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## Future-oriented mental time travel in individuals with disordered gambling



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### ABSTRACT

This study investigated the ability of individuals with disordered gambling to imagine future events. Problem gamblers ( $n = 35$ ) and control participants ( $n = 35$ ) were asked to imagine positive and negative future events for three temporal distances (one week, one year, 5–10 years). Then, a variety of phenomenological aspects of their future thoughts (e.g., sensory and contextual details, auto-noetic consciousness) were rated. Compared to control subjects, problem gamblers generated fewer positive and negative events across all temporal distances, an impairment that was correlated to verbal fluency scores. Furthermore, problem gamblers rated imagined events as containing fewer sensory and contextual details, and lacking auto-noetic consciousness. These findings demonstrate that problem gambling is associated with a reduced future-oriented mental time travel ability and, in particular, with diminished auto-noetic consciousness when imagining future events.

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## 1. Introduction

Recently reclassified as a 'Substance-Related and Addictive Disorder' in the Diagnostic and Statistical Manual Version 5 (DSM-5) (American Psychiatric Association, 2013), gambling disorder offers a unique condition to examine nonchemical factors in addiction. Around 2% of the general worldwide population (Hodgins, Stea, & Grant, 2011) shows non-ambiguous signs of poor control of their behavior despite the presence of multiple negative consequences—a main characteristic of addiction (APA, 2013). Several lines of research (e.g., personality, genetic, cognitive neuroscience) give weight to the idea that impulsivity is an active ingredient of disordered gambling (Grant, Odlaug, & Chamberlain, 2016; Odlaug, Schreiber, & Grant, 2013). For instance, gambling addiction is associated with sub-optimal decision-making, such as a high delay discounting rate and a lack of consideration for delayed consequences (Brevers, Bechara, Cleeremans, & Noël, 2013; Petry, 2001).

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Considering these findings, deleterious gambling behavior could be conceived as a series of decisions undertaken with insufficient forethought, a phenomenon that characterizes an impulsive mode of decision-making. Surprisingly little is known, however, about the capacity of individuals with disordered gambling to mentally navigate the future. Yet future-oriented mental time travel is crucial for human decision making and provides, in particular, a motivational 'brake' that counters impulsive and short-sighted decisions (Boyer, 2008). Research has indeed shown that future-oriented thoughts are common in everyday life (D'Argembeau, Renaud, & Van der Linden, 2011) and may support adaptive behaviors and self-control (Bulley, Henry, & Suddendorf, 2016).

Interestingly, episodic stimulation of the future, and in particular its emotional component, relies on the ventromedial prefrontal cortex (Benoit, Szpunar, & Schacter, 2014; Bertossi & Ciaramelli, 2016; D'Argembeau, Xue, Lu, Van der Linden, & Bechara, 2008), a brain region involved in decision-making under uncertainty (Platt & Huettel, 2008), which is disturbed in problem gamblers, notably when playing the Iowa Gambling task (Brevers et al., 2013). In addition, a shortened time horizon has been evidenced in individuals with addictive behavior (e.g., Keough, Zimbardo, & Boyd, 1999; Sher, Trull, Bartholow, & Vieth, 1999), including pathological gambling (Hodgins & Engel, 2002; but see Mackillop, Anderson, Castelda, Mattson, & Donovan, 2006). These different lines of research raise the possibility that disordered gambling might in part be due to difficulties in episodic foresight. Better understanding these potential future-oriented thought disturbances may prove useful for inspiring novel cognitive interventions addressing problem gambling.

From this perspective, the current study sought to investigate both quantitative (number of imagined events; MacLeod & Byrne, 1996) and qualitative (phenomenological characteristics; D'Argembeau & Van der Linden, 2004) aspects of future-oriented thought in problem gambling. In particular, we were interested in assessing potential differences in fundamental dimensions of episodic foresight (Atance & O'Neill, 2001): the amount of sensory and contextual details experienced when imagining future events and associated subjective feeling of mental time travel (referred to as auto-noetic consciousness; (D'Argembeau & Van der Linden, 2012)). We also explored whether the effects of the emotional valence (positive versus negative) and temporal distance of imagined events on these different aspects of future thoughts (D'Argembeau & Van der Linden, 2004) are modified in individuals with problem gambling.

Our second aim was to clarify the possible roles of future time perspective (i.e., individual differences in the general tendency to anticipate the future and plan for future goals; Zimbardo & Boyd, 1999) and episodic foresight (i.e., the ability to mentally simulate specific future events) in problem gambling. Previous studies have shown that future time perspective is significantly (although only moderately) related to measures of episodic foresight, such as the number of sensory descriptions provided when imagining future events (D'Argembeau, Ortoleva, Jumentier, & Van der Linden, 2010) or ratings of auto-noetic consciousness (Arnold, McDermott, & Szpunar, 2011). In the present study, we investigated whether future time perspective and episodic foresight may each contribute to gambling problems. Given the contribution of working memory and executive resources in episodic foresight (Cole, Morrison, & Conway, 2013; D'Argembeau et al., 2010; Hill & Emery, 2013), and reported executive deficits in problem gamblers (Brevers et al., 2012), working memory and verbal fluency were also assessed.

Our main hypothesis was that individuals with disordered gambling would present future-oriented mental time travel deficits and especially a reduced episodic foresight (i.e., a lower experience of sensory and contextual details and auto-noetic consciousness when imagining future events), considering the importance of this process in making (mal)adaptive decisions (Bulley et al., 2016). We also explored to what extent episodic foresight and future time perspective are associated constructs in problem gamblers.

## 2. Method

### 2.1. Participants

Thirty-five problem gamblers (with various gambling problem severity) and 35 control participants participated in the study. This sample size was determined in order to achieve a statistical power of 90%, considering an alpha error of 0.05 and a between-group effect size of  $d = 0.80$  (using G\*Power 3; Faul, Erdfelder, Lang, & Buchner, 2007). Problem gamblers were recruited through advertisement in different gambling areas (e.g., casino) across Belgium. Control participants were recruited mainly by word of mouth and through advertisement on social media (e.g. Facebook) and were not informed about the purpose of our research before the face-to-face interview. This procedure ruled out the possibility that control participants were particularly interested in gambling studies and practice. Participants who responded to the recruitment ads were screened over the telephone to ensure eligibility. All problem gamblers had a minimum of 3 on the Canadian Problem Gambling Index (CPGI) and fulfilled a minimum of 4 DSM-5 diagnostic criteria of gambling disorder. Thirty-four control participants had a score of 0 and 1 participant had a score of 2 of the CPGI. Suicidal intentions, acute psychotic symptoms, or current involvement in gambling treatment were exclusionary criteria. In addition, a minimum Mini-Mental State Examination (MMSE, Folstein, Folstein, & McHugh, 1975) score of 25 was required in order to exclude participants with severe cognitive impairment. Criteria were intentionally minimally restrictive to increase generalization. Participants were compensated 40 euros for their participation. The local ethical committee approved this study and all participants gave their informed written consent after the study had been fully described to them.

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