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Short communication

Expectation of having consumed caffeine can improve performance and mood

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ABSTRACT

We explored whether caffeine, and expectation of having consumed caffeine, affects attention, reward responsivity and mood using double-blinded methodology. 88 participants were randomly allocated to 'drink-type' (caffeinated/decaffeinated coffee) and 'expectancy' (told caffeinated/told decaffeinated coffee) manipulations. Both caffeine and expectation of having consumed caffeine improved attention and psychomotor speed. Expectation enhanced self-reported vigour and reward responsivity. Self-reported depression increased at post-drink for all participants, but less in those receiving or expecting caffeine. These results suggest caffeine expectation can affect mood and performance but do not support a synergistic effect.

Introduction

Caffeine, an adenosine receptor antagonist, is widely consumed throughout the world in beverages such as coffee, tea and energy drinks. It has mild psychomotor stimulant properties via its blockade of adenosine's inhibitory mechanisms. Caffeine consumption has been associated with self-reported increases in: wakefulness, alertness, ability to concentrate and energy (e.g. Peeling & Dawson, 2007). Placebo-controlled trials using objective measures can corroborate these reports; consumption of caffeine can produce significant improvements in: reaction time, short-term memory, vigilance, reasoning, response accuracy, attention, and general alertness (see Glade, 2010).

Paralleling its effects on cognition, caffeine consumption is also accompanied by improved mood including increased 'happiness' (Amendola, Gabrieli, & Lieberman, 1998), a reduction in depressive symptoms (Childs & de Wit, 2008), and decreased anxiety (Quinlan, Lane, & Aspinall, 1997), although there are conflicting results with respect to anxiety (Broderick & Benjamin, 2004).

That coffee produces stimulant effects is the prevailing societal view; such expectations about its effects on performance and mood are likely to impact on the magnitude of its effect – the well known placebo effect. Indeed, expectancy concerning the effects of an ingested substance has been repeatedly demonstrated to exert an influence on behaviour in the alcohol (Leigh & Stacy, 1991) and nicotine literature (Kelemen, 2008). Expectations about the effects of caffeine have also been shown to affect performance in studies in which participants have been led to believe that a decaffeinated coffee contained caffeine and given contrasting information about expected effects (Fillmore & Vogel-Sprott, 1992; Lotshaw, Bradley, & Brooks, 1996).

However, two double-blind studies which manipulated expectancy through accurate, deceptive or ambiguous information, failed to replicate caffeine expectancy effects for physiological, psychological and cognitive variables (Walach, Schmidt, Bihr, & Wiesch, 2001; Walach, Schmidt, Dirhold, & Nosch, 2002). Other studies partially support caffeine expectancy effects; for instance, Schneider et al. (2006) reported an expectancy effect for subjective alertness, but not for well-being or reaction time. Oei and Hartley (2005) took a slightly different approach and compared *pre-existing beliefs* about caffeine's effects as well as manipulating the message concerning whether caffeine had been consumed using the balanced placebo design. Those who had pre-existing beliefs that caffeine would stimulate them showed better signal detection performance under caffeine, but there was no overall effect of message, and no effects of pre-existing beliefs or message on reaction time or delayed recall. Elliman, Ash, and Green (2010), again using the balanced placebo design found an effect of expectancy (told caffeine) on sustained attention, but only when caffeine had actually been consumed (there was no effect of caffeine expectancy when decaffeinated coffee had been consumed) and no effect of expectancy on mood. Overall then, caffeine has well-documented psychomotor stimulant effects and there is evidence, at least in some individuals on some aspects of performance, that expectations about caffeine's effects can also impact on mood and performance.

In addition to its arousing effects, evidence indicates that caffeine interacts with neural systems involved in motivation and

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reward by antagonising the effect of adenosine on the mesocorticolimbic dopamine system (Ferré, 2010; Salamone et al., 2009; although see Nehlig, Armspach, & Namer, 2010). The effect of caffeine on reward motivation in humans has received very little attention, but the Card Arranging Reward Responsivity Objective Test (CARROT; Al-Adawi & Powell, 1997) has recently been used to explore this. The CARROT measures the extent to which participants' psychomotor performance is enhanced by financial incentive. Participants sort cards across four trials according to a simple rule. The average speed of card sorting across two non-rewarded trials is subtracted from card sorting speed on a rewarded trial (10p for every five cards sorted up to a maximum of £2) to provide an index of reward responsivity. Using this task, McFie (2005; doctoral thesis) found an enhancing effect of caffeine on reward responsivity in abstinent smokers. Augmented reward responsivity has also been reported with nicotine (Dawkins, Powell, West, Powell, & Pickering, 2006) and alcohol (Kambouropoulos & Staiger, 2001). Nevertheless, the extent to which expectations about effects of ingested substances impact on reward motivation has not been explored. The present study therefore aims to further elucidate the effects of caffeine and expectancy on subjective mood and attention/speed of processing using the balanced placebo design. It also aims to examine, for the first time in a double-blinded study, the effects of caffeine and expectancy on reward responsivity.

Method

Overview

Participants were randomly allocated to either caffeine or placebo condition and then completed two experimental tasks and a mood scale. Within these conditions, participants were either accurately informed or misinformed as to the caffeine content of the drink. Thus there were four between-participants conditions: given caffeine/told caffeine [GC/TC]; given caffeine/told decaff [GC/TD]; given decaff/told caffeine [GD/TC]; given decaff/told decaff [GD/TD].

Participants

88 non-smoking participants (44 female) aged 18–47 years (mean: 26) were undergraduate students and habitual coffee drinkers (consumed two or more cups of coffee per day for at least 6 months). Participants responded to posters advertising a study about 'the effects of caffeine on mood and cognitive performance.' They were asked to abstain from consuming caffeinated beverages for 2 h prior to testing (not confirmed) in order to maintain consistency at baseline but to ensure that they were not in an obvious state of withdrawal. The study was granted ethical approval from UEL's School of Psychology ethics committee.

Procedure

Within this double-blinded, between-subjects design, participants were randomly allocated to both a drink (caffeinated coffee vs. decaffeinated coffee) and an expectancy (told caffeine vs. told decaffeinated) condition. Groups were matched for gender (11 females and 11 males in each group) and age (group means: GC/TC 26.45 [7.73]; GC/TD 24.95 [6.40]; GD/TC 26.14 [6.83]; GD/TD 25.82 [6.92]).

Expectancy was manipulated by telling participants at the start of the session (either accurately or falsely) that they would receive an 'ordinary cup of caffeinated coffee' or an 'ordinary cup of decaffeinated coffee' (according to group allocation). After providing written informed consent, participants completed the short form of the Profile of Mood States including the four most relevant subtests (fatigue-inertia, depression-dejection, tension-anxiety, vigour-activity; POMS; MacNair, Lorr, & Droppleman, 1971) before being presented with the drink in a disposable foam cup. Participants were given 5 min to drink it and 55 min to wait (during which time they sat quietly and read) before commencement of testing.

Drinks were prepared by a research assistant in an adjacent room. One heaped teaspoon (approx. 2 g) of either caffeinated (Maxwell House; approx. 75 mg caffeine) or decaffeinated (Fair Trade Classic Coffee) coffee was used, with 250 ml of warm water and 28 ml milk (2× 14 ml of UHT semi-skimmed milk pots), no sugar added. This dose (75 mg caffeine) was chosen to reflect what participants would ordinarily consume in a cup of coffee in their everyday lives.

Participants then completed the following measures in fixed order: the standard computerised Stroop task with 40 congruent stimulus presentations (printed colour and written word the same) and 40 incongruent stimulus presentations (printed colour and written word differ); the Card Arranging Reward Responsivity Objective Test (CARROT, described in detail in Al-Adawi & Powell, 1997); and the POMS (short-form, as above).

Finally, participants were debriefed and if they had been misinformed, were told which drink they had actually been given. No participants suspected that they had been misinformed.

Results

All variables were analysed using ANOVA with two between-subjects factors: DRINKTYPE (caffeinated vs. decaffeinated coffee) and EXPECTANCY (told caffeine vs. told decaff). Within-subject factors differed according to variable as outlined below.

Stroop task

CONGRUENCY (congruent vs. incongruent) was a within-subjects variable in ANOVA for both Stroop accuracy (number correct) and reaction time (RT). As can be seen from Fig. 1, in the case of accuracy, there was a significant main effect of CONGRUENCY ($F(1,84) = 30.04$, $p < 0.0001$) reflecting greater accuracy in the congruent condition. There were also highly significant main effects of DRINKTYPE ($F(1,84) = 9.63$, $p < 0.005$) reflecting better performance in the caffeine group, and EXPECTANCY ($F(1,84) = 48.57$, $p < 0.0001$), with superior performance in the told caffeine (TC) condition. The CONGRUENCY × DRINKTYPE interaction was also statistically significant ($F(1,84) = 5.09$, $p < 0.05$). Post hoc independent samples t-tests revealed significantly better performance in the caffeine vs. decaffeinated group for incongruent (means: 36.68 vs. 34.73; $t(86) = -2.91$, $p = 0.005$) but not congruent (means: 37.36 vs. 36.36; $t(86) = -1.68$, $p = 0.10$) trials.

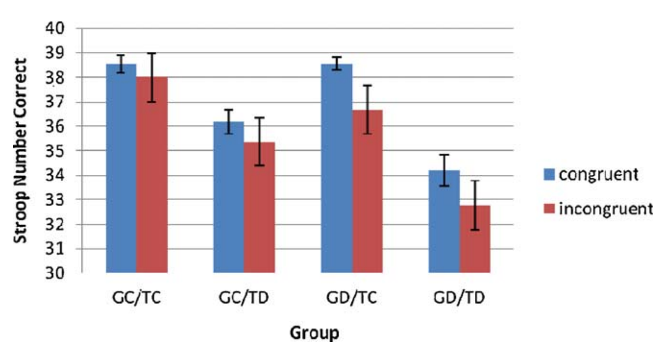

Fig. 1. Mean Stroop accuracy for congruent and incongruent words by caffeine and expectancy groups. Error bars are 1SE.