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Using Virtual Reality to Elicit Dysfunctional Thoughts in Individuals With Gambling Disorder

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Abstract

Dysfunctional thoughts contribute to the development and maintenance of gambling disorder. Although studies in the gambling field have mostly documented dysfunctional thoughts specific to gambling (gambling-specific thoughts; GSTs), gamblers also manifest thoughts that have been documented for other addictions (addiction-related thoughts [ARTs]), such as relief-oriented thoughts. Improvements in the efficiency of cognitive restructuring in gamblers requires better access to their dysfunctional thoughts, which may be achieved through exposure to a gambling situation in virtual reality (VR) or in imagination (IM). Although VR appears to present advantages in prompting gamblers to verbalize dysfunctional thoughts, no studies have compared VR to IM to verify these advantages. This study documents GSTs and ARTs as verbalized by individuals with gambling disorder during a gambling session in VR (n = 16) or in IM (n = 13). It also compares the number of GSTs and ARTs verbalized by gamblers in both conditions, as well as the different types of GSTs. Qualitative data were first analyzed and then transformed into quantitative data for frequency theme analyses and t tests. Results show that exposure to a gambling situation in VR allows access to more GSTs, as well as to a greater diversity of GSTs, than does exposure to gambling in IM; however, VR does not allow access to more ARTs, which suggests that these thoughts may be more automatic in gamblers, or that the VR environment was not designed to evoke these thoughts. Overall, the findings suggest that VR in a clinical context could help increase the efficiency of cognitive restructuring in gamblers.

Keywords: addictive disorder, gambling disorder, cognitive restructuring, imaginal exposure, virtual reality, dysfunctional thoughts

Résumé

Les pensées dysfonctionnelles contribuent au développement et au maintien de problèmes de jeu. Bien que les études dans le domaine du jeu présentent essentiellement des pensées dysfonctionnelles documentées spécifiques au jeu (pensées spécifiques associées au jeu), les joueurs manifestent également des pensées documentées liées à d'autres dépendances (pensées liées à la dépendance) telles que des pensées associées au soulagement. Pour améliorer l'efficacité de la restructuration cognitive auprès des joueurs, il est important d'avoir une meilleure compréhension de leurs pensées dysfonctionnelles. Cela peut se faire par l'exposition à une situation de jeu, en réalité virtuelle (RV) ou en imagination (IM). Bien que la réalité virtuelle semble inviter davantage les joueurs à verbaliser leurs pensées dysfonctionnelles, aucune étude n'a fait de comparaison entre la RV et l'IM. Cette étude documente les pensées spécifiques associées au jeu et les pensées liées à la dépendance, verbalisées par des personnes atteintes de troubles de jeu, pendant une séance de jeu en RV (n = 16) ou en IM (n = 13). Elle compare également le nombre de pensées liées à la dépendance et le nombre de pensées spécifiques associées au jeu, verbalisées par les joueurs dans les deux conditions, ainsi que les différents types de pensées liées à la dépendance. Les données qualitatives ont d'abord été analysées puis transformées en données quantitatives pour effectuer des analyses de thème et fréquence et des tests de *Student.* Les résultats montrent que l'exposition en RV permet d'accéder à plus de pensées spécifiques associées au jeu qu'avec l'IM, ainsi qu'à une plus grande diversité de pensées. La RV ne permet cependant pas d'avoir accès à plus de pensées, ce qui laisse croire que ces pensées peuvent être plus automatiques chez les joueurs ou que l'environnement de RV n'a pas été conçu pour évoquer ces pensées. Globalement, les résultats laissent supposer que la RV dans un contexte clinique pourrait accroître l'efficacité de la restructuration cognitive.

Introduction

Many factors are involved in the etiology of gambling disorder (GD), including erroneous thoughts (Sharpe, 2002) that result from erroneous interpretations of chance (Gaboury & Ladouceur, 1989). Erroneous thoughts contribute strongly to the development and maintenance of GD (Ellison, Vale, & Ladouceur, 2017; Fortune & Goodie, 2012; Goodie & Fortune, 2013) and may even serve as precursors for gambling behaviours (Yakovenko et al., 2016). Erroneous interpretations during a gambling session push gamblers to continue gambling (Ciccarelli, Griffiths, Nigro, & Cosenza 2016).

Most gamblers express erroneous thoughts during a gambling session: 68% to 81% of gamblers' verbalizations are erroneous in this situation (Gaboury & Ladouceur, 1989; Ladouceur, 2004). Some authors have attempted to categorize erroneous thoughts

(Devynck, Giroux, & Jacques, 2012; Ladouceur et al., 2001; Toneatto, 1999); despite the current consensus regarding what constitutes an erroneous thought, however, the categories used to distinguish them differ—often on the basis of subtleties—from one study to the next. For example, in Hagmann's (2016) typology, which is based on that of Toneatto (1999), *magnified gambling skills* refer to the tendency to overestimate one's personal ability to win, *attribution errors* refer to the use of personal skills or abilities to explain wins, and *behavioural superstitions* concern the belief that it is possible to influence the outcome of the game with personal behaviours (e.g., seating preferences). The definitions of these categories all seem to refer to the concept of illusion of control, which consists of the belief that personal ability can influence the outcome of the game more than objectively possible (Langer, 1975). Illusions of control often underlie behaviours that make the gambler feel active, such as choosing the video lottery terminal (VLT) or using a stopping device (Ladouceur & Sévigny, 2005). Thus, a subclassification of erroneous thoughts could benefit research by providing a more thorough understanding of the cognitive dynamic in gambling. From a clinical standpoint, such a precise description of erroneous thoughts may not be necessary in that, after cognitive restructuring, gamblers who realize that they have no control over the outcome of the game will cease to believe in many of the erroneous thoughts related to the concept of illusion of control.

In this article, categories of erroneous thoughts are considered to be (a) misinterpretations of randomness; (b) erroneous verbalizations about the winning odds of the game, which can be called misinterpretations of negative expected gains; (c) misinterpretations of near misses; (d) superstitions; and (e) illusions of control (Devynck et al., 2012; Ladouceur et al., 2001). Erroneous thoughts, which are defined as an incorrect understanding of concepts related to chance, are specific to gambling and have been well documented (Barrault & Varescon, 2012). In addition to these *gambling-specific* thoughts (GSTs), thoughts that are unrelated to the concept of chance but expressed by individuals with addictive disorders are called *addiction-related thoughts* (ARTs).

Addiction-Related Thoughts

Self-control thoughts. According to Raylu and Oei (2004), gamblers see themselves as being unable to stop gambling. This perception arises from their impression of intolerable distress and the fact that they are unable to control themselves (e.g., "I'm not strong enough to stop"). These thoughts (self-control thoughts) may prevent gamblers from taking an active role in reducing or controlling their gambling habits, which may, in turn, create a self-fulfilling prophecy. This phenomenon is also observed in individuals who struggle with substance addiction (Beck, Wright, Newman, & Liese, 1993; Burman, 2003).

Anticipatory, relief-oriented, and permissive thoughts. Gamblers tend to have positive expectations regarding the effects of gambling (Raylu & Oei, 2004). Among the possible reasons to gamble and to continue gambling despite persistent losses is the desire to escape problems (Nower, Derevensky, & Gupta 2004; Wood & Griffiths, 2007) and to feel better (Wood & Griffiths, 2007). According to the model of

Beck et al. (1993), expecting positive effects from the addiction constitutes an anticipatory thought, and expecting reduced suffering corresponds to relief-oriented thoughts. These thoughts (e.g., "I'm going to use, I can't tolerate boredom") are activated in at-risk situations (e.g., a person who is bored goes to a bar to socialize) and tend to induce cravings (i.e., intense desire to use). These cravings may stimulate *permissive thoughts*: "Everyone is using so why shouldn't I?" The individual then seeks out the addictive substance. Permissive thoughts allow addicted individuals to minimize the potentially damaging effects of consumption, thus enabling them to continue using without fear or guilt (Burman, 2003).

ARTs are a target of cognitive restructuring in the field of addiction disorders (Beck et al., 1993; Burman, 2003), but this does not appear to be the case in the specific field of gambling. Indeed, in a recent systematic review on cognitive restructuring with gamblers (Chrétien, Giroux, Goulet, Jacques, & Bouchard, 2017), none of the reviewed studies had considered ARTs as a target of cognitive restructuring (only GSTs were considered); however, since gamblers also verbalize ARTs, they should also be considered a target of cognitive restructuring.

Identifying Dysfunctional Thoughts in a Clinical Setting

In a clinical context, identifying dysfunctional thoughts correctly (in this article, both GSTs and ARTs are considered dysfunctional thoughts) is an essential step toward correcting them (Bouchard et al., 2013; Ladouceur, Sylvain, Boutin, & Doucet, 2000). Gambling exposure is the most frequently used technique for accessing dysfunctional thoughts in studies on cognitive restructuring (Chrétien et al., 2017). Exposure to gambling through imagination (IM) or *in vivo* induces cravings in gamblers (Blaszczynski, Drobny, & Steel, 2005; Jimenez-Murcia et al., 2012), which are known to prompt them to behave irrationally (Sévigny & Ladouceur, 2003) and to verbalize dysfunctional thoughts (Bouchard et al., 2017).

Although exposure to gambling in IM or *in vivo* is a scientifically supported technique to induce cravings and to give therapists access to dysfunctional thoughts, it may remain limited (IM) or questionable (*in vivo*). For example, gamblers may have difficulty in imagining gambling stimuli in IM exposure, especially if the gambling session took place long ago (Sharpe, 2004). Likewise, certain gamblers may have trouble verbalizing dysfunctional thoughts because of the cognitive burden of having to imagine a gambling session in detail (Bouchard et al., 2017). Given these potential difficulties, exposing gamblers to a real gambling environment would be relevant for facilitating identification of dysfunctional thoughts; however, *in vivo* exposure may lead to a loss of control, as the therapist does not decide when and whether the game stops or continues (Kushner et al., 2008). It also poses an ethical dilemma by encouraging an individual with GD to spend real money in a gambling venue (Bouchard et al., 2012).

Virtual Reality Exposure

Gambling exposure in a virtual reality (VR) environment appears to be an option that facilitates access to dysfunctional thoughts while counteracting some of the limitations of traditional techniques such as IM or *in vivo* exposure. VR is generated by a computer that immerses the user in a three-dimensional environment through glasses and peripheral equipment (Pratt, Zyda, & Kelleher, 1995). In VR exposure, gamblers have access to visual stimuli such as game sequences on VLTs.

Studies on VR exposure show that it induces cravings in gamblers (Garcia-Palacios, Lasso de la Vega, Botella, & Quero, 2006; Giroux et al., 2013; Park et al., 2015). In 2017, three studies on VR were conducted by Bouchard et al. The first, carried out with 36 occasional gamblers (i.e., who gambled twice a year or less) and 28 frequent gamblers (who gambled at least once a month), showed that cravings induced in VR are comparable to those stimulated by a real VLT. The second was a pilot study that documented the clinical usefulness of VR with 34 individuals with GD (20 in VR and 14 in IM). It showed that therapists tend to ask gamblers to express their thoughts and emotions more in VR than they do in IM. VR exposure also helps therapists identify more at-risk situations than IM exposure does. Finally, gamblers who were exposed to gambling in VR were expected to verbalize more dysfunctional thoughts than were gamblers exposed to it in IM (observed twice more), but this difference was not significant because of the lack of statistical power. The third study assessed the safety of VR immersions from the cravings experienced by 25 individuals with GD (14 in VR and 11 in IM). During the post-exposure session, gamblers exposed to gambling in VR did not feel stronger and more persistent cravings than did gamblers exposed to gambling in IM. Finally, therapists who used VR had no problem dealing with gamblers' post-exposure cravings.

In sum, VR seems to be a safe and controlled environment in which to efficiently induce strong cravings. It also allows therapists to access relevant clinical information about gamblers' emotions and thoughts. Given these observations, it is possible that exposure to gambling in VR will prompt gamblers to verbalize more dysfunctional thoughts than will exposure to gambling in IM. In addition, since VR allows gamblers to interact with visual cues such as game sequences on VLTs, they may verbalize a larger diversity of GSTs, thus allowing therapists to gain access to more GSTs to work with.

Objectives

This study explored the content of verbalizations of individuals with GD who were exposed to a gambling session in VR or in IM. More specifically, it aimed to identify GSTs and ARTs verbalized by participants by exposure condition and to compare the number of GSTs, the diversity of GSTs, and the number of ARTs verbalized by gamblers. Gamblers exposed to a gambling session in VR were expected to verbalize more GSTs and ARTs, as well as a larger diversity of GSTs, than were gamblers exposed to a gambling session in IM.

Method

Research Design

This study was conducted as a conversion mixed-method design. This design is used when one type of data is transformed into another type (Guest, Namey & Mitchell, 2012), such as quantification of qualitative data (e.g., theme frequencies; Weller & Romney, 1988).

Sample

The sample was composed of 29 individuals with GD (16 in VR and 13 in IM) who met the criteria described in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; American Psychiatric Association, 2013) and participated in the third study of Bouchard et al. (2017). The audio recordings from the first of the four therapy sessions that these individuals attended were used in the present study. Table 1 presents the sociodemographic characteristics of the sample. All participants gave their informed consent for the secondary use of their data, such as the therapy session audio recordings. The objective of the therapy session was to expose participants to a gambling situation (in VR or IM). In the VR environment, the therapist guided participants through seven pre-established steps that were based on the intensity of the craving evoked during exposure. The procedure steps began in a street close to a bar, just a few meters away from an automated teller machine. As the exposure progressed, participants were brought to a bar, and then to the VLTs where they could begin gambling. Participants were asked to verbalize their thoughts throughout the VR exposure session. Participants in the IM condition were asked to imagine and describe a typical gambling session and to verbalize their thoughts while imagining themselves before, during, and after a gambling session. In both conditions, the therapist intervened with Socratic questioning to evoke at-risk situations, emotions, and dysfunctional thoughts in participants.

Procedure

The audio recordings were confidential and sent to Université Laval's Centre québécois d'excellence pour la prevention et le traitement du jeu. The first author transferred the sociodemographic characteristics to a data set in Microsoft Excel.

Analyses

Qualitative analyses were conducted with QDA Miner software, version 4.1.21, by using categories that were (a) predetermined through a deductive process from previous studies and (b) inferred through an inductive process (Blais & Martineau, 2006). The purpose of an inductive qualitative analysis is to give meaning to the content that arises from raw data through the creation of themes (Thomas, 2006). For each phase of the codification process, interrater agreements were calculated by

Table 1
Diagnostic Scores and Sociodemographic Data of the Sample

	VR	IM	*p*
PGDI (score/9)	*M* = 7.13 (*SD* = 1.89)	*M* = 7.85 (*SD* = 0.9)	.19
Age	*M* = 47.25 (*SD* = 13.28)	*M* = 45.23 (*SD* = 11.56)	.67
Gender			.84
Female	50%	46.2%	
Male	50%	53.8%	
Civil status			.04*
Single	43.8%	69.2%	
Married	0%	15.4%	
Widow	0%	7.7%	
Separated or divorced	31.3%	0%	
Common-law union	25%	7.7%	
Education			.55
Elementary	6.3%	0%	
High school	37.5%	23.1%	
College	31.3%	53.8%	
Professional	18.8%	23.1%	
University	6.3%	0%	
Occupation			.17
Full-time	31.3%	61.5%	
Part-time	0%	7.7%	
Retired	12.5%	7.7%	
Unemployed	12.5%	23.1%	
Social assistance	12.5%	0%	
Invalid	18.8%	0%	
Other	12.5%	0%	
Household income			.66
Low (<$30,000)	18.8%	30.8%	
Medium ($30–60,000)	50%	30.8%	
High ($60–90,000)	18.8%	15.4%	
High (>$90,000)	12.5%	23.1%	

Note. PGDI = Pathological gambling diagnostic interview (based on *DSM-5*); VR = virtual reality; IM = imagination.
*$p < .05$.

the first author and a doctoral candidate in psychology on 21% of the sample. Cohen's kappa indices varied from 0.82 to 0.91.[1]

Qualitative data were converted into quantitative data to quantify the thoughts verbalized by participants in both conditions and to compare the proportions of thoughts verbalized by using students' *t* tests for independent samples. Because the number of total thoughts verbalized differed between the two conditions, a priori control analysis was used to correct this non-equivalency. Comparisons were conducted on the mean ratios, calculated as the dependent variable divided by total thoughts (see Ladouceur, 2004). Quantitative analyses were performed with SPSS

[1]Further details regarding the qualitative analysis steps are available upon request.

(version 22) software. The alpha significance level was set at .05. When necessary, a Bonferroni correction was applied.

Results

GST and ART categories were predetermined from the theoretical context. All dysfunctional thoughts verbalized by participants could be categorized into these nine predetermined categories (five for GSTs and four for ARTs). Thus, no other dysfunctional thought categories were created during the inductive process. The five GST categories were (a) superstitions, (b) illusions of control, (c) misinterpretations of near misses, (d) misinterpretations of negative expected gains, and (e) misinterpretations of randomness. The four ART categories were (a) self-control thoughts, (b) relief-oriented thoughts, (c) anticipatory thoughts, and (d) permissive thoughts. Tables 2 and 3 describe the GSTs and ARTs, respectively. In addition, qualitative analyses revealed the presence of an adequate thoughts theme, which referred to verbalizations that reflected an accurate understanding of the concept of chance (Ladouceur, 2004).

Inductive content analyses also revealed thoughts that were not dysfunctional or adequate. These thoughts, identified as other types of thoughts, included seven themes: (a) the hope of winning; (b) organization and preparation of a gambling session and its subthemes, which included (b.1) money management, (b.2) schedule management, (b.3) gambling session duration management, and (b.4) lies to others to conceal gambling habits; (c) preferences and opinions related to gambling or its environment and its subthemes, which included (c.1) preferred gambling activity, (c.2) location of the preferred VLTs, (c.3) ways to gamble, (c.4) ambience, (c.5) other individuals at the bar, and (c.6) substance consumption; (d) the desire to remain in control of one's gambling habits; (e) craving; (f) emotional consequences related to gambling; and (g) factual thoughts. This last theme included all verbalizations that did not contain ideological content and could not be categorized into the other themes. Table 4 presents the other types of thoughts and examples of verbalizations.

Group Comparisons

Table 5 presents the percentage of all verbalized thoughts (GSTs, ARTs, adequate thoughts, and other types of thoughts) by exposure condition (VR or IM).

Gambling-specific thoughts. Gamblers in the VR condition verbalized significantly more GSTs ($M = 0.301$; $SD = 0.149$) than did gamblers in the IM condition ($M = 0.201$; $SD = 0.083$), $t(27) = 2.\ 15$, $p < .025$.[2]

As indicated in Table 6, among GST categories, there was only one significant difference: misinterpretations of randomness between conditions, $t(27) = 2.92$, $p < .01$. More misinterpretations were verbalized in the VR condition ($M = 0.053$; $SD = 0.063$) than in the IM condition ($M = 0.006$; $SD = 0.014$).

[2]A logistic regression shows the same result pattern.

Table 2
Dysfunctional Thoughts: Gambling-Specific Thoughts

Theme	Definition	Example
Superstitions	Illusory correlation between behaviour, or a thought of a metaphysical, supernatural, or sacred nature, and the belief that these may increase chances of winning. They are manifested by (1) the possession of a significant or symbolic object, (2) praying, (3) considering luck as a state that fluctuates in accordance with a phenomenon or a particular situation.	1. Gambler: I keep it because it is a souvenir from my mother (lucky charm elephant). She was lucky. This way, maybe I will have my mother's luck. (IM). 2. Gambler: I pray to win. I literally pray. I say: my God, please. (VR) 3. Gambler: There is a new waitress, so I will probably be lucky. (VR)
Illusions of control	Overestimation of one's personal capacity to influence the outcome of the game. They are manifested by behaviours or thoughts that may give gamblers the impression that they can control their gambling environment, for example: (1) choosing the VLT, (2) changing VLTs or game after losses, (3) strategies that attempt to fool or understand the VLT, (4) making bets on the basis of past experiences, and (5) trusting own instincts.	1. Gambler: There are two machines on one side, three on the other. I will choose my favourite one – the one at the entrance. Therapist: Why is that one your favourite? Gambler: Uh, well because I often won on that one. (IM) 2. Gambler: The machine is no good anymore, it will not pay, so I'm changing. (VR) or Gambler: This game does not pay. I am going to change games. (IM) 3. Gambler: Ok. I will put some back in at 5. Therapist: What are you thinking to yourself when you lose after winning? Gambler: Oh, I tell myself that I will confuse the machine a bit. I will return at 5. (VR) or Gambler: I start slowly on the machine. To feel its vibe, to tame it or train it. (VR) 4. Gambler: I prefer to play with 5 numbers because it pays more. I saw many people win with 5 numbers. (IM) 5. Gambler: If it is not meant to work, my gut will tell me. I often rely on it. (IM)

Table 2 Continued.

Theme	Definition	Example
Misinterpretations of near misses	Incorrect interpretation of the results of the game, such as interpreting a game sequence as if the results were on a continuum when they are dichotomous: winning or losing. They are manifested by an interpretation of losses as a close win.	1. Gambler: I almost won a free game. I just needed a 7. Let's continue. (VR).
Misinterpretations of negative expected gains	Misunderstanding of the realistic odds of winning. They are manifested by (1) the idea that is it possible to make significant gains over a long-term period and (2) the belief that it is possible to win back lost money.	1. Therapist: Do you tell yourself anything else when you are close to the ATM like this? Now, you are going to withdraw 100. What else do you tell yourself? Gambler: Uh, not really. Because… I tell myself that with 100 bucks, I should be able to win. I will win for sure. (VR) 2. Gambler: I am losing. I am going to try to win back my money as fast as possible. (VR)
Misinterpretations of randomness	Incorrect comprehension of the game's results. The gambler erroneously interprets the game as being due to pay after a series of losses, whereas these game sequences are independent of each other.	1. Gambler: Well this is the third time that it won't give me anything. The fourth time around, it should pay. Now it is due to pay. (VR)

Note. VR = virtual reality; IM = imagination; ATM = automated teller machine.

Table 3
Dysfunctional Thoughts: Addiction-Related Thoughts

Theme	Definition	Example
Self-control thoughts	Emphasize the idea that it is impossible to control one's gambling habits.	Gambler: Like last time, I was telling myself go away, go away, you know. Therapist: You were speaking out loud then? Gambler: Well just inside to myself. Therapist: You were trying then. Gambler: Just to myself. But I swear that I can't get up from my chair. (IM)
	Refer to the idea that gambling helps to reduce distress.	Gambler: It's like I forget absolutely everything when I'm gambling. (VR)
Anticipatory thoughts	Gambling is perceived or felt as something that evokes a feeling of well-being or pleasure.	Therapist: What do you tell yourself before entering? Gambler: Oh well, I say oh my God, this is fun. I am going to enjoy myself for a bit. (VR)
Permissive thoughts	Consist of gamblers giving themselves the right to begin or continue a gambling session by rationalizing or minimizing potential negative consequences.	Gambler: Well now, I tell myself that I lost everything anyway. It won't be worse if I lose again. Therapist: May as well lose everything? Gambler: Well I'm not saying… I won't be poor, you know. (VR)

Note. VR = virtual reality; IM = imagination.

Although there was no significant statistical difference between conditions for the verbalization of misinterpretations of near misses, $t(27) = 1.65$, $p = .06$, none of the IM gamblers verbalized this type of thought, whereas 18.8% of VR gamblers did.

Diversity of GSTs. Among five possible GST categories, gamblers in the VR condition verbalized significantly more different categories of GSTs ($M = 2.94$; $SD = 1.18$) than did gamblers in the IM condition ($M = 2.08$; $SD = 0.86$), $t(27) = 2.19$, $p < .025$.

Addiction-related thoughts. There were no significant differences between conditions regarding the number of ARTs verbalized (VR: $M = 0.079$; $SD = 0.462$ vs. IM: $M = 0.105$; $SD = 0.099$), $t(27) = -0.89$, $p = .194$.

Discussion

This study aimed to explore the content of verbalizations of individuals with GD in treatment who were exposed to a gambling session in VR or in IM. A quantitative objective was to verify whether the VR exposure condition allowed for the identification of more GSTs and ARTs verbalized by participants, as well as a larger diversity of GSTs, than that in the IM exposure condition.

Table 4
Other Types of Thoughts

Theme	Definition	Example
Hope to win money	Thoughts that refer to the hope of winning money. Does not refer to winning probabilities (*would have been dysfunctional or adequate*). Does not refer to a belief (*would have been a superstition*).	I hope I will win.
Craving	Thoughts that refer to desire or urge to gamble or physical symptoms related to gambling urge (e.g., heart palpitations). Does not refer to a conviction or a belief.	I feel anxious about me sitting before the machine. I look around and now I'm feeling very excited. My hear is beating so fast
Desire to remain in control during gambling	Thoughts that refer to a desire to remain in control during gambling. Does not refer to a desire to control the game (*which would have been an illusion of* control). Does not refer to a belief that it is impossible to control oneself when gambling (*would have been self-control* thoughts).	I try to stay concentrated, because I don't want to lose control. I stay in control. I can quit the game if I really want it.
Organization and preparation to enable gambling	Thoughts that refer to something that makes the gambling session's debut or pursuit possible. Can refer to management of money, schedule, and time to play. Can refer to routines. Can refer to lies to others.	I told my girlfriend that I was going to my mom's place, but I honestly went to the bar to gamble. I withdraw $60. If I only take $20, I won't play long enough. A typical day of gambling. I wake up, take a shower and drink coffee. I leave home and stop at the "restaurant" on the road. Systematically, I stop at an ATM to withdraw $100. I go to the bar, enter, and go straight to the machines.

Table 4 Continued.

Theme	Definition	Example
Preferences and opinions concerning gambling or gambling environment	Thoughts that refer to preferences or opinions concerning the environment, ambience, choice of a game, rules of a game, other persons in the environment, etc.	When I gamble, I don't want to socialize. I want to be alone. I prefer the Lucky 7 games. The game is funnier than the others. It is nice that it has an ATM in the bar. It makes it faster when I want to withdraw money.
Emotional consequences related to gambling	Emotions felt by gamblers during gambling. Does not refer to craving symptoms.	At this very moment, knowing that I'm over, I feel very good. I'm enjoying my pleasure. I lost all my money. All in the machine. I just want to leave the place head down. I'm feeling very guilty.
Factual thoughts	Factual thought verbalized by the gambler. Frequently refers to unelaborated or insufficiently explored thought.	I sit at the machine. Let's play.

Note. ATM = automated teller machine.

Table 5
Percentage of Gambling-Specific Thoughts, Addiction-Related Thoughts, Adequate Thoughts, and Other Types of Thoughts Among Total Verbalized Thoughts by Condition

Condition	Total verbalized thoughts			
	Gambling-specific*	Addiction-related	Adequate	Other types
Virtual reality (n = 467)	143 (30.1%)	40 (7.9%)	6 (1.2%)	278 (60.9%)
Imagination (n = 478)	101 (20.1%)	53 (10.5%)	3 (0.7%)	321 (68.7%)
Total (n = 945)	244 (25.1%)	93 (9.2%)	9 (0.9%)	599 (64.8%)

*$p < .025$.

Table 6
Percentage of Categories of Gambling-Specific Thoughts Among Total Verbalized Thoughts by Condition

Condition	Gambling-specific thoughts				
	Sup	IC	NM	NEG	MR*
Virtual reality	2.57%	6.56%	1.29%	14.4%	5.25%
Imagination	1.45%	8.55%	0.00%	9.54%	0.60%

Note. Sup = superstitions; IC = illusions of control; NM = misinterpretations of near misses; NEG = misinterpretations of negative expected gain; MR = misinterpretations of randomness.
*$p < .01$.

Gambling-Specific Thoughts

The hypothesis that gamblers in the VR condition would verbalize more GSTs than gamblers in the IM condition was confirmed. This may be explained by the fact that exposure in the VR condition provides visual cues that may generate a feeling of truly being in a gambling environment and thus prompt the gamblers to verbalize their thoughts and feelings. This readiness to verbalize thoughts may be amplified by the fact that the VR condition also causes gamblers to become emotionally aroused and spontaneous. Thus, therapists are more inclined to question gamblers about their emotions and thoughts with this exposure method (Bouchard et al., 2017).

The hypothesis that gamblers in the VR condition would verbalize a larger diversity of GSTs than would gamblers in the IM condition was also confirmed. This may be explained by the fact that the VR condition exposes gamblers to visual cues, especially VLT interfaces, which allows them to observe specific game sequences. These cues may encourage gamblers in the VR condition to verbalize more easily on these gambling sequences and to reveal more misinterpretations of randomness than gamblers who are exposed to the IM condition do. Indeed, only gamblers in the VR condition verbalized misinterpretations of near misses; they were stimulated by gambling sequences (visual cues), which prompted the verbalization of interpretation

errors. Conversely, the IM condition did not present gamblers with tangible visual stimuli, which may explain why verbalizations of GSTs specifically associated with these stimuli were less present in this condition. Indeed, these gamblers had to imagine gambling visual sequences in order to verbalize misinterpretations of randomness or of near misses, which can be difficult. Thus, the results suggest that VR in a treatment context may bring gamblers to verbalize GSTs that they may not verbalize in IM, which supports the relevance of using VR technology to assess gamblers' thoughts. Despite these findings, an important consideration is that the high frequency of a thought (e.g., illusion of control) may not equate with a more significant contribution to GD. For example, a person may think, only once, that "it is possible to confuse a VLT" and this thought may be as important as another thought verbalized 20 times; however, the more that dysfunctional thoughts are verbalized, the more clinical material therapists have access to.

For the other GST categories (illusion of control, superstitions, and misinterpretations of negative expected gains), there were no differences between the two exposure conditions. The absence of differences between conditions may be explained by a lack of statistical power because these GST categories could also have been elicited more in an immersive context such as VR. Nevertheless, whether in IM or in VR, exposure offers gamblers an opportunity to verbalize GSTs. The qualitative manifestations of the different GST categories observed in this study are similar to those documented previously (Ejova, Delfabbro, & Navarro, 2015; Giroux & Ladouceur, 2006; Ladouceur, Sylvain, et al., 2000; Leonard, Williams, & Vokey, 2015); however, some authors categorize reliance on instinct for decision making as a form of superstition (Joukhador, Blaszczynski, & Maccallum, 2004). In the present study, we considered it as an illusion of control, that is, the result of gamblers' excessive confidence in their ability to influence the outcome of the game instead of a metaphysical belief based on external resources (e.g., praying).

Addiction-Related Thoughts

Whereas most studies on dysfunctional thoughts have focused exclusively on GSTs, this study also included four categories of dysfunctional thoughts related to addiction in general (i.e., anticipatory, relief-oriented, self-control, and permissive thoughts); however, the hypothesis that gamblers in the VR condition would verbalize more ARTs than would those in the IM condition was not confirmed. This result suggests that the VR condition may not allow for better access to ARTs than the IM condition does. In contrast to GSTs, ARTs may be more easily accessible and automatic in gamblers. Personal mood may have a more determinant role than gambling cues do in stimulating these thoughts. In support of this idea, Wood and Griffiths (2007) showed that in a sample of 50 problem gamblers who were interviewed about the development of their gambling problem and the role of gambling in their lives, gambling to forget one's problems (relief-oriented thoughts) was the most popular reason for gambling. Gambling to induce a state of pleasure or relaxation (anticipatory thoughts) was also mentioned. Hence, ARTs may be more easily accessible through direct questioning (e.g., "Why do you gamble?" or "What does gambling

provide for you?"), not only for research purposes, but also for clinical reasons. Considering this possibility, exposure does not currently appear to be an indispensable therapeutic tool for accessing ARTs; however, the null findings for ARTs between VR and IM may also have been caused by a lack of statistical power as a result of the small sample size.

Although most authors in the gambling field have conceptualized anticipatory and relief-oriented thoughts as reasons or motivations to gamble, we refer to them as dysfunctional thoughts. According to a systematic review, no studies have addressed ARTs as a target of cognitive restructuring (Chrétien et al., 2017). Conceptualizing these thoughts as dysfunctional thoughts rather than reasons or motivations to gamble could be useful in a clinical context. Although gambling to forget problems may be viewed as a maladaptive coping strategy for which interventions must be oriented toward emotion regulation (e.g., relaxation or exploring alternative behavioural strategies), cognitive restructuring could also be adapted for relief-oriented thoughts and anticipatory thoughts. Cognitive restructuring for these thoughts could allow gamblers to reconsider their validity, which may increase awareness of their potential long-term consequences. Finally, the observation that self-control, permissive, relief-oriented, and anticipatory thoughts are verbalized by individuals with GD in a clinical setting raises questions about potential issues of cognitive restructuring with these individuals. Do therapists fail to correct some dysfunctional thoughts? In the field of substance addiction, these dysfunctional thoughts are the target of cognitive restructuring (Burman, 2003).

Other Types of Thoughts

In addition to dysfunctional and adequate thoughts, other themes associated with gambling emerged from exposure to it in this study (VR and IM; see Table 2). In a clinical setting, witnessing these verbalizations could provide additional value to therapy by allowing the therapist to personalize interventions for the gambler. For example, a gambler who lies to his wife about his gambling habits may be motivated to change after he begins to see the potential consequences of his behaviour in therapy.

Careful observation of the content of these different themes related to gamblers' thoughts led to another question: Would a more thorough exploration of dysfunctional thoughts by the therapist have facilitated their emergence during the exposure sessions? For example, the verbalization "I prefer to gamble in a bar rather than in a casino" cannot be identified as a dysfunctional thought because the reason for this preference remains unknown; however, a follow-up question such as "Why do you prefer bars to casinos?" could bring the gambler to further develop his or her thoughts, some of which may be erroneous (e.g., better chances of winning in bars than in casinos). These thoughts could then be addressed in cognitive restructuring. The present study supports the relevance of in-depth exploration of gamblers' thoughts, which may at first seem trivial from a clinical standpoint.

Strengths and Limitations

This study has limitations. First, the coders were not blind to the conditions, because the qualitative data allowed for the identification of the condition to which the gambler was assigned. Second, the small sample size limited the statistical power of the quantitative analyses. Nevertheless, the study included a rigorous qualitative method with an interrater agreement procedure at each phase of the analysis. The large number of dysfunctional thoughts (n = 337) offered a vast portrait of different manifestations of dysfunctional thoughts of the gamblers in treatment, which could in turn help to develop an instrument that includes both GSTs and ARTs.

Conclusion

This study explored dysfunctional thoughts of individuals with GD in VR and IM exposure. It also compared the effectiveness of these two types of exposure in evoking dysfunctional thoughts. In sum, VR exposure appears to be superior to IM exposure for accessing both a higher number and a larger diversity of GSTs; however, VR does not seem to be superior to IM for evoking ARTs. This may be because the VR environment was specifically designed to evoke GSTs, with less attention given to implicitly evoking ARTs. Hence, using VR in a clinical setting may facilitate cognitive restructuring in individuals with GD. This study proposed a new method to conceptualize the dysfunctional thoughts of individuals with GD, which could lead to new clinical considerations for cognitive restructuring. A randomized clinical trial should be undertaken to test the efficiency of cognitive restructuring in VR exposure.

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