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*Serious Gamification. Motivating Adolescents To Do Cognitive Training*

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*Serious Gamification* - Motivating Adolescents to do Cognitive Training

Adolescence is a developmental period characterized by a considerable increase in the prevalence externalizing behavior, such as experimenting with alcohol. Although this behavior does not necessarily lead to mental problems, excessive use at this age can lead to health problems, school dropout, and addiction problems later in life. As such, early intervention is important to prevent escalation. Training or re-training of cognitive processes, such as working memory capacity and automatic attentional processes towards alcohol, can be effective in helping adolescents to get a grip on and decrease their alcohol use. However, these training procedures are usually perceived as long and boring. The use of serious games may provide a solution by aiding in motivating adolescents to do cognitive training. The research behind the application of gaming techniques to evidence-based cognitive training paradigms, and cognitive bias modification (CBM) in particular, is still in its infancy. As such, the general aim of this projects was to investigate if and how serious gaming techniques can be used to motivate adolescents and young adults to do cognitive training that is aimed at decreasing their alcohol intake. To do so we first developed a framework on which to base these serious games. The framework distinguishes between a number of steps in the development of serious games, based on cognitive training (CBM in particular), starting with an original, evidence based training paradigm and adding game-elements in various degrees.

Based on this framework, we developed and investigated a number of serious games, which were the basis of the other chapters in this thesis. There were three goals in each of these serious game training studies. The first goal was to restore balance to the cognitive system, by either strengthening the adolescents' cognitive control functions (e.g., working memory, inhibition), or modifying their automatic, appetitive processes (e.g., attention or approach tendencies towards alcohol) that typically develop through prolonged alcohol use. The second goal, as a result of the cognitive change, was to decrease adolescents' problematic alcohol use. The third and final goal was to evaluate whether the game variant of the training indeed increased motivation to train amongst the sample beyond the level of that in the regular, non-gamified training. The first two empiric studies described in this thesis (**Chapters 3** and **4**) made use of a shell-type game called the CityBuilder Game, which relates to Step 4 in the model (**Chapter 2**). **Chapter 3** shows that serious game elements can help to increase motivation to increase working memory capacity in high school adolescents. Although the training turned out to be successful at increasing working memory capacity, it did not do so beyond the level of increase found in the control condition in which participants only trained with relatively easy exercises (sequences of three squares). Importantly, motivation to do the post-training working memory assessment was found to have significantly lowered in the gamified WMC-training condition, relative to the non-game and control training conditions. This may be due to the sudden lack of motivating rewards during the post-training assessment after multiple sessions of game-training in this condition, specifically. It could therefore be that the training gain of participants in the game condition was underestimated. Interestingly, the self-reported, explicit measure of motivation to train did not show participants had a preference for the game version of the training, but participants in the gamified condition did train significantly longer. The game was thus able to increase motivation to train, but the effect did fade over time until it was no longer different from the non-game conditions. The training did not lead to significantly lower drinking, which may have been due to the fact that drinking levels in the school-based sample were very low at baseline.

The second study with the CityBuilder Game (**Chapter 4**) was specifically aimed at identifying the specific role of point-rewards (cf. Step 1) and point-rewards with value in a shell game (cf. Step 4) as alcohol-specific inhibition reinforcers. Alcohol-specific inhibition was found to increase, and self-reported alcohol intake was found to be lower, in all conditions after the Go/No-Go training. However, the effect of the training on alcohol-specific inhibition was more pronounced when the training itself was also alcohol-specific. Rewarding of correct behavior during training with arbitrary points or with points that held value in the shell-game was found not to significantly reinforce this training effect beyond giving minimal feedback only.

The next two chapters (**Chapters 5** and **6**) focused on exploring integrating elements of fun into the training paradigms (cf. Steps 2 and 3) by adding a social gaming context, swiping gestures in a mobile environment, and extensive visuals. The first study in **Chapter 5** described the Cheese Ninja Game, where game elements were integrated into an evidence-based CBM paradigm. The game was also embedded inside a social media environment (www.facebook.com) to measure the added effects of social feedback. While no cognitive training effects were found, adding (social) game elements did increase appreciation for the training as well as participants' motivation to train. The second study presented in this chapter concerned a mobile CBM training, which appeared to increase motivation to train in terms how often participants trained, but this effect disappeared after controlling for baseline motivation to train. Importantly, despite changing several key aspects of the normal training paradigms, both variants did not underperform compared to their regular training counterparts in this student sample. Finally, in **Chapter 6** the Shots Game was evaluated. This game, based on the visual probe attentional bias retraining paradigm, introduced mainly an elaborate point-rewards system (cf. Step 1), as well as some fancy graphics and sounds, integrated well into the task (cf. Step 2). However, contrary to the other games presented in this thesis, the Shots Game had no additional gameplay elements included. The results showed that the attentional bias for alcohol was reduced only by the regular visual probe training, and not by playing the game. Nevertheless, self-reported drinking behavior was not affected by any of the training variants. As expected, motivation to train was shown to decrease over time, but this happened in all conditions, suggesting that the motivational features of the Shots Game were not enough to counteract the tiresome nature of the training. Moreover, motivation to start drinking less after the training actually decreased after playing the game, which may indicate potential detrimental effects of a disappointing gamification. Thus we showed here, inadvertently, that gamification is not without its risks, which has important implications for future serious game development and research.

**Conclusions**

In sum, this thesis has provided a new, evidence-based framework for the development and evaluation of serious games based on cognitive training paradigms, accompanied by a number of studies investigating the various potential benefits of such modifications. It can be concluded that serious games can be a promising new way to reach at risk youth, through prevention as well as intervention, and cognitive training can be a firm scientific basis for the design of those serious games. However, as this field is still young, more research is needed to determine for whom these cognitive training games work best, and which game elements should be used or avoided. As such, serious game research, as well as training outcomes, could benefit from keeping expectations modest.

For a broader discussion of the results presented in this thesis, the reader is referred to **Chapter 7**.