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## Alexithymia and Caffeine: The Role of Caffeine Expectancies and Craving

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### Abstract

Alexithymia refers to difficulties in identifying and describing feelings and is often associated with problematic substance use for a variety of substances. A recent study investigating the relationship between alexithymia and caffeine use found that university students with alexithymia reported typically consuming nearly twice as much caffeine as those without alexithymia. The current study assessed the potential role of caffeine expectancies and craving in mediating this relationship. University students ( $n = 104$ ) aged 18-30 years, who regularly consumed both caffeine and alcohol, completed the following measures: a demographic questionnaire, Toronto Alexithymia Scale-20 (TAS-20), Beck Anxiety Inventory, Caffeine Expectancy Questionnaire (CaffEQ), Caffeine Consumption Questionnaire, Sensitivity to Punishment and Sensitivity to Reward Questionnaire, and the Alcohol Use Disorders Identification Test. Hierarchical regression and path analyses indicated that caffeine expectancies and caffeine craving mediated the relationship between alexithymia and caffeine consumption. Given that alexithymia is common in samples of clients undergoing treatment for substance dependence for a variety of substances, alexithymia appears to be associated with increased susceptibility to drug cravings – even for a drug as mild in its typical effects as caffeine.

*Keywords:* alexithymia, caffeine, craving, caffeine expectancies, anxiety

### Alexithymia and Caffeine: The Role of Caffeine Expectancies and Craving

The term “alexithymia” comes from the Greek words *a* (lack), *lexis* (word) and *thymos* (mood), which together refers to a “lack of words for emotions.” Alexithymia, a personality trait characterized by difficulties in identifying and describing feelings, lack of imagination and an externally oriented thinking style (Nemiah, Freyberger & Sifneos, 1976), has been linked to heavy substance use for a variety of substances including alcohol, caffeine and cannabis (e.g., Lyvers, Duric & Thorberg, 2014; Lyvers, Jamieson & Thorberg, 2013; Thorberg, Young, Sullivan & Lyvers, 2009). To date, little research has examined the relationship between alexithymia and the most commonly used of all psychoactive drugs, caffeine. Lyvers, Duric and Thorberg found that university students with high levels of alexithymia reported consuming nearly twice as much caffeine as did those without alexithymia. However, the reason for this relationship proved elusive, as possible mediational influences of frontal lobe dysfunction, impulse control, reward sensitivity and excessive alcohol consumption were all ruled out by the findings. Extending the previous research, the current study examined caffeine use in relation to alexithymia as assessed by the Toronto Alexithymia Scale (TAS-20; Bagby, Parker & Taylor, 1994), caffeine expectancies as measured by the recently developed Caffeine Expectancies Questionnaire (CaffEQ; Huntley & Juliano, 2012), and other relevant factors in an effort to understand the alexithymia-caffeine relationship.

The etiology of alexithymia remains unclear. There is evidence that alexithymia is a stable personality trait (Martinez-Sanchez et al., 2003), but can also in some cases be a transient or state phenomenon (Honkalampi, Hintikka, Saarinen, Lehtonen & Viinamaki, 2000). Other evidence suggests that genetic (Jorgensen, Zachariae, Skytthe & Kyvik, 2007) and environmental factors (e.g., physical or emotional trauma or neglect; Thorberg, Young, Sullivan & Lyvers, 2011; Zlotnick, Mattia & Zimmerman, 2001) may also influence the development of alexithymia. The etiology of alexithymia may reflect an interaction of personality traits and life events (Zeitlan &

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McNally, 1993). For example, individuals with high anxiety sensitivity and who have also experienced some form of trauma may learn to constrict their emotions or avoid having emotional experiences altogether, thus developing alexithymia.

Worldwide, the prevalence rate of alexithymia in adults within the general population is reported at 5-13% (Franz et al., 2008; Mattila, Salminen, Nummi, & Joukamaa, 2006), but is considerably higher in clinical samples at 40-67% (Lyvers, Hinton et al., 2014; Thorberg, Young, Sullivan & Lyvers, 2009). The evidence for gender differences in alexithymia is mixed, with some studies finding no gender difference, others reporting slightly higher rates in males, and others finding higher rates in females (e.g., Mason, Tyson, Jones & Potts, 2005). The prevalence rate of alexithymia in clinical samples is significantly higher than in the general population, particularly in samples with substance dependence, where the rate of alexithymia is around 45% - 67% (Evren et al., 2008; Lyvers, Hinton et al., 2014; Thorberg et al., 2009; van Rossum, Laheij, de Doelder, de Jong, & Jansen, 2004). Even in community and university student samples, alexithymia is associated with heavier use of substances including alcohol (Lyvers, Lysychka & Thorberg, 2014), cannabis (Lyvers, Jamieson & Thorberg, 2013) and caffeine (Lyvers, Duric & Thorberg, 2014).

Caffeine (1,3,7-trimethylxanthine) is the most accessible, socially accepted and widely consumed psychoactive drug in the world (de Meija & Ramirez-Mares, 2014; Lara, 2010) and is a naturally occurring alkaloid found in over 60 species of plants (Gray, 1998). Perhaps 80% of the world's population consumes caffeine, largely for its mild stimulant properties arising from its antagonism of the inhibitory neuromodulator adenosine (Childs & de Wit, 2006; Huntley & Juliano, 2012). The most popular caffeine vehicles include coffee, tea, chocolate, energy drinks, soft drinks, dietary supplements and over the counter medications, however the majority of the caffeine ingested comes from drinking coffee (approximately 100 mg per serve; Bryan, 2008; Huntley & Juliano, 2012). Many caffeine consumers do not experience adverse side effects of

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caffeine (Bonita, Mandarano, Shuta, & Vinson, 2007), however, some caffeine consumers - even those who consume as little as 100 mg per day - may experience anxiety, sleep disturbance, and/or signs of caffeine dependence (Juliano & Griffiths, 2004).

Alexithymia as indexed by TAS-20, and anxiety as indexed by the Beck Anxiety Inventory (BAI), typically show moderate positive correlations of .39-.42 (Lyvers, Duric & Thorberg, 2014; Lyvers, Lysychka & Thorberg, 2014). In some individuals caffeine promotes or elicits symptoms of anxiety and panic, especially when high doses of caffeine are consumed (>300mg; Lieberman, 1992; Moore, 2014). Therefore, one might anticipate that people with alexithymia, who tend to be more anxious, would learn to avoid caffeine in order avoid aversive anxiogenic drug responses. However, Lyvers, Duric and Thorberg found that students identified as having high levels of alexithymia based on TAS-20 cut-off scores consumed nearly twice as much caffeine ( $M= 503.06$  mg) as their borderline ( $M= 274.29$  mg) or non-alexithymic peers ( $M= 275.09$  mg),  $p < .01$ . Results paradoxically showed that BAI anxiety scores were significantly positively related to both alexithymia scores and caffeine consumption. Further, in a hierarchical regression TAS-20 was the only positive predictor of caffeine consumption after controlling for a variety of other potentially relevant trait variables. Path analyses were used to investigate possibilities that the heavier caffeine consumption of those with alexithymia reflected an attempt to deal with frontal lobe related attentional or impulse control deficits or aftereffects of heavy alcohol use, with no evidence supporting either hypothesis. The basis of the alexithymia-caffeine relationship thus remained a mystery.

According to Social Cognitive Theory, human behavior is largely regulated by the anticipated outcome (i.e., expectancy) of a particular behavior and the extent to which that behavior is governed by rewarding and punishing consequences (Bandura, 1999). For example, individuals who have more positive alcohol expectancies tend to consume higher amounts of alcohol, with positive consequences reinforcing their drinking behavior (Connor, Young, Williams

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& Ricciardelli, 2000; Young & Oei, 1996). Research by Thorberg et al. (2011b) showed that among clients undergoing treatment for alcohol dependence, alcohol expectancies partially mediated the association between alexithymia and drinking. The present study used the CaffEQ to assess caffeine expectancies in an attempt to understand the association between alexithymia and caffeine consumption in a similar fashion. The CaffEQ is a relatively new, psychometrically sound instrument that was developed to identify the beliefs or expectancies that drive individuals to consume caffeine (e.g., caffeine keeps me alert; Huntley & Juliano, 2012). The CaffEQ has seven subscales: Withdrawal/Dependence, Energy/Work Enhancement, Anxiety/Negative Physical Effects, Social/Mood Enhancement, Appetite Suppression, Physical Performance Enhancement and Sleep Disturbance. Of particular interest in the present study was the Withdrawal/Dependence subscale and one of its items, "I often crave caffeine," as previous work has indicated that alcohol craving is higher among alcohol dependent patients if they have alexithymia (Thorberg et al., 2011a), and craving mediates the alcohol-alexithymia link in social drinkers (Lyvers, Lysychka & Thorberg, 2014). Thus we predicted that not only would TAS-20 alexithymia scores be positively related to caffeine consumption as in the previous study (Lyvers, Duric & Thorberg, 2014), but also that the CaffEQ Withdrawal/Dependence subscale item "I often crave caffeine" would mediate this relationship.

Previous research investigating the relationship between alexithymia and alcohol use found that those with alexithymia scored higher on indices of anxiety and sensitivity to punishment than their non-alexithymic counterparts (De Gucht, Fischler & Heiser, 2004; Lyvers, Hasking, Albrecht & Thorberg, 2012). In the Lyvers, Duric and Thorberg (2014) caffeine study, sensitivity to punishment negatively predicted caffeine consumption after TAS-20 alexithymia scores were added to the regression model, suggesting that among those with lower levels of alexithymia the anxiogenic effects of caffeine discouraged caffeine intake by those with higher anxiety sensitivity. The present study thus also administered the SPSRQ as in the previous study, which had found that

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both the sensitivity to punishment (SP) and sensitivity to reward (SR) scales were significantly correlated with caffeine consumption such that SP showed a negative relationship and SR a positive relationship – the latter presumably reflecting primary rewarding effects of the drug.

In summary, the purpose of the current study was to follow up on Lyvers, Duric and Thorberg's (2014) research in further examining the relationship between alexithymia and caffeine consumption by measuring caffeine expectancies and craving. In line with previous findings, caffeine consumption was expected to be positively related to TAS-20 alexithymia scores. BAI and SP were also anticipated to be positively related to TAS-20 as in the previous study. In terms of caffeine expectancies, for the theoretical reasons described above, caffeine expectancies and caffeine craving were expected to mediate the relationship between alexithymia and caffeine consumption, given the previously reported alexithymia-alcohol relationships described earlier above.

## Method

### Participants

The participants recruited for this study were university students enrolled at a South-East Queensland University. Inclusion criteria required the participants to be at least occasional consumers of caffeine and aged between 18 and 30 years. Those who indicated that they had previously sustained a serious head injury were excluded from the study, as traumatic brain injury is linked to poor emotional awareness and higher rates of alexithymia (Henry, Phillips, Crawford, Theodorou & Summers, 2006; Williams & Wood, 2010). Of the 126 participants who completed the study, 17 were removed from the dataset due to missing data, failure to meet the age requirements, positive indication of a head injury or failure to indicate consent. A further 5 were removed from the data set as they were identified as multivariate outliers. The final sample consisted of 104 current university students of whom 18 were male and 86 were female, with a mean age of 20.83 years ( $SD = 2.45$  years).

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Participants were recruited in two ways. Firstly, the study was advertised on the university's online research participation system. This method allowed students enrolled in a first year psychology course ( $n = 79$ ) to volunteer for the study in order to receive one credit point towards their course mark. The other 25 participants were university students who were directly approached on campus and handed a flyer advertising the study. Students who were recruited outside of the participant pool program were eligible to enter a draw for a chance to win a \$50 gift voucher. All participants were able to sign up and complete the study at any time or location and on a computer or device (e.g., mobile phone or Ipad) of their choice. They were advised as per the explanatory statement that participation was voluntary, their data were anonymous and that they were able to withdraw from the study at any time without adverse repercussions.

## Materials

**Demographic questionnaire.** The demographic questionnaire obtained information on the participant's age, gender, country of origin, highest level of education completed, whether they used alcohol, caffeine, tobacco or illicit drugs, and if they had ever suffered a serious head injury.

**Toronto Alexithymia Scale-20 (TAS-20).** The TAS-20, developed by Bagby, Parker and Taylor (1994), is a 20-item self-report questionnaire designed to measure alexithymia. The TAS-20 has a three factor structure, Difficulty Identifying Feelings (DIF), Difficulty Describing Feelings (DDF) and Externally Oriented Thinking (EOT), with 7, 5 and 8 items representing each factor respectively as well as an overall total score. For present purposes only the total score was used. Items are rated using a five-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*). Participants are asked to indicate how much they agree or disagree with a statement by selecting one answer for each. Items include "I am often confused about what emotion I am feeling" (DIF), "It is difficult for me to find the right words for my feelings" (DDF) and "I prefer to analyze problems rather than just describe them" (EOT). After reverse scoring five items, a total alexithymia score, with a range of 20 – 100, is obtained by summing the ratings for the 20 items.

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A total score that is equal to or less than 51 indicates no alexithymia, scores between 52 and 60 indicate borderline alexithymia, and scores equal to or greater than 61 indicate high levels of alexithymia. The TAS-20 is reported to have sound validity and adequate to good test-retest reliability and internal consistency for the full scale, with reported Cronbach's alphas of .80 - .86 (Bagby, Parker & Taylor, 1994; Parker, Taylor & Bagby, 2003; Thorberg et al., 2010). Internal consistency for the full scale TAS-20 in the current study was high with a Cronbach's alpha of .85.

**Caffeine Expectancy Questionnaire (CaffEQ).** The CaffEQ, developed by Huntley and Juliano (2012), is a 47-item self-report questionnaire designed to assess a person's beliefs concerning the anticipated outcomes of consuming caffeinated products. The CaffEQ measures caffeine expectancies on seven dimensions: Withdrawal/Dependence, Energy/Work Enhancement, Anxiety/Negative Physical Effects, Social/Mood Enhancement, Appetite Suppression, Physical Performance Enhancement and Sleep Disturbance. The CaffEQ is scored using a six-point Likert scale from 1 (*very unlikely*) to 6 (*very likely*). Sample items include "I need to have caffeine everyday" (Withdrawal/Dependence), "Caffeine makes me feel more alert" (Energy/Work Enhancement), "Caffeine decreases my appetite" (Appetite Suppression), "Caffeine makes me friendlier" (Social/ Mood Enhancement), "I can exercise for longer if I have caffeine" (Physical Performance Enhancement), "Caffeine makes me feel nervous" (Anxiety/Negative Physical Effects) and "Using caffeine late in the day disrupts my sleep" (Sleep Disturbance). Total scores can range from 47 to 282, with higher scores indicating greater endorsement of the likelihood of positive or negative effects of caffeine. Subscale scores can be calculated by summing the subscale items for each factor. Normative data for the CaffEQ was based on a large sample (N = 1046, age range 18 to 75 years) from the general population in the United States (Huntley & Juliano, 2012). The authors reported high test-retest and internal consistency reliabilities for the CaffEQ and its subscales. In the current study, internal consistency was high for both the total scale (.96) and subscales (.86 – .95).

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**Caffeine Consumption Questionnaire (CCQ).** The CCQ was initially developed by Landrum, Meliska and Loke (1988) as a self-report instrument to assess the amount of caffeine consumed through various caffeine vehicles, including caffeinated drinks and over the counter drugs. The CCQ was later refined by Landrum (1992), however the present study used a modified version previously used by Lyvers, Duric and Thorberg (2014) which included new caffeine vehicles such as energy drinks that were not available decades ago. The modified version asks the participant to record the average amount of caffeine (in mg) that they consume each day from a wide variety of listed caffeine sources. Information on the average unit (in mg) is provided to help the participant calculate the average number of milligrams per day consumed for each product. A total score on the amount of caffeine consumed each day (in mg) is obtained by summing the recorded totals for each of the caffeinated products.

**The Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ).** The SPSRQ is a 48 item self-report measure comprised of two independent scales that assess two behavioral systems of Gray's model of personality (Torrubia, Avila, Molto & Caseras, 2001). The Sensitivity to Punishment (SP) scale and the Sensitivity to Reward (SR) scale assess Gray's Behavioral Inhibition System (BIS) and Behavioral Approach System (BAS) respectively. Both scales are comprised of 24 yes-no statements, with odd items comprising the SP scale and even items comprising the SR scale. SP items include "Are you easily discouraged in difficult situations?" and "As a child, were you troubled by punishments at home or at school?" SR items include "Do you like to take drugs because of the pleasure you get from them?" and "Do you like to compete and do everything you can to win?" To obtain SP and SR scores, *yes* answers are summed for the relevant scale to obtain a total score between 0 and 24. Higher scores on the SP or SR scales reflect greater sensitivity to punishment or reward, respectively. Both scales of the SPSRQ were reported to have good long-term (three months to one year) test-retest reliability as well as internal consistency reliability, with reported Cronbach's alphas of .81 - .83 for the SP

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scale and .74 - .78 for the SR scale (Torrubia et al., 2001; O'Connor, Colder & Hawk, 2004). In the current study, the SP and SR scales also had good internal consistency with Cronbach's alphas of .79 and .78, respectively.

**Beck Anxiety Inventory (BAI).** The BAI, developed by Beck, Epstein, Brown and Steer (1988), is a 21-item instrument that consists of descriptive statements designed to assess the severity of anxiety in those aged 17 years and older (Beck & Steer, 1993). The BAI is scored using a four-point Likert scale ranging from 0 (*not at all*) to 3 (*severely; I could barely stand it*) with participants asked to read each item carefully and indicate how much the symptom has bothered them in the past week, including today. BAI items include "Numbness or tingling," "Nervous," and "Indigestion or discomfort in abdomen." A total score between 0 and 63 is obtained by summing responses to each of the 21 items, with higher scores indicating greater anxiety. Scores from 0 to 7 indicate minimal anxiety, scores of 8-15 indicate mild anxiety, scores of 16-25 indicate moderate anxiety and scores of 26-63 indicate severe anxiety. Beck and Steer reported the BAI to have high test-retest and internal consistency reliability in a sample of psychiatric patients, showing a Cronbach's alpha of .92. Similar findings in other populations have also been reported (Fydrich, Dowdall & Chambless, 1990). Internal consistency for the BAI in the current study was also high with a Cronbach's alpha of .91.

**The Alcohol Use Disorders Identification Test (AUDIT).** The AUDIT is a 10-item interview or self-report instrument that was developed to assist in identifying individuals that may have early alcohol problems and to identify those whose alcohol consumption may be causing harm to their health (Babor, de la Fuente, Saunders & Grant, 1992). For each item, participants are asked to indicate a response that best fits their drinking practices. The AUDIT assesses three domains: alcohol consumption (items 1-3), dependence symptoms (items 4-6) and alcohol-related harm (items 7-10). Items for each of these domains respectively include "How often do you have a drink containing alcohol?," "How often during the last year have you found that you were not able

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to stop drinking once you started?” and “How often during the last year have you had a feeling of guilt or remorse after drinking?” Items are scored using a five-point Likert scale with the response options ranging either from 0 (*Never*) to 4 (*4 or more times a week*), 0 (*1 or 2*) to 4 (*10 or more*), 0 (*Never*) to 4 (*Daily or almost daily*), or 0 (*Never*), 2 (*Yes, but not in the last year*) to 4 (*Yes, during the last year*), depending on the question. The AUDIT yields a total score between 0 and 40 by summing item responses. Higher scores indicate greater risk of alcohol-related problems (Babor, Higgins-Biddle, Saunders & Monteiro, 2001). Swedish research using a sample from the general population found good test-retest reliability at a retest interval of one month,  $r = .84$  (Selin, 2003). The AUDIT is also reported to have good internal consistency in university student samples with a reported Cronbach’s alpha of .81 (Kokotailo et. al, 2004). The internal consistency for the scale in the current study was also good with a Cronbach’s alpha of .83.

### Procedure

Once ethical approval was granted by the university ethics committee, participants were either recruited through the university psychology pool or were directly approached by the researcher on the university grounds as described earlier above. Participants accessed the online survey by clicking on a link included in the study sign-up information or, if recruited in-person by the researcher, they were given a link which they could access on the internet at a later time convenient to them. The online survey, administered via Survey Monkey, consisted of an explanatory statement and the questionnaires in a fixed order of demographics questionnaire, BAI, TAS-20, SPSRQ, CCQ, CaffEQ, and AUDIT, followed by a thank you screen with instructions on either how to claim course credit or how to enter the random draw. Once a participant completed a screen they were unable to go back to modify their answers.

### Results

According to their CCQ scores more than half (58%) of the caffeine consumed by participants was in the form of coffee, with tea and energy drinks providing most of the caffeine

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from other sources. Participants categorized as fully alexithymic based on their TAS-20 scores (i.e.,  $> 60$ ; Bagby et al., 1994) comprised 9% of the sample, which is in the middle of the range of alexithymia reported in the general population (Franz et al., 2008; Mattila et al., 2006). Chi-square test showed that alexithymia status was not associated with gender,  $p = .26$ . The TAS-20, AUDIT and CCQ total scores as well as the Withdrawal/Dependence, Physical Performance and Sleep Disturbance subscales of the CaffEQ were all positively skewed and thus underwent square root transformations. BAI scores and the Appetite Suppression subscale of the CaffEQ were more strongly positively skewed and underwent logarithmic transformations. The Energy/Work subscale of the CaffEQ was negatively skewed and therefore underwent a reflect and square root transformation.

**Intercorrelations.** Pearson's correlations were calculated to assess relationships among scale and subscale scores of interest. The intercorrelations for the total scales and CaffEQ subscales are shown in Table 1. As expected, TAS-20 scores were significantly positively correlated with BAI, CCQ, SP and the total CaffEQ. Further, as expected TAS-20 was significantly positively correlated with the Withdrawal/ Dependence subscale of the CaffEQ. However, TAS-20 was also significantly positively correlated with every other CaffEQ subscale except Energy/Work Enhancement. CCQ scores additionally showed significant positive associations with SR and the total CaffEQ along with six of the seven subscales of the CaffEQ. BAI scores were significantly positively correlated with the Anxiety/Negative Physical Effects subscale of the CaffEQ, consistent with a sensitivity of anxious individuals to anxiogenic effects of caffeine.

**Path analyses.** A path analysis was conducted to determine whether caffeine expectancies mediated the relationship between alexithymia and caffeine consumption in line with predictions. In order to test whether mediation exists four conditions must be met (Baron & Kenny, 1986). First, the predictor variable needs to be significantly correlated with the dependent (criterion) variable. Second, the predictor variable also needs to be significantly

correlated with the mediator. Third, the mediator must also be significantly correlated with the dependent variable while controlling for the predictor variable. Finally, a full mediation is determined if the predictor variable does not correlate with the dependent variable when the mediator has been entered into the analysis. In order to test these conditions three regression analyses were conducted and mediation was assessed via a Sobel test. A standard regression analysis found a significant relationship between TAS-20 scores and CaffEQ total scores,  $F(1, 102) = 7.97, p < .01$ , accounting for 6.3% of the variance ( $R^2 = .063, p < .01$ ). A hierarchical regression analysis found a significant relationship between the TAS-20 and CCQ scores,  $F(1, 101) = 7.07, p < .01$ , accounting for 6.5% of the variance ( $R^2 = .07, p < .01$ ). However in step 2 of the hierarchical regression only the mediator, CaffEQ total scores, was significant,  $F(2, 100) = 12.01, p < .001$ , as shown in Table 2. All four conditions of the mediation were thus met and a Sobel test confirmed full mediation, that is, the relationship between alexithymia scores and caffeine consumption was mediated by caffeine expectancies,  $z = 2.82, p < .01$  (see Figure 1).

A second path analysis was conducted to investigate whether the CaffEQ craving item mediated the relationship between TAS-20 alexithymia and CCQ caffeine consumption as predicted. The first standard regression found a significant relationship between TAS-20 scores and the CaffEQ item "I often crave caffeine,"  $F(1, 102) = 5.239, p = .024$ , accounting for 4.9% of the variance ( $R^2 = .049, p < .05$ ). A hierarchical regression analysis found a significant relationship at step 1 between TAS-20 and CCQ scores,  $F(1, 101) = 7.07, p < .01$ , accounting for 6.5% of the variance ( $R^2 = .065, p < .01$ ). In step 2 only craving scores were significant,  $F(2, 100) = 13.40, p < .001$ , as shown in Table 3. All four conditions of the mediation were thus met and a Sobel test confirmed full mediation, that is, the relationship between alexithymia scores and caffeine consumption was mediated by caffeine craving,  $z = 2.03, p < .05$  (see Figure 2).

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## Discussion

The primary predictions of this study were supported. Caffeine expectancies and caffeine craving mediated the relationship between TAS-20 alexithymia scores and caffeine consumption. The present study also replicated the previous findings of Lyvers, Duric and Thorberg (2014) such that TAS-20 scores had significant positive relationships with caffeine consumption and BAI anxiety scores as well as punishment sensitivity as measured by the SP scale of the SPSRQ. Alexithymia scores were positively associated with total CaffEQ caffeine expectancies and with most subscales including Withdrawal/Dependence in line with predictions.

In both social drinkers (Lyvers, Simons, Hayes & Thorberg, 2014) and alcohol dependent samples (Thorberg et al., 2011), alexithymia was found to be associated with the alcohol expectancy of affective change. Thus the association of alexithymia with heavier alcohol consumption appeared to be motivated in part by the expectation of mood altering or disinhibiting effects of the drug. The present study assessed caffeine expectancies in relation to alexithymia scores and caffeine consumption based on the notion that specific expectancies would likewise mediate the link between caffeine and alexithymia as was found for alcohol. However the situation proved far more complex for caffeine than for alcohol as no less than six out of seven caffeine expectancies were significantly positively associated with alexithymia scores, including expectancies of both positive and negative effects of caffeine. Thus the positive association of alexithymia scores with caffeine expectancies may be merely attributable to the fact that those scoring higher on this personality dimension consume more caffeine, have more experience of the drug's effects and therefore stronger expectations of nearly all the effects the drug typically has - which of course leaves open the question of why alexithymia is associated with heavier caffeine consumption in the first place.

One possibility raised by the present findings is that alexithymia is associated with

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greater vulnerability to drug cravings, perhaps due to functional deficiencies in corticolimbic pathways involved in emotional processing and self-regulation. The present finding that caffeine craving mediated the relationship between alexithymia scores and caffeine consumption is consistent with previous research findings that alexithymia is associated with stronger substance cravings and more substance-related intrusive thoughts (Lyvers, Lysychka & Thorberg, 2014; Thorberg et al., 2011a). Thus even in the case of the mild psychoactive drug caffeine, it appears that those scoring higher on alexithymia experience stronger cravings that drive them to seek and consume the drug at higher levels. Given the high prevalence of alexithymia in clinical samples of substance dependent patients (e.g., Lyvers, Hinton et al., 2014; Thorberg et al., 2009) and the association of alexithymia with heavier substance use in the general community (e.g., Lyvers et al., 2012, 2013), those with higher levels of alexithymia may be particularly susceptible to drug cravings and compulsive use. Alexithymia may thus serve as a marker for poor executive self-regulation, encompassing not only the regulation of negative emotional states (e.g., Lyvers, Makin, Toms, Thorberg & Samios, 2014) but also aversive craving states as well. The association of alexithymia with eating disorders (Nowalkowski, McFarlane & Cassin, 2013) is also relevant in this context, as not only do eating disorders involve food cravings but also many caffeinated beverages are regarded as pleasantly flavorful by most consumers. Future research could thus examine potential associations between the alexithymia dimension and non-drug forms of craving, such as cravings for food.

The present study had a number of limitations that must be considered. One was the predominantly female university student sample, which limits the generalizability of the findings. As discussed earlier however, according to previous research alexithymia does not show consistent associations with gender, and this was the case in the present study as well. The sample size lacked sufficient power to compare the seven caffeine expectancies assessed

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by the CaffEQ between fully alexithymic participants (9% of the sample) and those without alexithymia, however as mentioned above alexithymia scores were significantly positively related to all but one of the seven caffeine expectancies assessed by the CaffEQ, so the likelihood of a particular expectancy uniquely distinguishing between those with alexithymia and those without alexithymia (as was previously found for alcohol expectancies) would appear to be minimal in any case. Despite its limitations, the present study succeeded in supporting its predictions, and the results add to the current theoretical understanding of the links between alexithymia, social cognitive theory, craving and substance use.

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Table 1

*Intercorrelations for Scores on the TAS-20, BAI, CCQ, SPSRQ SP and SR, AUDIT, CaffEQ total and CaffEQ subscales*

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. TAS-20 <sup>a</sup>	-													
2. BAI <sup>#</sup>	.410**	-												
3. CCQ <sup>a</sup>	.256**	.176	-											
4. SP	.278**	.267**	.146	-										
5. SR	.176	.133	.215*	.191	-									
6. AUDIT <sup>a</sup>	.171	-.019	-.134	.030	.424**	-								
7. CaffEQ	.269**	.372**	.415**	.116	.225*	.096	-							
8. CaffEQ-W/D <sup>a</sup>	.213*	.250*	.454**	.039	.123	.003	.851**	-						
9. CaffEQ-E/WE <sup>a</sup>	-.114	-.304**	-.271**	-.016	-.152	-.152	-.768**	-.571**	-					
10. CaffEQ-AS <sup>a</sup>	.264**	.354**	.223*	.106	.312**	.125	.681**	.463**	-.407**	-				
11. CaffEQ-S/ME	.246*	.271**	.332**	.045	.181	.092	.854**	.706**	-.800**	.502**	-			
12. CaffEQ-PPE <sup>a</sup>	.206*	.277**	.255**	.071	.151	.067	.667**	.532**	-.514**	.496**	.593**	-		
13. CaffEQ-A/NPE	.239*	.338**	.258**	.257*	.196*	.101	.617**	.342**	-.259**	.471**	.355**	.248*	-	
14. CaffEQ-SD <sup>a</sup>	.198*	.199*	.180	.141	.095	.020	.575**	.299**	-.320**	.381**	.331**	.319**	.602**	-

*Note.* TAS-20 = Toronto Alexithymia Scale-20. BAI = Beck Anxiety Inventory. CCQ = Caffeine Consumption Questionnaire. SP = Sensitivity to Punishment subscale. SR = Sensitivity to Reward subscale. AUDIT = Alcohol Use Disorders Identification Test. CaffEQ = Caffeine Expectancy Questionnaire. W/D = Withdrawal/Dependence subscale. E/WE = Energy/Work Enhancement subscale. AS = Appetite Suppression subscale. S/ME = Social/Mood Enhancement subscale. PPE = Physical Performance Subscale. A/NPE = Anxiety/Negative Physical Effects subscale. SD = Sleep Disturbance subscale.

<sup>a</sup>Transformed scores.

\* $p < .05$ . \*\* $p < .01$

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Table 2

*CaffEQ Caffeine Expectancies as a Mediator of the Relationship Between TAS-20 Alexithymia and CCQ Caffeine Consumption*

Variables	$\Delta R^2$	B	SE B	$\beta$	t
CaffEQ total score (DV)					
Step 1	.07*				1.63
TAS-20 <sup>a</sup>		12.54	4.44	.27	2.82**
CCQ <sup>a</sup> (DV)					
Step 1	.07*				0.23
TAS-20 <sup>a</sup>		1.93	0.73	.26	2.66*
Step 2	.13**				-0.36
TAS-20 <sup>a</sup>		1.15	0.71	.15	1.62
CaffEQ total score		0.06	0.02	.37	3.99**

Note: DV = Dependent variable. CaffEQ = Caffeine Expectancy Questionnaire.

CCQ = Caffeine Consumption Questionnaire. TAS-20 = Toronto Alexithymia Scale-20.

<sup>a</sup>transformed scores.

\* $p < .01$ . \*\* $p < .001$ .

Table 3

*Caffeine Craving as a Mediator of the Relationship Between TAS-20 Alexithymia and CCQ Caffeine Consumption.*

Variables	$\Delta R^2$	B	SE B	$\beta$	t
CaffEQ item 'I often crave caffeine' (DV)					
Step 1	.05*				-0.21
TAS-20 <sup>a</sup>		0.42	1.82	.22	2.29*
CCQ <sup>#</sup> (DV)					
Step 1	.07**				0.23
TAS-20 <sup>a</sup>		1.93	0.73	.26	2.66**
Step 2	.15***				0.35
TAS-20		1.27	0.69	.17	1.84
CaffEQ item 'I often crave caffeine'		1.57	0.36	.39	4.30***

Note: DV = Dependent variable. CaffEQ = Caffeine Expectancy Questionnaire. CCQ = Caffeine Consumption Questionnaire. TAS-20 = Toronto Alexithymia Scale-20.

<sup>a</sup>transformed scores.

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

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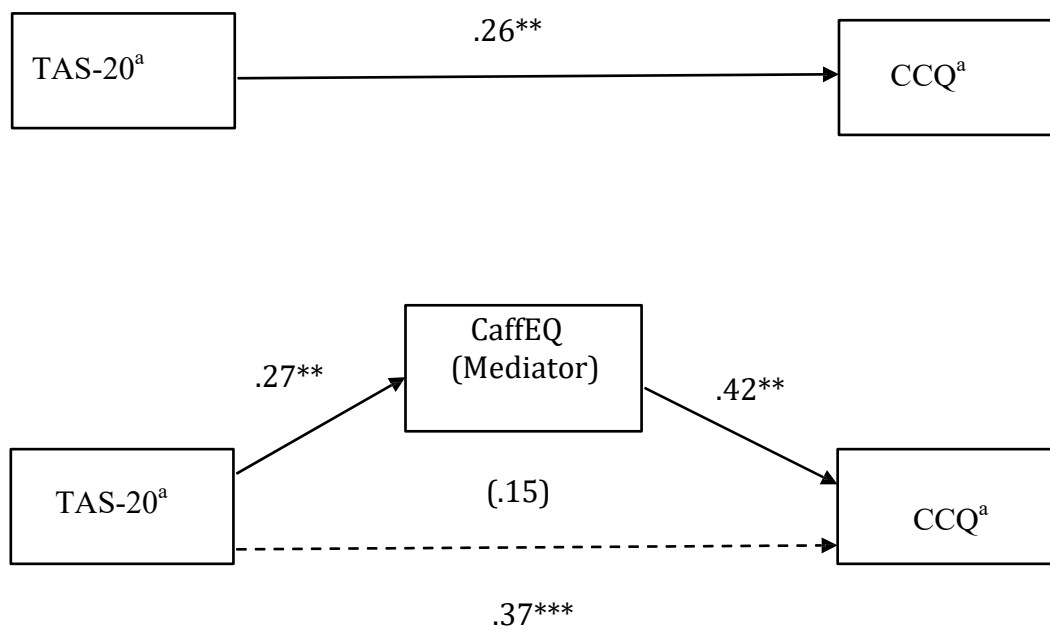
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Figure 1. The direct and mediated pathways between TAS-20, CaffEQ and CCQ scores.

Note: Values represent standardized weights.

<sup>a</sup>transformed scores.

\* $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .



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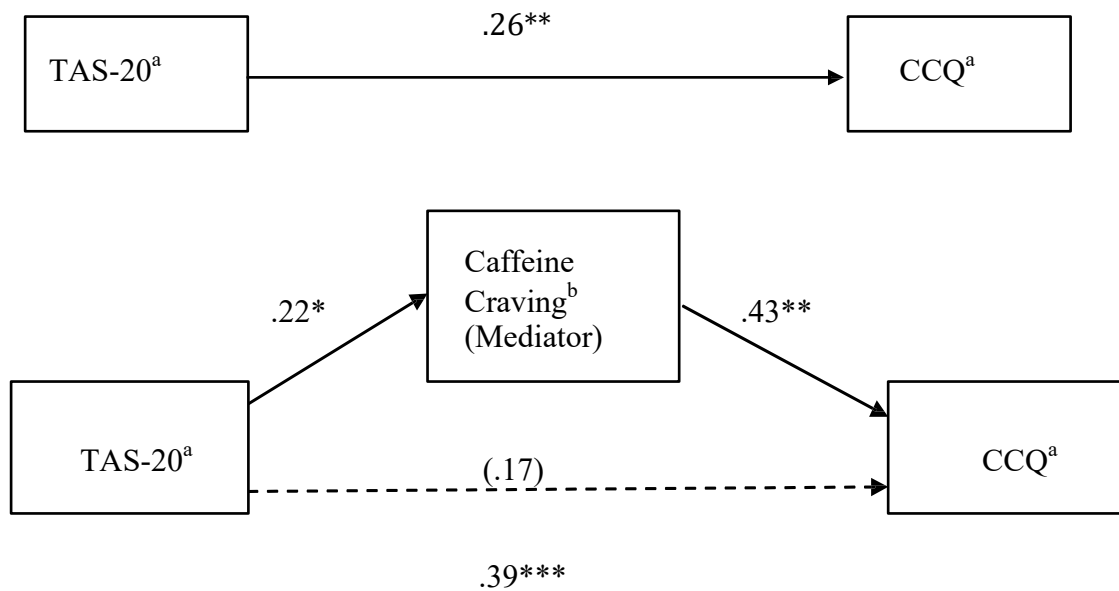
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Figure 2. The direct and mediated pathways between TAS-20, Caffeine Craving and CCQ scores.

Note: Values represent standardised weights.

<sup>a</sup>transformed scores. <sup>b</sup>Caffeine Expectancy Questionnaire item 'I often crave caffeine.'

\* $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .



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