Original Paper

Placebo caffeine reduces withdrawal in abstinent coffee drinkers

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Abstract

Background: Expectancies have been shown to play a role in the withdrawal syndrome of many drugs of addiction; however, no studies have examined the effects of expectancies across a broad range of caffeine withdrawal symptoms, including craving.

Aims: The purpose of the current study was to use caffeine as a model to test the effect of expectancy on withdrawal symptoms, specifically whether the belief that one has ingested caffeine is sufficient to reduce caffeine withdrawal symptoms and cravings in abstinent coffee drinkers.

Methods: We had 24-h abstinent regular coffee drinkers complete the Caffeine Withdrawal Symptom Questionnaire (CWSQ) before and after receiving decaffeinated coffee. One-half of the participants were led to believe the coffee was regular caffeinated coffee (the 'Told Caffeine' condition) and one-half were told that it was decaffeinated (the 'Told Decaf' condition).

Results: Participants in the Told Caffeine condition reported a significantly greater reduction in the factors of cravings, fatigue, lack of alertness and flu-like feelings of the CWSQ, than those in the Told Decaf condition.

Conclusions: Our results indicated that the belief that one has consumed caffeine can affect caffeine withdrawal symptoms, especially cravings, even when no caffeine was consumed.

Keywords

Addiction, caffeine, coffee, craving, decaffeinated coffee, expectancy, placebo effect, withdrawal

Introduction

Numerous studies demonstrate that expectancies can affect the withdrawal symptoms of many addictive drugs (Colagiuri et al., 2009; Francis and Nelson, 1984; Gottlieb et al., 1987; Juliano and Brandon, 2002; Phillips et al., 1986; Senay et al., 1977; Tyrer et al., 1983). Caffeine is an addictive substance that is consumed by 80–90% of adults (Gilbert, 1984; Ressig et al., 2009) and has a well-established withdrawal syndrome (American Psychiatric Association, 2013; Juliano and Griffiths, 2004); however, despite the ubiquity of caffeine use, no study to date has tested the effect of expectancies on the full range of caffeine withdrawal symptoms, including cravings, using an empirically verified caffeine withdrawal symptom questionnaire.

The most commonly reported caffeine withdrawal symptoms are headache, fatigue or drowsiness, depressed or dysphoric mood, irritability, decreased alertness, difficulty concentrating and flu-like symptoms such as nausea, vomiting, or muscle pain and stiffness (Juliano and Griffiths, 2004). Craving, while not listed as a withdrawal symptom in the *Diagnostic and Statistical Manual of Mental Disorders: DSM-5* (American Psychiatric Association, 2013) substance withdrawal disorders, is nevertheless important for the study of any withdrawal syndrome, because it is an index of motivation to consume a drug (Sayette et al., 2000) that spikes following abstinence and is cited as a common cause of relapse (Kozlowski and Wilkinson, 1987; Shiffman, 1979).

In their review of caffeine withdrawal, Dews et al. (2002) propose two indirect lines of evidence suggesting that withdrawal from caffeine may be susceptible to the effect of expectancy. First, studies have found that caffeine withdrawal is most pronounced for subjective symptoms, often in the absence of corresponding declines in objective performance (Lane and Phillips-Bute, 1998; Phillips-Bute and Lane, 1997). Dews et al. (2002) argue that this dissociation indicates a negative expectancy effect. Second, Dews et al. (2002) argue that the considerable variability in onset and incidence of caffeine withdrawal symptoms cannot be explained by the pure pharmacological effects of caffeine, implicating psychological factors like expectancy. For example, estimates of the prevalence of headache in abstinent caffeine users range from 9% (Hughes et al., 1995) to 100% (Naismith et al., 1970); and in the individuals who experience headaches, there is considerable variance in peak onset, ranging from 27 to 51 hours of abstinence (Griffiths et al., 1990).

Some evidence already supports these ideas. It was found that instructions about the caffeine content of a beverage increase arousal and alertness (Flaten and Blumenthal, 1999; Kirsch and Rosadino, 1993; Kirsch and Weixel, 1988; Lotshaw et al., 1996), and contentedness and calmness (Mikalsen et al., 2001), irrespective of its actual caffeine content. This suggests that expectancy about receiving caffeine can induce positive effects; yet it remains to be seen whether the *negative* components of caffeine withdrawal,

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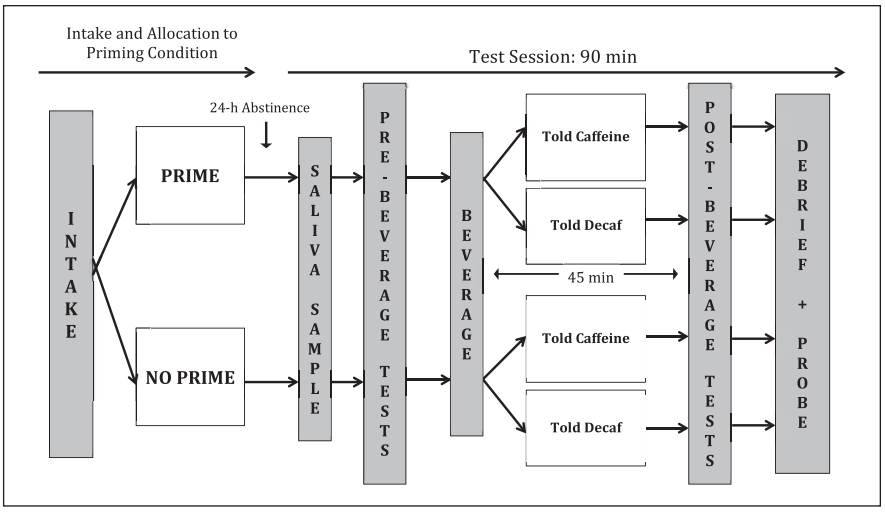

Figure 1. Study design. We gave the Prime condition a written prime in their Participant Information Statement, suggesting that they were likely to experience withdrawal symptoms. The No prime condition received no prime. The Told Caffeine condition were told they were receiving caffeinated coffee. The Told Decaf condition were told truthfully that they were receiving decaffeinated coffee. The pre- and post-beverage tests were, in order: blood pressure, CWSQ and RVIP task.
CWSQ: Caffeine Withdrawal Symptom Questionnaire; RVIP: Rapid Visual Information Processing.

such as headaches, negative mood and fatigue, can be reversed by instruction about beverage caffeine content alone. Harrell and Juliano (2009) examined the effect of instruction on a range of caffeine withdrawal symptoms; however, the instructions given to participants pertained to the effect of caffeine on motor performance, rather than whether or not they had ingested caffeine.

Other studies have found evidence that expectancies mediated abstinence-induced headache; however, these studies contained methodological weaknesses such as the omission of important statistical information and details about the type of random-allocation instructions given to participants (Rubin and Smith, 1999; Smith, 1996). To our knowledge, no studies have examined whether instructions concerning the caffeine content of a beverage can reverse or reduce withdrawal across a wide range of withdrawal symptoms. Thus, the primary aim of the current study was to test, using an empirically validated caffeine withdrawal questionnaire, whether the expectancy of having consumed caffeine can reduce withdrawal following 24 hours of abstinence, and to determine which specific withdrawal symptoms are most sensitive to expectancy effects.

A secondary aim of the study was to test whether information priming would influence the reported intensity of withdrawal symptoms. Written warnings about side-effects have been shown to increase subsequent reporting of those side-effects (Colagiuri et al., 2012; Myers et al. 1987; Neukirch and Colagiuri, 2013). This study sought to explore whether written information about the likelihood of withdrawal symptoms could similarly increase caffeine withdrawal, by priming one-half of participants with a warning about commonly experienced caffeine withdrawal symptoms.

Methods

Design

This study used a 2×2×(2) mixed design, as shown in Figure 1. The first factor was priming, where participants were either given information suggesting that abstaining from caffeine could lead to substantial withdrawal symptoms (Prime condition) or were not given this information (No prime condition). The second factor was expectancy, where participants were given decaffeinated coffee and were either told that it was caffeinated (Told Caffeine condition) or decaffeinated (Told Decaf condition). The third factor was time, either pre-coffee ingestion (pre-beverage) or post-coffee ingestion (post-beverage). The primary outcome of interest was self-reported caffeine withdrawal symptoms; however, blood pressure readings and a test of concentration were also performed, and were recorded at both time points.

Participants

The study participants were 89 (60 female gender) adult (mean age 21.3; range 18–45) moderate to heavy coffee drinkers (⩾ 3 cups per weekday) who were studying at the University of Sydney and participating in exchange for either course credit (n = 84) or for a $30 payment. All participants gave informed consent to participate in a study on the effect of caffeine on cognitive performance and they were fully debriefed at the conclusion of the study, given that the true purpose of the study was to understand the effect of expectancy on withdrawal symptoms.

A desired sample size of 20 people per group (40 per main-effect group) was determined by consulting the published studies that examine the caffeine placebo effects, which had observed moderate-to-high effect sizes for the outcomes that were equivalent to caffeine withdrawal (e.g. the variables alertness and tension, in Kirsch and Weixel (1988)).

Materials and methods

Demographic and Caffeine use Questionnaire. Participants' demographic information and daily caffeine use across all beverages was ascertained via a computerised questionnaire (see

Supplementary materials 1; ESM1). Estimates of the caffeine content of beverages were obtained from Barone and Roberts (1996) or from content listed by the manufacturer.

Drinks. Coffee was prepared in a DeLonghi Magnifica Automatic Coffee Machine, using Peet's Major Dickason's Blend Decaffeinated coffee beans. These beans contain approximately 4% of the caffeine content of regular caffeinated coffee beans, amounting to $\leq$ 4 mg of caffeine per cup.

Caffeine Withdrawal Symptom Questionnaire (CWSQ). A computerised version of the CWSQ by Juliano et al. (2012) was used to assess withdrawal symptoms. The 32 items comprising this version of the CWSQ are arranged into nine separate factors:

- Drowsiness/fatigue;
- Decreased alertness/difficulty concentrating;
- Mood disturbances;
- Decreased sociability/motivation to work;
- Nausea/upset stomach;
- Flu-like feelings;
- Headache;
- Acute caffeine effects; and
- Craving.

Participants were asked to rate to what extent they were experiencing each symptom, on a 5-item response scale, from 0 ('not at all') to 4 ('extremely'). The maximum possible score was 128. For a full list of items, see ESM2.

Rapid Visual Information Processing (RVIP) task. In order to disguise the true purpose of the study, the participants were given a version of the RVIP task, a test of sustained attention used by Colagiuri and Boakes (2010). In this 5-minute task, the participants were required to monitor single digits appearing on a screen in semi-random order and to detect strings of three consecutive odd or three consecutive even digits amongst the random digits. Performance on the test was measured via hit rate, false-alarm rate, reaction time and a composite accuracy score.

Blood pressure. We measured systolic and diastolic blood pressure via an Omron HEM-7221 electronic sphygmomanometer.

Exit questionnaire/manipulation check. A computerised exit questionnaire probed participants for awareness of the manipulation and their estimate of the caffeine content of the coffee they had received (ESM5.)

Procedure

To reduce the possibility of demand characteristics, participants were recruited under the guise of a study testing the effects of caffeine on cognitive performance. Participants signed up for the study by booking a test session on the University of Sydney website for research participation. Upon signing up, participants were randomly allocated to either the 'Prime' or 'No prime' condition. The priming manipulation was administered via a Participant Information Statement (PIS) that was sent to participants by email. In the email, participants were instructed to read the PIS carefully prior to the test session. The participant information statements that were sent to the 'Prime' and 'No prime' condition were identical, except that those given the prime contained the following additional text (excerpt from the Participant Information Statement for the Prime condition):

> "IMPORTANT: Because caffeine withdrawal symptoms become stronger over time it is likely that you will experience some withdrawal symptoms due to abstaining from coffee. These withdrawal symptoms can include headache, fatigue, difficulty concentrating, irritability, depression, flu-like feelings, nausea, upset stomach and cravings. If any of these withdrawal symptoms become too severe please contact the researchers."

See ESM3 and ESM4 for both versions of the PIS.

Participants were told in advertisements for the study, in the initial contact email, and on the PIS sent out with the contact email that they must drink more than three cups of coffee on a standard weekday and be caffeine abstinent for 24 hours, in order to be included in the study. Using a 'bogus pipeline' procedure to enhance compliance with the 24-h abstinence requirement (Murray et al., 1987), participants were told in the email and PIS that abstinence would be verified upon arrival, via a saliva test.

The study participants were tested individually in a single 90-minute test session. Prior to this session, they were allocated to either the 'Told Caffeine' or 'Told Decaf' conditions. In order to screen out the participants who did not meet the inclusion criteria, the participants were asked upon arrival at the test session how many cups of coffee a day they drank and when they last consumed caffeine. If participants answered either < 3 cups per day or < 24 h since the last caffeine was consumed, they were not tested.

Participants meeting eligibility criteria had their saliva samples collected, and the demographic and caffeine use questionnaire was administered. All questionnaires were completed on computers in the test lab, during the 90-min test session. Following the demographic and caffeine use questionnaire, participants had their blood pressure measured, and took the RVIP and CWSQ tests for the first time. Next, participants were given their cup of coffee, which was prepared in front of them in the test room. All participants received decaffeinated coffee. Beans used to make the participants' coffee were placed in the test room prior to the participants' arrival, according to group allocation, either in the original packaging or in decoy packaging of a popular caffeinated blend sold by Gloria Jean's coffee chain. During preparation of the coffee, participants in the 'Told Decaf' condition were instructed that they had been allocated to a control condition of the study and would therefore receive decaffeinated coffee. The 'Told Caffeine' condition, on the other hand, were not given any further instructions, because all participants had been led to believe that they would be receiving caffeinated coffee as part of the general study description. Participants then consumed their coffee, after which they were allowed a 45-minute 'caffeine absorption period,' in which they remained in the lab but were free to study, browse the internet or use their smartphones. Following the 'absorption period,' participants had their blood pressure read, and took the RVIP and CWSQ tests for a second time. Finally, participants were given the exit questionnaire and debriefed as to the true nature of the study.

All the procedures in this study were approved by the University of Sydney's Human Research Ethics Committee and were conducted in accordance with the 1964 declaration of Helsinki.

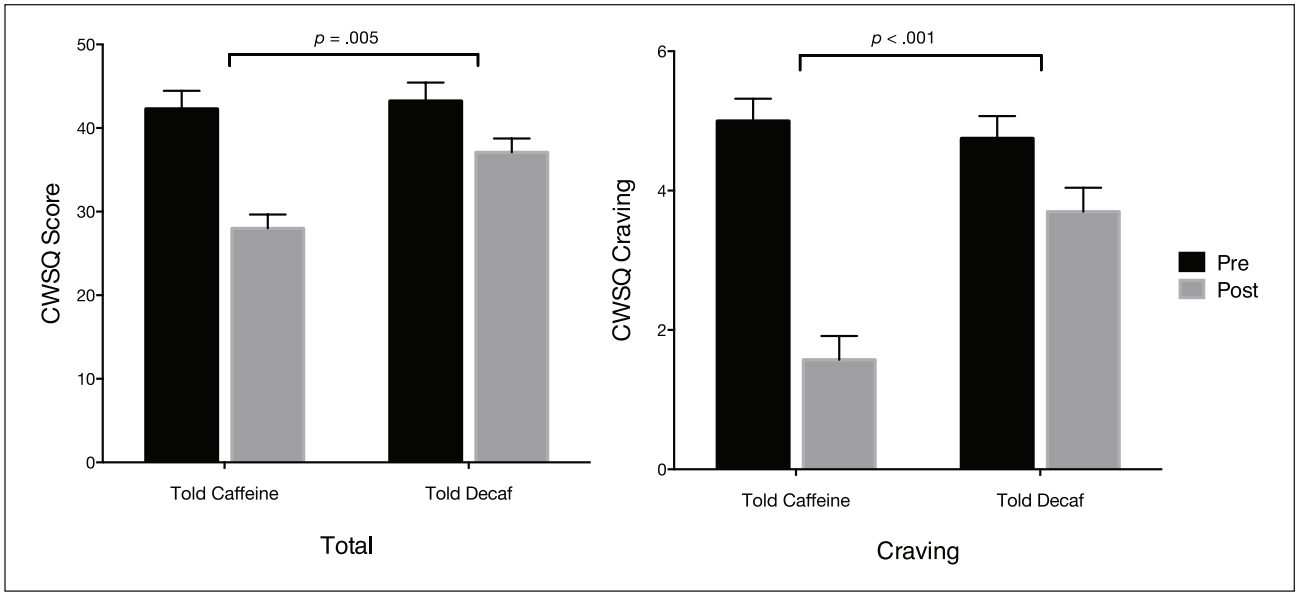

Figure 2. Effect of expectancy before and after decaffeinated coffee, on total reported caffeine withdrawal symptoms (left) and on cravings (right). Higher scores indicate more severe withdrawal. All participants received decaffeinated coffee. The Told Caffeine condition were told that their coffee contained caffeine, whereas the Told Decaf condition were told theirs was decaffeinated.

Results

Caffeine use

Mean caffeine consumption per weekday from all sources (e.g. coffee, tea or cola) was 554.1 mg (SD = 295.8). Coffee was the most commonly consumed caffeinated product. A 2-way analysis of variance (ANOVA) revealed no significant between-condition differences in daily caffeine consumption (Priming: $F_{(1,88)} = 0.21$; $p = .647$. Expectancy: $F_{(1,88)} = 1.07$; $p = .304$).

Effect of expectancy

2×2×(2) ANCOVAs, with priming and expectancy as the between-subjects factors, and time (pre- versus post-beverage) as the within-subject factor, were conducted on the CWSQ scores, blood pressure and RVIP scores. Eight participants from the Told Caffeine condition and seven participants from the Told Decaf condition whose belief in the caffeine content of their beverage was incongruent with their instructions were excluded from analysis, leaving 37 in each condition ($N = 74$). The exclusion of these participants did not affect the overall pattern of significant results.

There was a significant interaction between expectancy and time in total CWSQ scores ($F_{(1,69)} = 8.36$; $p = .005$, $\eta_p^2 = .108$), with the Told Caffeine condition reporting a reduction of 14.6 points from pre- to post-beverage, compared to a 5.5-point reduction in the Told Decaf condition. Figure 2 shows graphs of both the mean Total CWSQ scores and the CWSQ craving factor scores pre- and post-beverage, according to expectancy group allocation. There was no effect of expectancy on blood pressure nor any of the RVIP measures.

Between-group means pre- to post-beverage, *F*- and *p*-values and effect size estimates for total CWSQ scores; and the nine CWSQ factors are reported in Table 1. Of the nine CWSQ factors, four showed significant interactions between expectancy and time, with significantly greater post-beverage reductions in craving ($F_{(1,69)} = 22.53$; $p < .001$; $\eta_p^2 = .246$), decreased alertness and difficulty concentrating ($F_{(1,69)} = 8.29$; $p = .005$, $\eta_p^2 = .107$), drowsiness and fatigue ($F_{(1,69)} = 4.64$; $p = .035$; $\eta_p^2 = .063$), and flu-like feelings ($F_{(1,69)} = 4.22$; $p = .044$; $\eta_p^2 = .058$) observed in the Told Caffeine condition than the Told Decaf condition.

Effect of priming and time

There were significant main effects of time, with CWSQ scores ($F_{(1,69)} = 15.73$; $p < .001$), systolic blood pressure ($F_{(1,69)} = 15.80$; $p < .001$) and the RVIP false alarm rate ($F_{(1,69)} = 21.40$; $p < .001$) decreasing; and the RVIP hit rate ($F_{(1,69)} = 4.91$; $p = .016$) and RVIP accuracy scores ($F_{(1,69)} = 12.72$; $p = .001$) increasing significantly across all groups, from pre- to post-beverage.

There was no significant main effect of priming on CWSQ scores, nor any of the other dependent variables. Nor were any significant 2-way interactions observed between priming and time, nor priming and expectancy. There were no significant 3-way interactions between priming, time and expectancy.

Belief about beverage caffeine content

In the exit questionnaire, study participants rated the likelihood that their beverage contained caffeine. Responses were coded as follows:

- 'Certainly caffeinated' = 7;
- 'Probably caffeinated' = 6;
- 'Possibly caffeinated' = 5;
- 'Don't know' = 4;
- 'Possibly decaffeinated' = 3;

Table 1. Mean CWSQ total and factor scores pre- and post-beverage, according to expectancy.

CWSQ	Told it was caffeine		Told it was decaf		*F*	η_p^2	*p*
	Pre (SD)	Post (SD)	Pre (SD)	Post (SD)			
Total score	42.70 (13.4)	28.14 (8.9)	43.03 (12.8)	37.57 (11.1)	8.36	.108[a]	.005[a]
Factors							
Drowsiness/fatigue	6.32 (3.6)	2.65 (2.3)	6.78 (3.3)	5.22.(2.8)	4.64	.063[a]	.035[a]
Decreased alertness	9.70 (3.0)	7.84 (2.7)	10.56 (2.7)	10.51 (2.4)	8.29	.107[a]	.005[a]
Mood	1.89 (2.3)	0.89 (1.4)	2.35 (2.8)	1.65 (2.6)	0.17	.002	.681
Decreased sociability	10.51 (2.6)	8.54 (2.4)	10.35 (.41)	9.57 (.39)	2.08	.029	.154
Nausea/upset stomach	0.81 (1.8)	0.43 (1.1)	1.08 (2.0)	0.46 (1.2)	0.33	.005	.566
Flu-like feelings	4.70 (1.2)	4.27 (.87)	4.05 (1.4)	4.16 (.96)	4.22	.058[a]	.044[a]
Headache	1.97 (2.2)	0.81 (1.0)	1.65 (2.0)	1.19 (1.8)	2.04	.029	.158
Acute caffeine effects	1.78 (1.9)	1.13 (1.4)	1.38 (1.6)	1.02 (1.3)	0.45	.006	.504
Craving	5.00 (1.8)	1.57 (1.9)	4.81 (2.0)	3.78 (2.3)	22.53	.246[a]	< .001[a]

[a]Significant *p*-values.
CWSQ: Caffeine Withdrawal Symptom Questionnaire.

- 'Probably decaffeinated' = 2; and
- 'Certainly decaffeinated' = 1.

A simple linear regression was performed to test the extent to which these beliefs predicted change in overall CWSQ scores (i.e. pre-beverage CWSQ – post-beverage CWSQ; with higher scores indicating a greater reduction in reported withdrawal symptoms) and cravings, specifically. Because all participants, regardless of instruction, indicated some estimate of the likelihood that their beverage was caffeinated, the regression was conducted using all 89 participants. The strength of belief that the beverage was caffeinated significantly predicted the magnitude of the reduction in both total CWSQ score (R^2 = .047; $F_{(1,87)}$ = 4.282; b = 8.175; SEb = 3.95 and p = .041) and for craving (R^2 = .087; $F_{(1,87)}$ = 8.241; b = 0.36, SEb = 0.13 and p = .005). This meant that for every 1-point increase in participants' estimates of likelihood that there was caffeine in their beverage, there was a predicted 1.39-point decrease in their post-beverage total withdrawal symptoms score and a 0.36-point decrease in their craving score.

Discussion

The results of this study demonstrate that caffeine withdrawal symptoms can be reduced by the simple belief that caffeine has been ingested, even when it has not. Participants who were led to believe that they were receiving caffeinated coffee showed a significantly greater reduction in total CWSQ scores following consumption of their beverage, than those who were told that they had consumed decaf. Supporting this, the participants' ratings of the likelihood that their beverage contained caffeine were positively correlated with the magnitude of the reduction in CWSQ scores.

Our symptom-by-symptom analysis indicated that four specific symptom clusters were susceptible to alteration by expectancy, namely: craving, decreased alertness and difficulty concentrating, drowsiness and fatigue, and flu-like feelings. It is particularly noteworthy that cravings for caffeine were significantly reduced by administration of placebo caffeine. This suggests that the belief that one has ingested caffeine is sufficient to reduce not only unpleasant withdrawal symptoms such as fatigue and diminished alertness, but also the motivation to consume caffeine. Previous research examining the effects of expectancy on cravings for other addictive substances such as tobacco has shown mixed results, with some studies finding expectancy-induced reductions in cravings (Darredeau and Barrett, 2010; Juliano and Brandon, 2002) and others finding no effects of expectancy (Gottlieb et al., 1987; Hughes et al., 1989; Tate et al., 1994). To our knowledge, this is the first study to demonstrate that expectancy alone can reduce cravings in abstinent caffeine users.

The findings for drowsiness and fatigue, and decreased alertness and difficulty concentrating, are consistent with other studies that specifically targeted these symptoms, which have shown that abstinent caffeine users who believe they have ingested caffeine feel more alert and less fatigued (Flaten and Blumenthal, 1999; Kirsch and Rosadino, 1993; Kirsch and Weixel, 1988; Lotshaw et al., 1996). In contrast, other caffeine withdrawal symptoms, such as nausea, headache and mood factors, were not significantly influenced by the expectancy manipulation in the current study. This suggested that, in the context of caffeine withdrawal symptoms, sensations such as alertness, fatigue and craving are more susceptible to the type of top-down alteration of perception by expectancy that is thought to be involved in some placebo effects (Brown et al., 2008; Wall, 1993) than are sensations such as nausea, headache and mood. It should be noted that nausea (Quinn and Colagiuri, 2015) and mood (Dinnerstein and Halm, 1970) have been shown to be susceptible to manipulation by instruction in non-caffeine-related studies; therefore, an alternative explanation is that these symptoms may take longer than 45 min to reverse than the symptoms that did show significant changes.

Like all withdrawal syndromes, caffeine withdrawal is not a unitary phenomenon, but is rather a cluster of symptoms across multiple modalities (e.g. cognitive, affective and somatic). Thus, it is not surprising that some clusters may be more affected by expectancy than others. Even within the affected symptoms, there was some variation in the effectiveness of the expectancy manipulation, with a very large effect size for cravings (η_p^2 = .246), a large effect size for decreased alertness and difficulty concentrating (η_p^2 = .107), and

a moderate effect size for drowsiness and fatigue (η_p^2 = .063), and flu-like feelings (η_p^2 = .058). By comparison, the effect size for mood, which was not significantly changed by expectancy, was extremely small (η_p^2 = .002). It was interesting that headache, which is generally the most robust and commonly reported of the caffeine withdrawal symptoms (Juliano and Griffiths, 2004), was not significantly affected by expectancy, with a small numerical change from 1.97 pre-beverage to 1.57 post-beverage, out of 8 points. There is evidence that headaches due to caffeine withdrawal do not peak until 27–51 h after abstinence (Griffiths et al., 1990); therefore, it is possible that the 24-hr abstinence period used in the current study created a floor effect, in the sense that headaches prior to the intervention were already too low to be significantly reduced by the expectancy manipulation.

The finding that time caused decreases in withdrawal irrespective of group allocation was interesting, considering that one would expect participants in the Told Decaf condition, who knew their abstinence would continue because they were drinking decaf, to report an increase in withdrawal between pre- and post-beverage. A possible explanation is that contextual cues relating to the taste, touch and smell of coffee elicited conditioned withdrawal-reduction effects, despite participants knowing they were receiving no caffeine.

It was also interesting to note that the written prime included in the Participant Information Statement did not appear to have any effect on reported pre-beverage withdrawal symptoms. It is possible that this was due to caffeine consumers being sufficiently well aware of the negative consequences of abstinence that a simple written prime had no effect on their expectancies (Rohsenow and Marlatt, 1981); however, given that a number of participants booked and attended the test session without having fully read even the prerequisites for admission to the study, it is possible simply that many failed to read the prime. Thus, it would be interesting to explore other priming manipulations that involve a more salient prime in the future.

This study found that that the expectancy-induced withdrawal reduction effects can persist for 45 min, a duration similar to that required for peak caffeine absorption (42 min) from coffee (Liguori et al., 1997). This is well past the duration of placebo-induced increases in alertness of 15–20 min observed in previous studies (Kirsch and Rosadino, 1993; Kirsch and Weixel, 1988). Future research should further extend the period of time between administration of placebo caffeine and measurement of withdrawal symptoms, in order to determine the durability of these expectancy effects.

The current study had several potential limitations. First, the study was single-blind only, which can result in increased demand characteristics. Second, because there was no objective test of abstinence from caffeine, confirmation that participants abstained from caffeine for 24 hours prior to testing relied on self-report. This could result in either the under- or over-reporting of symptoms, due to biases such as social desirability. Third, there was no measure of the pre-existing expectancies held by participants concerning withdrawal symptoms, which may have interacted with the priming and expectancy manipulations. In future research, a caffeine expectancy questionnaire such as the Caffeine Expectancy Questionnaire (CaffEQ) used by Huntley and Juliano (2012) could be administered to address this. Fourth, the average daily coffee consumption of participants in this study (554 mg) was relatively high, compared with the average (280 mg) for the US population (Barone and Roberts, 1996). Thus, it is possible that both the withdrawal and the expectancy effects that were observed in this study were more pronounced than they would be in a sample population whose consumption was lower; however, participants in Griffiths et al. (1990) displayed marked withdrawal symptoms, despite their daily caffeine consumption being considerably lower that the US average. Thus, the effects of expectancy may occur irrespective of average consumption, as long as the level of use leads to at least some withdrawal symptoms, although this needs to be tested. Lastly, although the sample size for this study was based on sample sizes used by previous studies that found caffeine expectancy effects for withdrawal-related phenomena (e.g. Kirsch and Weixel, 1988), formal power analyses were not conducted.

Overall, the current study indicated that a number of caffeine withdrawal symptoms can be reduced by expectancy, namely: craving, decreased alertness and difficulty concentrating, drowsiness and fatigue, and flu-like feelings. These findings add to the growing body of research indicating that in addition to known pharmacological factors, expectancies concerning current levels of a drug in the body also play a significant role in the way that individuals addicted to that drug perceive their withdrawal symptoms. Caffeine Withdrawal Syndrome has been added to the list of substance use disorders in the most recent edition of the DSM, DSM-5 (American Psychiatric Association, 2013). These results suggested that expectancy-based interventions designed to reduce or eliminate drug intake may serve as a useful adjunct to existing interventions, both for caffeine use specifically, and for other substance use disorders.

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