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Caffeine's influence on gambling behavior and other types of impulsivity

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Abstract

Background—Young adulthood is a developmental period frequently associated with occurrence of impulsive behaviors including gambling. It is estimated that 73% of children and 87% of adults in the United States regularly use caffeine. Questions remain, however, concerning the role of nutrition, specifically the amount and frequency of caffeine consumption, in the development and maintenance of impulsive behaviors such as gambling.

Methods—One-hundred seventy-two young adults who gamble were recruited from two Mid-Western university communities in the United States using media advertisements. Caffeine intake over the preceding year was quantified using the Caffeine Use Questionnaire. Clinician rating scales, questionnaires, and cognitive tests germane to impulsivity were completed. Relationships between caffeine intake and demographic, gambling symptom, and neurocognitive measures were evaluated using correlational analyses controlling for multiple comparisons.

Results—Greater caffeine intake was correlated significantly with worse gambling pathology and select cognitive functioning.

Conclusions—These data suggest a particularly strong relationship between caffeine intake and symptoms of gambling pathology and neurocognitive deficits. Providing education about healthy diet may be especially valuable in gamblers and in community settings where gambling advertisements feature prominently. Future work should explore the mediating mechanisms between caffeine intake and gambling symptoms.

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Introduction

Young adulthood is a developmental period frequently associated with occurrence of impulsive behaviors (Stone et al., 2012; Casey, 2015). Peer group influences, genetics, brain development, and life transitions have all been studied as elements contributing to the elevated rates of impulsive behaviors in this age group (Chambers & Potenza, 2003; Quinn et al., 2011). It is estimated that 73% of children and 87% of adults in the United States regularly use caffeine (Branum et al., 2014; Frary et al., 2005). Caffeine has been reported to improve mood, attention, wakefulness, and energy (Stewart et al., 1997; Malinauskas et al., 2007). Many people who gamble report using caffeine to increase their attention and ability to stay awake and continue gambling. Although largely considered innocuous, caffeine's effects on the development and maintenance of impulsive behaviors such as gambling remain unstudied.

The data regarding caffeine's role in impulsivity are largely mixed, and much of the conflict results from understanding the role of age, gender, low versus high dose of caffeine, and chronic versus acute use of caffeine. Having said that, studies of adolescents or young adults have generally found that caffeinated beverages are positively associated with risk-taking, impulsivity, and sensation-seeking (Temple et al., 2017; Arria et al., 2011; Jones and Lejuez, 2005; Kponee et al., 2014). Other studies, however, suggest that caffeine does not appear to alter inhibition of behaviors (measured with the stop-signal task; Tieges et al., 2009) or decision-making (Killgore et al., 2009). These findings might be explained by the fact that research suggests individuals are capable of self-regulating caffeine intake to achieve maximum benefit with minimal negative effects (Smith, 2002).

The aforementioned studies did not account for psychiatric disorders, which have been commonly associated with significant individual differences in cognition (Krabbendam et al., 2005; Castaneda et al., 2008). Considering these limitations of the extant literature, more information is needed to discern whether caffeine use has a significant effect on cognition in young adults who already display impulsive behaviors as evidenced by problem gambling behavior. Thus, the present study examined clinical characteristics and multiple facets of cognition in young adult problem gamblers Based on the extant literature, we hypothesized that amount and frequency of caffeine use would be associated with greater cognitive impulsivity and more severe symptoms of gambling behavior.

Methods

One-hundred seventy-two participants were recruited from the surrounding communities near two large Midwestern universities for a study on impulsive behavior in young adults. Inclusion criteria were age 18-29 years, being non-treatment seeking, and having gambled at least five times in the preceding year (this was used as a proxy for some baseline level of impulsive behavior). Subjects were excluded if they were unable to give informed consent or were unable understand/undertake the study procedures. All study procedures were carried out in accordance with the Declaration of Helsinki. The Institutional Review Board of the University of Chicago approved the study and the consent statement. Participants were compensated with a $50 gift card for a local department store.

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Assessments

Participants completed standard diagnostic interviews, basic demographic information, self-report impulsivity inventories, and a computerized cognitive battery focusing on impulsivity.

The Caffeine Use Questionnaire (CUQ; Modi et al., 2010) was used to examine amount of caffeine use in each participant. The CUQ is a reliable questionnaire that presents a list of nine categories of commonly consumed sources of caffeine. Participants indicate how often they use one serving (e.g. one can, one cup) of each source of caffeine by checking one of the following; never, 1-3 per month, 1 per week, 2-4 per week, 5-6 per week, 1 per day, 2-3 per day, 4-5 per day, 6 or more per day. The CUQ also provided the approximated caffeine content of each category of caffeine source in order to obtain the estimated amount of caffeine used.

Gambling symptoms during the past 12 months were evaluated using the Structured Clinical Interview for Gambling Disorder (SCI-GD), a nine-item instrument covering the DSM-5 criteria (Grant et al., 2004; modified to reflect DSM-5). Gambling symptom severity was evaluated using the Yale Brown Obsessive Compulsive Scale Modified for Pathological Gambling (PG-YBOCS) (Pallanti et al., 2005).

Psychiatric morbidity was assessed using the Mini International Neuropsychiatric Inventory (MINI) (Sheehan et al., 1998) and the Minnesota Impulsive Disorders Interview (MIDI) (Grant, 2008) by trained raters.

Neurocognitive variables were assessed using the Cambridge Neuropsychological Test Automated Battery (CANTAB) system. The following assessments were included in this analysis: Intra-Extra Dimensional Set Shift Task (IED), Stop Signal Task (SST), Cambridge Gambling Task (CGT), Spatial Working Memory Task (SWM), and One Touch Stockings of Cambridge (OTS). These tasks were chosen in accordance with previous findings in subjects with gambling.

Intra-Extra Dimensional Set Shift Task (IED) The IED is a computerized version of the Wisconsin Card Sorting task. Participants are tasked with learning an underlying rule established by the computer. Once the rule is learned, the rule will be switched and the participant must re-learn the new rule, adapting to computer feedback. (Owen et al. 1991)

Stop Signal Task (SST) The SST tests the participant's ability to quickly stop a directed action when a stop signal is introduced into the activity. The computer screen shows an arrow facing left or right. The participant must press the corresponding left or right arrow on the keyboard. However, at random, after the arrow is presented on the screen, a beep will sound. When the beep sounds the participant must refrain from pressing the proper arrow on the keyboard (Aron et al. 2007; Logan et al. 1984).

Cambridge Gambling Task (CGT) The CGT examines the participants' behavior when presented with a gambling situation. The computer screen shows 10 boxes in varying ratios of blue and red color. Behind one of the 10 boxes is a token. The participant must first decide which color box he or she believes has a higher probability of hiding the coin. They then must decide how many imaginary points they want to bet on their guess. Possible bets

first start at lower values and steadily increase. Halfway through the task the direction of possible bets reverses and possible bets start at higher values and steadily decrease. The participant must press the screen when their desired bet presents itself (Rogers et al. 1999)

Spatial Working Memory Tasks (SWM) The SWM assesses working memory and strategy. Participants are presented with a number of boxes on the screen. Behind one of the boxes is a coin. By pressing the boxes, the participant must find the coin. After finding the coin the first time, the coin will switch to a new location under a new box. The participants are tasked with finding the coins in the most efficient manner without repeatedly looking at the same boxes already examined (Owen et al., 1990).

One Touch Stockings of Cambridge (OTS) The OTS task assesses working memory, spatial planning and executive function. The computer screen shows two images, each with three colored balls, located in a specific arrangement as if hanging in a sock from a rod. The top image shows the desired end placement of each of the three balls. The participant is asked how many single moves it would take to move colored balls from their position in the bottom image so that the bottom image then matches the top image (Williams-Gray et al., 2007).

Statistical Analysis

In order to examine CUQ responses with linear regression, caffeine use frequency selections were averaged so that each category represents a single number of servings per week in a continuous variable (e.g. 1-3 per month = .5 per week, or 2-3 per day = 2.5 per day). These values were then multiplied by the estimated amount of caffeine content for each caffeine source to obtain a value representing the amount of caffeine intake per week (e.g. 2 cups of caffeinated coffee per week multiplied by 137mg caffeine per cup of coffee = 274mg of caffeine per week).

Relationships between caffeine and clinical variables were examined for correlational associations using Pearson-Product Moment Correlation Coefficients, Point Biserial Correlation Coefficients, and Biserial Correlation Coefficients. Statistical significance was defined as $p < 0.05$.

Results

In the 172 participants, mean caffeine use was XXX. In terms of gambling clinical measures, greater total caffeine intake was significantly correlated with higher PG-YBOCS urge scores ($r=0.184$; $p<.05$), higher PG-YBOCS behavior scores ($r=0.196$; $p<.05$), and higher total PG-YBOCS scores ($r=0.197$, $p<.005$).

In terms of cognitive measures, higher total caffeine intake was significantly correlated with worse performances on the XX (r=xxx; pxxx) and XX (r=xxxx, pxxxx).

Discussion

Despite caffeine intake representing a fundamental behavior in daily existence, little is known about whether the amount and frequency of caffeine relates to impulsive behaviors

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such as gambling. The key finding was that greater caffeine intake was associated with more severe gambling symptoms and XXX. Caffeine intake was not related to other aspects of impulsivity, notably personality measures, cognitive measures, or presence of one or more impulse control disorders.

Building upon prior research which reported rates of health problems among gamblers (references), this study focused on a single health variable (caffeine intake) and examined its relationship to gambling-related behaviors and neurocognitive assessments in a large group of non-treatment-seeking individuals with subsyndromal gambling disorder. The mean daily amount of caffeine in our sample was XX, an amount somewhat higher than reported in the population at large in the United States (XXX). The key finding of this study was that caffeine among gamblers was associated with significantly more money lost to gambling per week and select cognitive dysfunction. Specifically, impairments in aspects of decision-making and XX were found.

Partially consistent with our hypothesis, we found that caffeine use was associated with individuals with worse gambling symptoms (i.e. worse SCI-PG and PG-YBOCS). The association between caffeine and gambling could be mediated in multiple, non-mutually exclusive manners. For example, individuals who gamble might be more likely to over use caffeine to stay awake or help with attention. A second possibility is that specific individuals (e.g., those who are more impulsive) may be predisposed to engage excessively in both over-use of caffeine and gambling. Some support for this last interpretation comes from the literature demonstrating elevated rates of substance use among those who gamble (reference). If caffeine use and gambling behavior stem from a single underlying drive, such as impaired decision-making and attention, these findings would suggest that treatment strategies enhancing these cognitive abilities might be particularly helpful for targeting both caffeine use and maladaptive gambling among those with subsyndromal gambling disorder. If however the gambling behavior is a manifestation of the over use of caffeine (i.e. someone who uses excessive caffeine gambles longer and makes worse decisions regarding bets), then focusing on caffeine reduction may need to be implemented as part of the gambling treatment approach. Additional longitudinal research is needed to clarify the temporal relationship between caffeine and gambling and allow for the development of more effective treatment strategies for individuals with co-occurring gambling and excessive caffeine use.

Turning to the neurocognitive findings, XXX

Despite this being one of the first studies to explore the clinical and neurocognitive correlates of caffeine intake in subsyndromal gamblers, several limitations should be noted. We selected cognitive tests based on a review of the existing literature (reference) coupled with the need not to expose subjects to excessively long testing batteries; as such we did not quantify all domains and future work could examine other functions such as temporal discounting, Iowa Gambling Task performance, or executive planning. Because medication use was not a reason for exclusion, the use of psychotropic medications may have affected some of the cognitive testing. We did not track medication use in the subjects, and so this finding may benefit from replication in subjects who are known not to be taking medications. The issue of potential gender influences over gambling and how this relates to

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caffeine use is clinically important, but our study was not powered or designed to address this issue, which merits attention in its own right in a future study. Finally, our results were based on individuals with a subsyndromal form of gambling disorder and whether these results generalize to those who meet formal diagnostic criteria for a gambling disorder remains unknown.

Our results suggest that caffeine use among subsyndromal gamblers may not be simply a consequence of gambling behavior. Instead, and perhaps somewhat different from the other health issues in gamblers, caffeine use appears to be associated with worse gambling behavior and several core cognitive domains of impulsivity that are strongly related to gambling problems. As such, caffeine use may have a synergistic relationship to gambling that needs to be addressed clinically and may have a complicated neurobiological relationship that is worthy of further study. We do not yet know the temporal relationship of dysfunction in decision-making, gambling behavior and caffeine. It is an open question as to whether the cognitive deficits identified predispose towards gambling and/or caffeine. If this turns out to be the case, these findings would suggest that using cognitive measures might lead to improved early detection of those who will develop both caffeine use and gambling problems, and possibly other impulsive behaviors. Intervention at the cognitive level (for example, cognitive therapy addressing decision-making instead of gambling behavior) in those who display this impaired decision-making, therefore, could theoretically abort the development of several serious pathologies.

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