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# Commonly used stimulants: Sleep problems, dependence and psychological distress

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ABSTRACT

*Background:* Caffeine and nicotine are commonly used stimulants that enhance alertness and mood. Discontinuation of both stimulants is associated with withdrawal symptoms including sleep and mood disturbances, which may differ in males and females. The present study examines changes in sleep quality, daytime sleepiness and psychological distress associated with use and dependence on caffeine and nicotine.

*Methods:* An online survey comprising validated tools to assess sleep quality, excessive daytime sleepiness and psychological distress was completed by 166 participants (74 males, 96 females) with a mean age of 28 years. Participants completed the study in their own time, and were not offered any inducements to participate.

*Results:* Sleep quality was poorer in those dependent upon caffeine or nicotine, and there were also significant interaction effects with gender whereby females reported poorer sleep despite males reporting higher use of both stimulants. Caffeine dependence was associated with poorer sleep quality, increased daytime dysfunction, and increased levels of night time disturbance, while nicotine dependence was associated with poorer sleep quality and increased use of sleep medication and sleep disturbances. There were strong links between poor sleep and diminished affect, with psychological distress found to co-occur in the context of disturbed sleep.

*Conclusions:* Stimulants are widely used to promote vigilance and mood; however, dependence on commonly used drugs including caffeine and nicotine is associated with decrements in sleep quality and increased psychological distress, which may be compounded in female dependent users.

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## 1. Introduction

Caffeine and nicotine are commonly used stimulants that are legally available in many countries. While stimulants enhance alertness and mood, their discontinuation is associated with withdrawal symptoms including disturbed sleep and poor affect. Given that these stimulants are used to promote alertness, and their discontinuation is associated with sleep and mood disturbances, the present paper examines how dependence is related to self-reported sleep quality and psychological distress.

Caffeine is primarily ingested via dietary sources including beverages such as coffee, tea and soft-drinks. It is the most widely used psychoactive drug in the world, with 80% of the world's population estimated to have used caffeine (James, 1997). Caffeine dosages in commercially available products have increased since in the mid-1990s (Reissig et al., 2009). Given this, studies of the effects of caffeine intake are warranted (Duffey and Popkin, 2007), and section III of the DSM5 includes caffeine use disorder as a condition of interest and encourages further study. Moderate caffeine consumption is often considered benign (Daly and Fredholm, 1998; James and Stirling, 1983). However, caffeine is an addictive substance that is used for its rewarding properties (Hughes et al., 1998; Strain et al., 1994) including to promote alertness (Partridge et al., 2013). Continued use of caffeine is associated with tolerance and withdrawal symptoms such as headache, fatigue, and mood disturbances even in low-moderate users who abruptly cease use (Silverman et al., 1992). Caffeine produces a variety of effects that are related to dose, sensitivity and tolerance (Strain et al., 1994). For example, low doses of caffeine (up to 200 mg) are associated with feelings of alertness, self-confidence, increased wellbeing and decreased sleepiness (Silverman and Griffiths, 1992), while higher

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doses (200–800 mg) can produce feelings of anxiety or nervousness (Evans and Griffiths, 1991).

Nicotine is the primary psychoactive component of cigarette smoke. Despite smoking rates having decreased in many western countries in the past decade, between 15 and 25% of adults in Australia, New Zealand and the United States report smoking in the past year (ABS, 2011–2012; Ministry of Health, 2010; CDCP, 2015). In contrast to caffeine, smoking cigarettes is a risk factor for several diseases (Benowitz, 2010; Ezzati and Lopez, 2003). While not normally considered among the 'harder' stimulant drugs such as cocaine or methamphetamine, cessation is difficult (Laviolette and Van Der Kooy, 2004), and smoking has been ranked in the top three risk factors for global burden of disease (Lim et al., 2012). Nicotine is a highly addictive substance (Benowitz, 2008), with the average cigarette estimated to deliver a dose of between 10 and 30 μg/kg (Matta et al., 2007). In addition to acting as a positive reinforcer, nicotine has been shown to improve cognition particularly motor ability, performance and some attentional tasks (Heishman et al., 2010; Rusted et al., 2009). Cessation of nicotine is associated with withdrawal (Schneider and Jarvik, 1983) with common symptoms including irritability, anxiety, anger, difficulty concentrating, sleep disturbance, increased appetite, and weight gain (De Biasi and Dani, 2011).

### 1.1. Sleep studies

Laboratory based studies have demonstrated that caffeine has alerting and performance enhancing properties (Roehrs and Roth, 2008). For example, acute administration of caffeine close to normal bed time results in increased sleep latency, and decreased total sleep time including decreased slow-wave sleep (Karacan et al., 1976; Nicholson and Stone, 1980). Similar sleep findings have been reported following repeated administration of caffeine (400 mg, 3 times per day for 7 days) with changes in total sleep time and slow wave sleep, with tolerance to the effect developing over the course of a week (Bonnet and Arand, 1992). In addition, there is some evidence that caffeine consumption earlier in the day will also affect sleep on subsequent nights by reducing total sleep time and reducing sleep efficiency (Landolt et al., 1995).

Studies have assessed the acute effects of nicotine in smokers, during withdrawal, and during nicotine replacement therapy, as well as in non-smokers administered nicotine (Jaehne et al., 2009). Laboratory based studies in smokers have reported extended sleep latency, decreased total sleep time, extended REM sleep latency and decreased slow wave sleep following nicotine administration (Zhang et al., 2006), with these effects mirrored in subjective reports of smokers who report problems with falling asleep and daytime sleepiness (Wetter and Young, 1994). During nicotine withdrawal sleep quality is decreased, and there are increased numbers of night time awakenings and poor affect, which can last up to 20 days (Jaehne et al., 2009). Polysomnography findings between different studies examining nicotine withdrawal have been inconsistent, likely reflecting differences in the degree of nicotine dependence of participants and differences in psychometric tools used (Jaehne et al., 2009). Studies assessing sleep in non-smokers have demonstrated acute changes in sleep architecture, chiefly dose-dependent reductions in REM, followed by REM rebound in subsequent sleep episodes (Gillin et al., 1994).

While these laboratory studies have demonstrated differences in sleep architecture and daytime sleepiness levels, there has been an inconsistent use of validated subjective sleep instruments in studies with drug using populations (Arnedt et al., 2007). The use of subjective tools is important for diagnosing insomnia complaints (Mayers and Baldwin, 2006; Mayers et al., 2003), given that the clinical symptoms for the diagnosis of insomnia include symptoms which need to be quantified such as: (a) difficulty initiating or maintaining sleep, and (b) duration of the disturbance which must persist for at least 1 month (Shekleton et al., 2010). Use of validated sleep and sleepiness measures enables specific features of sleep disturbance to be characterised, and also the relationship with psychological distress to be examined given the close links between sleep and mood (Staner, 2010).

### 1.2. Gender

Females have traditionally reported smaller consumption of caffeine (Liu et al., 2012) and to smoke less than males, however there have been changes in gender role and attitudes in many countries which are linked with an increased proportion of women smoking at rates now similar to males in many western countries (Hitchman and Fong, 2011). With changes in the amounts and patterns of use of common stimulants there may also be changes in relative harms (Becker and Hu, 2008), however studies have inconsistently considered gender differences, despite evidence that stimulants affect males and females differently (Becker et al., 2001). For example, caffeine has been shown to cause sustained changes in blood pressure in females compared with males (Hartley et al., 2004), and that females may be better at detecting changes related to caffeine administration that are related to steroid hormone circulation (Temple and Ziegler, 2011). In addition, there are subjective differences in both subjective and the reinforcing effects of nicotine (Perkins et al., 2002).

While studies have examined the effects that stimulants have on sleep acutely and during withdrawal, and also their properties in promoting alertness and performance on specific tasks, the extent to which these drugs affect sleep and mood over longer periods of time and daytime functioning especially in those who are dependent is less clear. The present study examines whether there are changes in self-reported sleep quality, daytime sleepiness and psychological distress associated with use and dependence on common stimulants – caffeine and nicotine. Given the noted gender differences in response to these stimulants, we also examine the role of gender in its interaction with dependence.

## 2. Materials and methods

### 2.1. Participants

The present sample comprised 166 participants (74 males, 96 females) with a mean age of 28.43 years (range 16–60 years). The majority of the sample (70%) was employed either on full-time or part-time basis, and 52% were currently studying on either a full-time or a part-time basis. Most participants had some level of post-secondary school education, with 14.5% having a trade or apprenticeship, and 57% having an undergraduate or postgraduate university qualification.

### 2.2. Materials

Participants were asked about their frequency of use and purchase locations on average per week for caffeine and nicotine. To aid recall in determining the number of caffeine-containing beverages, participants were provided with a list of beverages and foods that contain caffeine, and asked to estimate their average daily dose. To assess participants' dependence on these stimulants, participants completed the severity of dependence scale for both caffeine and nicotine. The Severity of Dependence (SDS) scale is a 5-item scale which asks about use of a particular substance in the previous month. It provides a short, easily administered scale which can be used to measure the degree of dependence experienced by users of different types of drugs (Gossop et al., 1995). A cut-off of 4 on the SDS has been used elsewhere to indicate dependency (e.g., Martin et al., 2006). The SDS has demonstrated both construct validity and high levels of internal consistency (Cronbach's alpha > 8) across difference drug types including stimulants, and across different populations (Gossop et al., 1995). In the present study, high levels of reliability were obtained for nicotine (Cronbach's alpha = .94) and caffeine (Cronbach's alpha = .83). A cut-off of "4" on the SDS scale is commonly used to separate "non-dependent" from "dependent" substance users.

Sleep was assessed using two validated measures assessing sleep quality and daytime sleepiness. The Pittsburgh Sleep Quality Index (PSQI), a 19-item scale that assesses sleep quality during the past month and contains seven subscales yielding a total score of up to 21 with global scores of >5 used to identify clinically

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