serious game training can be seen in Figure 3.
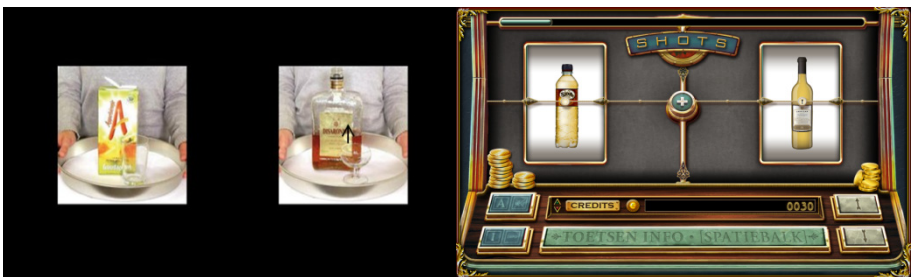
Fig. 3. Attentional Bias. Original task on the left; Game version on the right.

On the left we see a regular Visual Probe Task (originally developed by [15]), used in attentional bias modification. In this task, an alcohol-soda pair of pictures appears

simultaneously on screen. After 500 ms a small arrow becomes visible on either one of the pictures (only the soda during training). The user is instructed to quickly respond to the direction of the arrow (up or down). The bias is measured be comparing average reaction times on trials (stimulus-response pairs) where the arrow appears on the side of the alcohol picture, compared to when it appears on the side of the soda picture. The idea is that if there is an attentional bias towards the alcoholic beverages, this will be reflected by slower reaction times. On the right side of Figure 3 is the Shots Game [16], where this mechanism is embedded in a slot machine-like game. The game features fancy graphics and animations, as well as an elaborate reward system with the intention to make the training task itself more motivating. To use the machine, i.e., to spin the wheels, participants need to spend a coin. When the wheels are done spinning, a small arrow appears on either side, and if the response is correct, the player can earn up to 3 new coins, based on the speed of the response.
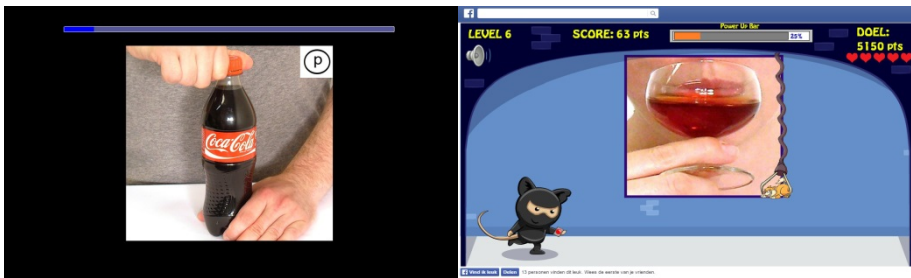
Fig. 4. Response Matching. Original task on the left; Game version on the right.

Figure 4 shows another example where game elements have been integrated directly into the task paradigm. The left image shows a typical Go/Nogo Task [17], where an unrelated cue (a letter P or F) appears on the image to indicate whether or not the user should press a response key. Interestingly, the content of the pictures is irrelevant to the task's instructions. However, by repeatedly pairing the no-go cue with pictures of alcohol, participants can be trained to associate alcohol stimuli with withholding a response. On the right is the Ninja Mouse Game on Facebook [18], where the user controls a Mouse character running through a tunnel, grabbing pieces of cheese and avoiding cats. The cheese and cats are similar to the P and F cues in the original task. Both are accompanied by 'posters' of alcohol and soda beverages in the tunnel, which are irrelevant to the game itself. One notable difference with the original task is that the game features a lateral scrolling movement of the pictures, while the original task has static pictures. Hence, validation of the adjusted paradigm is necessary. First results using pilot versions of these games indicate that participants are indeed more motivated to use them, compared to the original tasks. Currently ongoing research is looking at training effects among heavy drinking students.

3   Conclusion and Future Work

Typically, the measurement of these biases takes about 80 trials, whereas retraining can take up 600-2000 trials. As such, one needs significant motivation to sustain a certain level of performance on these tasks. While these game versions show promise in terms of motivating adolescents to train, it should be noted that this may not be enough to get regular, heavy drinking youth to spend the necessary hours on these trainings. A basic motivation to change their habits may be indispensable in order to actually achieve real behavioral changes. As serious games are inevitably a combination of some game elements and something serious, their level of fun often lies somewhere in between the regular task (boring) and the commercial games they are familiar with (mostly fun). As such, if they lack a motivation to change their problematic behavior, then their motivation to train may quickly decline and the training may be ineffective. We are currently setting up new research in which we assess both types of motivation in order to see the effects they may have on training efficacy.

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