CONFIRMATORY FACTOR ANALYSIS AND TEMPORAL STABILITY OF THE CAFFEINE EXPECTANCY QUESTIONNAIRE (CaffEQ)

By

Edward D. Huntley

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Chair:

Laura M. Juliano, Ph.D.

David A.F. Haaga, Ph.D.

James J. Gray, Ph.D.

Tracy Sbrocco, Ph.D.

Dean of the College of Arts and Sciences

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Date

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DEDICATION

This work is dedicated to my wife, Anu Agrawal and my family. Thank you for all of the years you have unfailingly given me your love and support. This degree is surely yours as much as it is mine. To my parents, I am indebted to you for instilling in your children the highest appreciation and respect for education.

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ABSTRACT

Caffeine is the most widely consumed behaviorally active drug in the world, yet little is known about the expectancies consumers have about its effects. In a series of prior studies, we assessed self-reported expectancies for caffeine among caffeine consumers and non-consumers to identify the nature and scope of caffeine expectancies and to develop a valid and reliable seven factor caffeine expectancy questionnaire (CaffEQ). In the present study the CaffEQ was administered to 665 participants to evaluate the fit of the hypothesized seven factor CaffEQ. Associations between CaffEQ factors and caffeine exposure, frequency of caffeine use, symptoms of substance dependence and caffeine administration vehicle were also accessed. The CaffEQ was readministered to 440 (66.2%) of the original sample approximately two weeks later to assess the temporal stability of the CaffEQ factors. Confirmatory factor analysis confirmed the seven factor solution indicating good model fit and test-retest reliability. The frequency and quantity of caffeine use was associated with greater expectancies for Withdrawal/Dependence, Energy/Work Enhancement, Appetite Suppression, Social/Mood Enhancement, and Physical Performance Enhancement and lower

expectancies for Anxiety/Negative Physical Effects and Sleep Disturbance, with the largest effects observed in the Withdrawal/Dependence scale. Caffeine expectancies predicted various features of substance dependence (e.g., use despite harm, withdrawal incidence and severity, perceived difficulty stopping use, tolerance) as well as latency to consume caffeine after waking. Expectancies for caffeine consumed via coffee were stronger than for caffeine consumed via soft drinks. The CaffEQ demonstrates good reliability and construct validity, and should facilitate the advancement of our knowledge of caffeine and drug use in general.

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CHAPTER 1

INTRODUCTION

Caffeine (1,3,7- trimethylxanthine) is the most widely consumed behaviorally active substance in the world (Bastia & Schwarzschild, 2003; James, 1997). It is found naturally in more than 60 species of plants (e.g., coffee, tea, cocoa) and is added to a variety of food products (e.g., carbonated beverages) and medications (e.g., analgesics) (Juliano, Anderson, & Griffiths, 2011). Approximately 87% of children and adults in the United States report regular use of caffeinated products (Frary, Johnson, & Wang, 2005) with an average daily intake among adult consumers of approximately 280 mg, or the equivalent of about 2 cups of coffee (Barone & Roberts, 1996).

The pharmacological effects of caffeine are well documented and are most likely mediated via antagonism of the endogenous neuromodulator adenosine, and functional relationships between adenosine and other neurotransmitter systems (e.g., dopamine; (Ferre, 2008). Low to moderate doses (e.g., 20-200 mg) of caffeine produce positive subjective effects including increased energy, alertness, well-being, and sociability, and decreased sleepiness and fatigue (Juliano et al., 2011). Furthermore, caffeine may improve cognitive and behavioral performance, especially under conditions of fatigue, sleeplessness or caffeine abstinence (James, 1997) and may improve athletic performance under certain conditions (Ganio, Klau, Casa, Armstrong, & Maresh, 2009). At higher acute doses (> 200 mg), caffeine is more likely to produce negative subjective effects such as anxiety, jitteriness, and gastrointestinal disturbances, and at very high doses can

produce restlessness, tremors, tachycardia, and psychomotor agitation (cf., Caffeine intoxication, (American Psychiatric Association, 2000). Caffeine also has negative effects on planned sleep, including delaying sleep onset and decreasing the reported quality of sleep (Alford, Bhatti, Leigh, Jamieson, & Hindmarch, 1996; Snel & Lorist, 2011). The physiological effects of caffeine include increased blood pressure, urinary output, respiration, gastric secretions, and colonic motor activity (Juliano et al., 2011).

Although caffeine is generally safe at typical dietary doses (i.e., < 400 mg per day), some behavioral features of caffeine use mirror behaviors associated with classic drugs of dependence. For example, chronic use of caffeine produces tolerance, as well as a characteristic withdrawal syndrome (e.g., headache, fatigue) among individuals who use as little as 100mg per day (Juliano & Griffiths, 2004). Many habitual caffeine consumers report an inability to modify caffeine use despite a desire to do so (Hughes & Oliveto, 1997). Caffeine can also cause discrete psychopathology (e.g., caffeine induced anxiety disorder, DSM-IV-TR, 2000), and can exacerbate existing psychological (e.g., anxiety, insomnia) or medical disorders (James, 2004). Furthermore, there is evidence that some individuals may continue to use caffeine despite experiencing symptoms indicative of a substance dependence problem (Oberstar, Bernstein, & Thuras, 2002; Strain, Mumford, Silverman, & Griffiths, 1994; Svikis, Berger, Haug, & Griffiths, 2005). In a three year retrospective analysis of individuals seeking care for caffeine abuse of supplemental caffeine 25.2% indicated their use of caffeine was for energy enhancement while 4.7% reported enhancement of mood. In this cohort 13% required hospitalization with 65% requiring admission to an intensive care unit (McCarthy, Mycyk, & DesLauriers, 2008). Hospitalization was highly correlated with concomitant recreational

abuse of other pharmaceutical products. Caffeine-related fatalities have also been reported in several case reports (Holmgren, Norden-Pettersson, & Ahlner, 2004; Kerrigan & Lindsey, 2005), including incidents where dietary supplements were misused and suicide.

Despite the widespread use of caffeine among individuals of all ages, its well-documented pharmacological effects, and its similarities to other recreational drugs, very little is known about individual's beliefs about the effects of caffeine. Beliefs about the effects of drugs, or drug expectancies, have been shown to be important predictors of drug taking behavior and drug effects. Thus, this represents an important gap in our knowledge about the worlds' most widely consumed mood altering drug.

Expectancies refer to an individual's beliefs about the expected outcome of a particular behavior. It is believed that drug expectancies are acquired via direct experiences with a drug as well as through observational learning and/or suggestion (Bandura, 1977, 1986). According to Social Learning Theory (SLT), expectancies can influence an individual's decision to take a particular course of action (e.g., deciding whether to consume a drug, Bandura, 1977, 1986). There is also evidence that drug expectancies may play a direct role in influencing the drug experience (i.e., the placebo effect, Kirsch, 1999). Research on drug outcome expectancies has been facilitated through the use of valid self-report instruments. Self-report expectancy measures have been developed for alcohol (Brown, Goldman, Inn, & Anderson, 1980), tobacco (Copeland, Brandon, & Quinn, 1995), marijuana (Schafer & Brown, 1991), cocaine (Jaffe & Kilbey, 1989), ecstasy (Engels & ter Bogt, 2004), methamphetamine (Halkitis, Mukherjee, & Palamar, 2007) and nicotine replacement products (Juliano & Brandon,

2004). Some have postulated that expectancies are epiphenomena correlates of previous behavior (Wilkins, 1986). However, longitudinal data on drug use motivation spanning a nine-year developmental trajectory from adolescence to adulthood supported the role of expectancy theory as a nonspurious and functionally autonomous influence on the use and abuse of drugs; adolescent alcohol motivation predicted a range of functionally related behaviors e.g. adult marijuana motivation (Stacy, MacKinnon, & Pentz, 1993; Stacy, Newcomb, & Bentler, 1991). Self-report expectancy measures have been shown to predict drug initiation, cessation, and relapse (Christiansen, Smith, Roehling, & Goldman, 1989; Copeland et al., 1995; Dijkstra & Borland, 2003; Halkitis et al., 2007) and reliably discriminate users from nonusers (Brandon & Baker, 1991; Engels & ter Bogt, 2004; Fromme, Stroot, & Kaplan, 1993; Jaffe & Kilbey, 1989; Schafer & Brown, 1991). Furthermore, assessment of expectancies has facilitated the understanding of placebo effects (Juliano & Brandon, 2002; Kirsch & Weixel, 1988), and there is evidence that manipulating drug expectancies influence both subjective and behavioral drug effects (Brandon, Juliano, & Copland, 1999; Fillmore & Vogel-Sprott, 1992; Fucito & Juliano, 2007; Harrell & Juliano, 2009).

It recently has been speculated that expectancies are the prime determinants of caffeine withdrawal symptoms (Dews, O'Brien, & Bergman, 2002; Rubin & Smith, 1999). However, there have been no controlled studies evaluating the role of expectancies in actual withdrawal symptomatology (see Juliano & Griffiths, 2005). Furthermore, very little is known about caffeine consumers' beliefs about the consequences of abstaining from caffeine. (Goldstein & Kaizer, 1969) asked coffee users what they would expect to happen if morning coffee was omitted. Participants reported that they would experience

irritability, inability to work effectively, nervousness, restlessness, lethargy, and headache with the heaviest users (5 or more cups daily) endorsing such symptoms to the greatest extent. Clearly, more information is needed about expectancies for caffeine withdrawal and how they may influence the manifestation of withdrawal symptoms.

Caffeine is no doubt an important model drug for investigating placebo effects and there is some evidence that placebo effects can be predicted from self-reported expectancies for caffeine. To date placebo studies that have assessed caffeine expectancies have focused on one particular effect and have used either 1-item and/or unvalidated measures. A validated measure that assesses the full range of potential beliefs about the effects of caffeine is needed.

There have been previous attempts to assess beliefs about the effects of caffeine however, heretofore a comprehensive and psychometrically sound measure of caffeine expectancies has been lacking. Perceptions of whether caffeine induced psychiatric and somatic effects (e.g., caffeine helps me think more clearly) were assessed among 152 medical inpatients with an 11-item measure (Greden, Victor, Fontaine, & Lubetsky, 1980). No psychometric information was provided about the 11-item expectancy measure. In another study, a 33-item survey about perceptions of caffeinated and non-caffeinated beverages mostly pertaining to health-related outcomes was administered to 238 undergraduates enrolled in a personal health class (97% Caucasian, M = 19.6 years) (Page & Goldberg, 1986). The survey consisted of 33 items that primarily assessed beliefs about the health effects of caffeine, positive and negative mood effects of caffeine, and taste and refreshing nature of caffeine. Individuals who preferred non-caffeinated beverages more strongly endorsed beliefs that caffeine was habit forming, and

led to poor health outcomes (e.g., caused ulcers, high blood pressure) and negative mood (e.g., irritability, nervousness) than those who preferred caffeine-containing beverages. However, these findings may not generalize well since the sample was limited to a relatively young undergraduate population enrolled in a personal health class. Furthermore, it is unclear how the items were developed and they do not address the full scope of beliefs about caffeine as most were health-related items. The assessment was comprised of a range of effects but no common factors were reported. Moreover, there is no information about psychometric properties of the measure and thus its reliability and validity is unknown. Bradley and Petree (1990) investigated the performance enhancing effects of caffeine (e.g., increase energy, improved concentration) and found that they were positively associated with reported caffeine consumption and reported symptoms of caffeine intoxication (Bradley & Petree, 1990). Although the authors replicated their results with two separate of undergraduate samples, Cronbach's alpha for the six-item expectancy measure was modest (.71 for study one and .73 for the follow up study). In addition, it is not clear how items were selected and evaluated for the inclusion in the assessment. Heinz, Kassel and Smith (Heinz, Kassel, & Smith, 2009) developed a 37-item four-factor caffeine expectancy questionnaire that accesses caffeine expectancies associated with withdrawal symptoms, positive effects, acute negative effects and mood effects. However, this measure has several significant limitations that may limit its genralizability and utility. The alcohol and smoking expectancy literature suggests that as people become more experienced with drugs their expectancies get more refined (Christiansen, Goldman, & Inn, 1982; Gustafson, 1992; Myers, McCarthy, MacPherson, & Brown, 2003; Wiers, Hoogeveen, Sergeant, & Boudewijn Gunning, 1997) therefore

the genralizability of these constructs is questionable since study participants were recruited from an undergraduate psychology participant pool. In addition to a relatively young and highly educated sample, non-caffeine consumers or users with high exposure were not included in item development and subsequent exploratory analyses. Leigh (1989) recommends including all types of drug users in the development of drug expectancy measures so that the full range of expectancies across the continuum of drug exposure is assessed. The quantification of caffeine exposure in the Heinze et al. (2009) sample was not estimated. Only the frequency of consumption of caffeine was included, making it difficult to understand how caffeine exposure is associated with caffeine expectancies beyond frequency of exposure. Caffeine exposure can vary based on frequency of exposure and the caffeine containing vehicle which can vary and extend beyond beverages to include dietary supplements, food and medications/pills. The Heinze et al. (2009) expectancy scale references drinking caffeinate beverages rather than caffeine in general which limits it generalizability. In addition, an agreement scale was used rather than a likelihood scale which would provide greater sensitivity allowing one to compare the relative strength of different beliefs and make comparisons across different situations (Leigh, 1989). Lastly the Heinze et al. (2009) caffeine expectancy questionnaire is exploratory in nature and the validity of the four factors derived have not been subjected to subsequent hypotheses testing through confirmatory factor analysis nor has the temporal stability been assessed.

These previous measures are quite limited as they do not cover the full scope of beliefs about caffeine, lack psychometric information, and target small and select subgroups. Other attempts to assess caffeine expectancies have been limited to an

analysis of only one-item or one category of potential consequences (e.g. performance effects) to reach conclusions about the relationship between self-reported expectancies and placebo effects (e.g., caffeine enhances performance, Fillmore, Mulvihill, & Vogel-Sprott, 1994; Fillmore & Vogel-Sprott, 1992; Kirsch & Weixel, 1988). One-item assessments or one construct assessments clearly limit our knowledge of the possible range of expectancies held for caffeine and have questionable psychometric properties. A validated assessment of expectancies covering the full range of effects of caffeine should facilitate the advancement of our knowledge of the role of expectancies for caffeine and drug effects in general.

The Caffeine Expectancy Questionnaire (CaffEQ) (Huntley & Juliano, 2007) was developed through a series of independent studies designed to elucidate the nature and scope of caffeine expectancies among a heterogeneous sample caffeine consumers and non-consumers. Unlike previous attempts to characterize caffeine expectancies, the development of the CaffEQ was not limited to an undergraduate student sample and included participants with a full range of caffeine exposure; including non-consumers. In addition, an estimate of caffeine exposure was quantified and the caffeine containing vehicle was specified by study participants rather than exclusively referring to drinking caffeinated beverages to access expectancies for caffeine. Exploratory factor analysis of the CaffEQ yielded a seven-factor solution including: Withdrawal/Dependence, Energy/Work Enhancement, Appetite Suppression, Social/Mood Enhancement, Physical Performance, Anxiety/Negative Physical Effects and Sleep Disturbance. The frequency and quantity of caffeine use was associated with greater expectancies for Withdrawal/Dependence, Energy/Work Enhancement, Appetite Suppression,

Social/Mood Enhancement, and Physical Performance Enhancement and lower expectancies for Anxiety/Negative Physical Effects and Sleep Disturbance. Expectancies for caffeine consumed via coffee were stronger than for caffeine consumed via soft drinks or tea. CaffEQ factors were also associated features of substance dependence (e.g., withdrawal severity, perceived difficulty stopping use). The CaffEQ measures the full scope of caffeine expectancies, has good reliability and construct validity. However, as with previous attempts to understand caffeine expectancies, the development of the CaffEQ was data driven and exploratory in nature. Testing the stability of the hypothesize seven-factor model of the CaffEQ and evaluating the temporal stability of the CaffEQ would help determine it the CaffEQ offers a more comprehensive and well validated instrument to assess expectancies for caffeine.

The development of assessment instruments, like the CaffEQ, often employs using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) in conjunction. Both EFA and CFA are based on the common factor model, however, EFA is a data driven and exploratory method to estimate the amount of variability among observed variables attributed to common factors (i.e. communality) to determine latent factor structure. CFA, on the other hand, is a special case of structural equation modeling that accesses the extent to which observed variables are associated to their latent factors; therefore CFA is a theoretically driven method of evaluation a hypothesized latent factor structure. CFA also provides one with several fit indices which may be utilized to identify areas of model misspecification.

This study was designed to improve the of investigation caffeine expectancy factors by addressing limitations of earlier research through the utilization of more rigorous methodology and a more heterogeneous sample with the intention of deriving results that may be generalizable to a larger group of individuals. The purpose of this investigation was to extend the development of the CaffEQ beyond exploratory analyses by utilizing CFA to test the validity of the hypothesized factor structure of the CaffEQ proposed by Huntley and Juliano (2007). This study represents the first attempt to characterize caffeine expectancy factors beyond an exploratory analysis by employing CFA. The seven-factor structure of the CaffEQ was expected to be replicated within a heterogeneous sample of caffeine consumers and to have stability over a test-retest interval of two weeks. We also expect to replicate our findings from our exploratory analysis of the CaffEQ by demonstrating that the CaffEQ factors are significantly correlated with caffeine exposure and frequency of use. As has been found with other drugs, it was hypothesized that the frequency and quantity of caffeine consumed and signs of substance dependence (e.g., withdrawal symptoms, difficulty stopping use) would be positively correlated with positive caffeine expectancies and negatively correlated with negative caffeine expectancies. We also predicted that individuals would hold the strongest expectancies for caffeine self-administered via coffee.

CHAPTER 2

METHODS

Participants

The present study was conducted in two phases, a baseline and a follow up assessment for which participants were recruited from various sources. Participant characteristics for each study phase are shown in Table 1.

Baseline assessment: large sample questionnaire administration with confirmatory factor analysis. Participants (N = 751) were recruited from various major metropolitan cities in the United States (e.g. Atlanta, Chicago, District of Columbia, Los Angeles, Miami, New York and Seattle) via advertisements (e.g., web-bulletin boards, flyers, word of mouth) inviting participants to complete a web-based survey on caffeine and its effects. We excluded from analysis 86 participants with incomplete or clearly spurious responses resulting in a total of sample of 665 participants. Participants ranged from 18 – 74 years old (M = 30.4 years). The majority of participants were female (81.0%), Caucasian (85.0%) and not college undergraduates (74.1%).

Follow up assessment: test-retest reliability. All study participants who completed the baseline assessment were invited to complete a follow up assessment two weeks after their initial assessment with 66.2% of respondents (N = 440) participating with the following demographic characteristics: ages 18 – 71 years old (M = 29.5 years), a majority were female (79.3%), Caucasian (83.8%) and not undergraduates (73.7%).

Table 1

Study Demographic Characteristics

	Baseline *M (SD)*	Follow-up *M (SD)*
Number of participants	665	440
Gender (% female)	81.00%	79.30%
Age	30.4 (12.0)	29.5 (11.6)
Race, %		
African American	4.9%	5.2%
Asian	4.0%	3.6%
Caucasian	85.0%	83.8%
Other	6.1%	7.3%
University/College student, %	25.9%	26.3%
Caffeine consumers (>20 mg/day), %	92.0%	90.6%
Daily caffeine use, %	58.6%	57.5%
Daily caffeine exposure among consumers (mg)	375.9 (319.1)	356.6 (310.2)
Daily caffeine exposure among consumers for beverages (mg)	362.3 (309.7)	349.7 (399.6)

Measures

Caffeine Exposure Questionnaire. This measure assessed current consumption of caffeinated products. Participants were asked to indicate the number of servings, typical serving size, typical brand, and number of days per week they consumed coffee, tea, caffeinated soft drinks, energy drinks, chocolate, and caffeine-containing medications/dietary supplements and foods. Data was entered into a spreadsheet that calculated total daily caffeine exposure. Caffeine values in the spreadsheet were obtained directly from manufacturers or were based on standard caffeine levels in various products (e.g., coffee) (Barone & Roberts, 1984, 1996; DeVellis, 2003; Nunnally & Bernstein, 1994). The data was entered by two independent raters and then checked for consistency.

Any discrepancies greater than 10 mg per day were then evaluated and rectified by a third rater. This measure has been used in a number of previous studies assessing caffeine consumption (Svikis et al., 2005).

Caffeine History and Caffeine Dependence Symptoms. Respondents were asked questions regarding their history of caffeine consumption and questions pertaining to some features of a DSM-IV-TR defined substance dependence syndrome including tolerance (same amount has less of an effect or need more to get the same effect), use of caffeine to alleviate or avoid withdrawal symptoms, using more than intended, physical or psychological problems (e.g., insomnia, anxiety) caused or made worse by caffeine. Participants were also asked if they had experienced caffeine withdrawal symptoms in the past year or ever, and asked to rate the severity of the symptoms on a scale from 1 (very mild) to 10 (extremely severe). Participants were asked to indicate how soon after waking up they consume their first caffeinated products with 5 choices ranging from 1. within 15 minutes to 5. greater than 2 hours. They were also asked to rate how difficult it would be to completely stop (or cut down) caffeine use on a scale from 1(not at all difficult) to 10 (extremely difficult). Lastly, they were asked to rate their desire to stop caffeine use from 1 (no desire at all) to 10 (very strong desire).

Caffeine Expectancy Questionnaire (CaffEQ; Huntley & Juliano, 2007). The CaffEQ is a 47-item self-report measure which accesses a range of expectancies for caffeine including: Withdrawal/Dependence, Energy/Work Enhancement, Anxiety/Negative Physical Effects, Social/Mood Enhancement, Appetite Suppression, Physical Performance Enhancement, and Sleep Disturbance. The CaffEQ has high

internal reliability (Cronbach's alpha = .80-.86). In the present study, total scale responses produced an overall alpha coefficients of .80 - .94. The CaffEQ also has good construct validity correlating with quantity of caffeine exposure, frequency of exposure, dependence and measures of anxiety and sleep quality.

Procedures

To assess the reliability of the CaffEQ factor structure and the test-retest reliability participants (N = 665) completed a web-based survey including the 47-item CaffEQ, current caffeine consumption and caffeine dependence symptoms. Upon completion study participants were directed to another secure website where they could enter a raffle for a chance to win one of 5 cash prizes (ranging between US $25 and US $200). If a participant was a student at American University and eligible to earn extra credit for participation in research a research study they had the option to earn extra credit to be applied towards a course rather than enter the raffle. Two weeks subsequent to completing the baseline assessment participants were invited to complete the CaffEQ and questions pertaining to caffeine dependence symptoms. Upon completion of the follow up survey, study participants were directed to another secure website where they could enter a raffle for an additional chance to win one of 5 cash prizes or receive extra credit towards a course if they were an eligible university student.

CHAPTER 3

RESULTS

Caffeine Exposure

Table 1 summarizes caffeine exposure variables for baseline and follow up assessments. Caffeine consumers were defined by mean consumption of greater than 20 mg of caffeine per day. Approximately 92.0% (*n* = 611) of participants were identified as caffeine consumers. Average caffeine exposure from all sources among consumers was 375.9 (*SD* = 319.1) mg/day. Average caffeine exposure from just beverages was 362.3 (*SD* = 309.7) mg/day. Participants were required to indicate which caffeinated product they used as the basis for their ratings of the expectancy statements. Coffee consisted of the majority of responses (*n* = 337, 50.7%) followed by soft drinks (*n* = 131, 19.7%), caffeine in general *(n* = 124, 18.6%), tea (*n* = 52, 7.8%), pills containing caffeine (*n* = 8, 1.2%) and other sources (e.g. energy drinks) (*n* = 13, 2.0%). No significant differences were observed between baseline and follow up assessment for frequency of caffeine exposure or proportion of caffeine consumers.

Confirmatory Factor Analysis (CFA)

To test the relative fit of the seven-factor CaffEQ model, a maximum likelihood CFA using the covariance matrix as input (LISREL version 8.8; Diamantopoulos & Siguaw, 2000) was performed in a sample of 665 participants. The overall fit of the model was evaluated using the following indices: (a) Comparative Fit Index (CFI; Bentler, 1990), (b) Non-normed Fit Index (NNFI; Bentler & Bonett, 1980), (c) Root

Mean Square Error of Approximation (RMSEA; Browne & Cudeck, 1992) and, (d) Standardized Root Mean Square Residual (SRMR; Jöreskog & Sörbom, 1996). A combination of indices was used to assess fit because neither index is unequivocally superior to the rest in all circumstances therefore consistency across various indices was used as the criterion in which to judge the acceptability of fit. An acceptable fit was determined if CFI, NNFI > .90. RMSEA measures the discrepancy per degree of freedom and is based on population error of approximation, with a values < .05 indicating a good fit and values between .05 to .08 indicating a reasonable fit. SRMR measures the average difference between the sample and the estimated population variances and covariances, with values ≤ .80 considered reasonable (Diamantopoulos & Siguaw, 2000; Hu & Bentler, 1999). The construct reliability was evaluated by calculating the composite reliability (ρc) for each factor (Diamantopoulos & Siguaw, 2000) with values greater than .6 indicating reliable measures for a given construct. In addition, the average variance extracted (ρv) i.e. the amount of variance captured by the factor relative to the amount of variance due to measurement error was also calculated with values > .5 being desirable.

Shown in Figure 1 are the standardized estimates resulting from testing the hypothesized seven-factor CaffEQ CFA model. The seven-factor CaffEQ had the following fit indexes: (a) CFI = .98, (b) NNFI = .98, (c) RMSEA = .06 and, (d) SRMR = .08 suggesting a satisfactory fit for the model. Composite reliability estimates ranged from.92 - .97 (Table 2), exceeding the .60 recommendation (Diamantopoulos & Siguaw, 2000), indicating adequate construct reliability for the CaffEQ factors. In addition, the amount of variance captured by the CaffEQ factors ranged from .56 - .82 (Table 2),

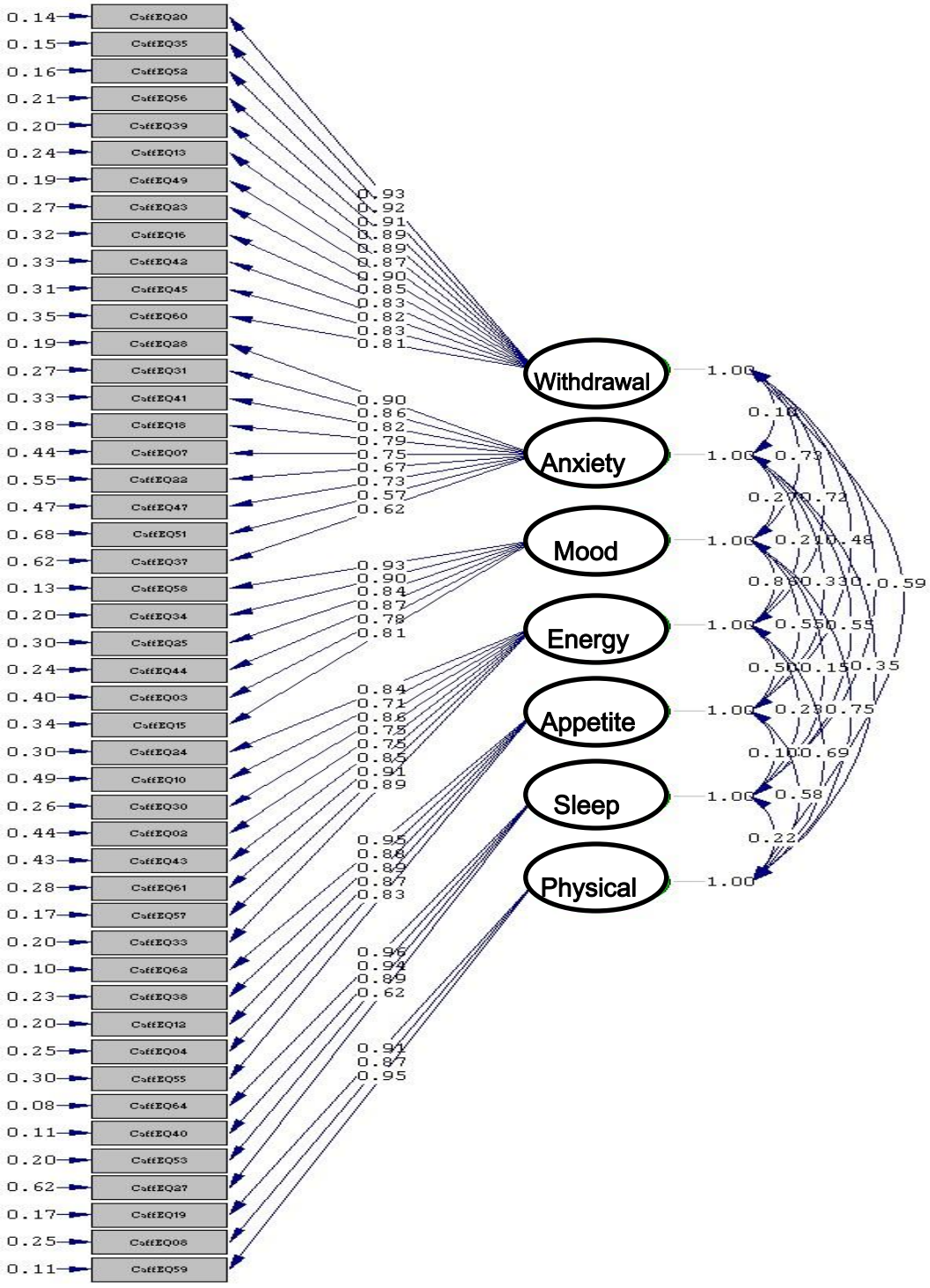

Figure 1. Standardized Parameter Estimates for the Hypothesized Seven-Factor Confirmatory Factor Analysis Model for the Caffeine Expectancy Questionnaire (CaffEQ)

exceeding the .50 recommendation (Diamantopoulos & Siguaw, 2000) indicating that the amount of variance captured by the factor was greater than measurement error, adding additional support for the support for reliability of the seven CaffEQ factors.

Table 2

CaffEQ CFA and Test-retest Reliability Estimates

	CFA (n = 665)		Test-retest (n = 440)
CaffEQ factor	Composite reliability (ρc)	Average variance extracted (ρv)	*r*
Withdrawal/Dependence	.97	.76	.94
Energy Enhancement	.94	.68	.88
Appetite Suppression	.95	.79	.84
Mood Enhancement	.94	.73	.89
Physical Performance Enhancement	.93	.82	.80
Anxiety/Negative Physical Effects	.92	.56	.89
Sleep Disturbance	.92	.75	.83

A one factor model was also given consideration and evaluated relative to the seven factor model for the CaffEQ. The fit indices for the one factor model yielded weak fit indices and relative to the seven factor model the AIC values indicated that the seven factor model was a more parsimonious fit compared to the one factor model (Table 3). These data suggest that the seven factor model was a better fit for the present sample. The intercorrelations among the seven CaffEQ factors (Table 4) ranged from .07 - .78

indicating shared variance among the factors and support of the original oblique factor utilized in the EFA.

Table 3

CaffEQ Fit Indices for Model Evaluation

Model	CFI	NNFI	RMSEA	90% CI for RMSEA	SRMR	AIC
One factor	.84	.84	.18	.17 - .18	.16	23622.53
Seven factor	.98	.98	.06	.05 - .06	.08	3753.39

Note. CFI indicates Comparative Fit Index, NNFI indicates Non-normed Fit Index, RMSEA indicates Root Mean Square Error of Approximation, SRMR indicates Standardized Root Mean Square Residual, and AIC indicates Akaike Information Criterion.

Table 4

CaffEQ Factor Correlations

	1	2	3	4	5	6	7
1. Withdrawal avoidance/Dependence	-						
2. Energy/Mood Enhancement	.66***	-					
3. Appetite Suppression	.43***	.45***	-				
4. Social Enhancement	.69***	.78***	.49***	-			
5. Performance Enhancement	.51***	.59***	.47***	.64***	-		
6. Negative Mood/Anxiety	.07	.20***	.25***	.19***	.25***	-	
7. Sleep Disturbance	.10*	.22***	.10*	.14***	.20***	.52***	-

Temporal Stability of the CaffEQ

To examine the temporal stability (test-rest reliability) of the instrument, the CaffEQ subscales were readministered to a subset of the sample (n = 440, 66.2%). Measures were readministered with a mean test-retest interval of 17 days (SD = 6.3) with a range from 14 to 58 days. The correlations among the two time points for each of the factors ranged from .80 - .94 (Table 2) indicating that the CaffEQ had good test-retest reliability over 2 week interval.

External Validation of the CaffEQ

Caffeine expectancies and caffeine use. To examine the convergent validity of the instrument, we computed means for each scale and examined their correlations with caffeine consumption variables including daily caffeine consumption and frequency of use. As shown in Table 5, individuals with greater mean daily caffeine consumption had higher ratings on all factors representing positive effects of caffeine and greater expectancies for Withdrawal/Dependence. Daily caffeine consumers (n = 390, 59.5%) were also compared to less than daily consumers (n = 275, 41.4%) illustrating similar findings after controlling for daily caffeine exposure as shown in Table 6.

Table 5

CaffEQ Factor Means and Correlations with Daily Caffeine Exposure (N = 665)

CaffEQ Factor	*M (SD)*	Daily caffeine exposure *r*
Withdrawal/Dependence	3.26 (1.49)	.44***
Energy/Work Enhancement	3.88 (1.22)	.26***
Appetite Suppression	2.59 (1.28)	.27***
Social/Mood Enhancement	3.10 (1.30)	.34***
Physical Performance Enhancement	2.51 (1.32)	.24***
Anxiety/Negative Physical Effects	2.45 (1.00)	-.03
Sleep Disturbance	3.04 (1.18)	-.07

***$p < .001$

Caffeine expectancies and caffeine dependence symptoms. Analyses of Covariance (ANCOVAs) were conducted to evaluate differences in expectancies among those who did and did not endorse each of the dependence-related items, controlling for current caffeine consumption. Figure 2 provides an illustrative example of the relationship between caffeine expectancies and the substance dependence related items, showing only the Withdrawal/Dependence expectancy factor. Even after controlling for current caffeine intake, each one of the substance dependence related items was associated with higher scores on the Withdrawal/Dependence expectancy scale, except

Table 6

Adjusted Means and Standard Errors for CaffEQ Factors for Daily Exposure Comparisons (N = 665)

CaffEQ Factor	a.) Daily exposure (n = 390)	b.) Less than daily exposure (n = 275)	F	η_p^2	Group comparisons
Withdrawal/Dependence	3.88 (0.06)	2.34 (0.07)	253.25***	.28	a > b
Energy/Work Enhancement	4.14 (0.06)	3.50 (0.07)	44.33***	.06	a > b
Appetite Suppression	2.72 (0.06)	2.40 (0.08)	9.86**	.02	a > b
Social/Mood Enhancement	3.40 (0.06)	2.66 (0.07)	55.74***	.08	a > b
Physical Performance Enhancement	2.73 (0.07)	2.17 (0.08)	28.48***	.04	a > b
Anxiety/Negative Physical Effects	2.38 (0.05)	2.52 (0.06)	2.98	.01	a = b
Sleep Disturbance	3.00 (0.07)	3.09 (0.09)	0.55	.00	a = b

Note. "=" indicates no significant difference between groups.

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

for problems caused or made worse by caffeine and being advised by a physician or health provider to cut down or eliminate the use of caffeine. Table 7 shows the endorsement rates of all of the assessed substance dependence related items as applied to caffeine use as well as summary of the ANCOVA analyses comparing expectancies among those who did and did not endorse each of the dependence-related items (see Appendix A tables A1-A7 for a summary each CaffEQ factor ANCOVA). Generally, those endorsing dependence-related items had higher scores on CaffEQ scale scores than those who did not. All seven CaffEQ scale scores (both positive and negative expectancies) were significantly greater among participants who reported withdrawal symptoms interfering with daily functioning (16.5% endorsed). In addition, individuals reporting tolerance to the effects of caffeine (45.6% endorsed), using caffeine to alleviate or avoid withdrawal symptoms (35.9% endorsed), using more caffeine than intended (51.3% endorsed), and having caffeine withdrawal symptoms in the past year (40.2% endorsed) (all p's < .05) had higher scores on the Withdrawal/Dependence, Energy/Work Enhancement, Appetite Suppression, Social/Mood Enhancement and Physical Performance Enhancement factors. Participants reporting that caffeine caused or made physical or psychological problems worse (13.6% endorsed) had higher scores on the negative CaffEQ expectancy factors, Anxiety/Negative Physical effects and Sleep Disturbance.

We assessed the associations between expectancy factors and other dependence related variables (e.g. severity of caffeine withdrawal) that were measured on a continuous scale while controlling for current caffeine exposure (Table 8). The reported

severity of withdrawal symptoms was significantly positively correlated with all CaffEQ expectancy scales (all *p's* < .01), with the exception of Anxiety/Negative Physical Effects and Sleep Disturbance. The perceived difficulty stopping caffeine consumption was significantly positively correlated with all expectancy scales (all *p*'s < .05) with the exception of Anxiety/Negative Physical Effects and Sleep Disturbance, which were significantly correlated with the desire to stop caffeine use (all *p*'s < .001). The time to consume caffeine after waking (i.e. latency of exposure) was significantly negatively correlated with all expectancy factors (all *p's* < .001) with the exception of Appetite Suppression, Anxiety/Negative Physical Effects and Sleep Disturbance. That is, three positive expectancy factors and Withdrawal/Dependence, expectancies were greater among those with a shorter latency to consume caffeine upon waking. The desire to cut down caffeine use was significantly positively correlated with Anxiety/Negative Physical Effects and Withdrawal/Dependence (see Table 8).

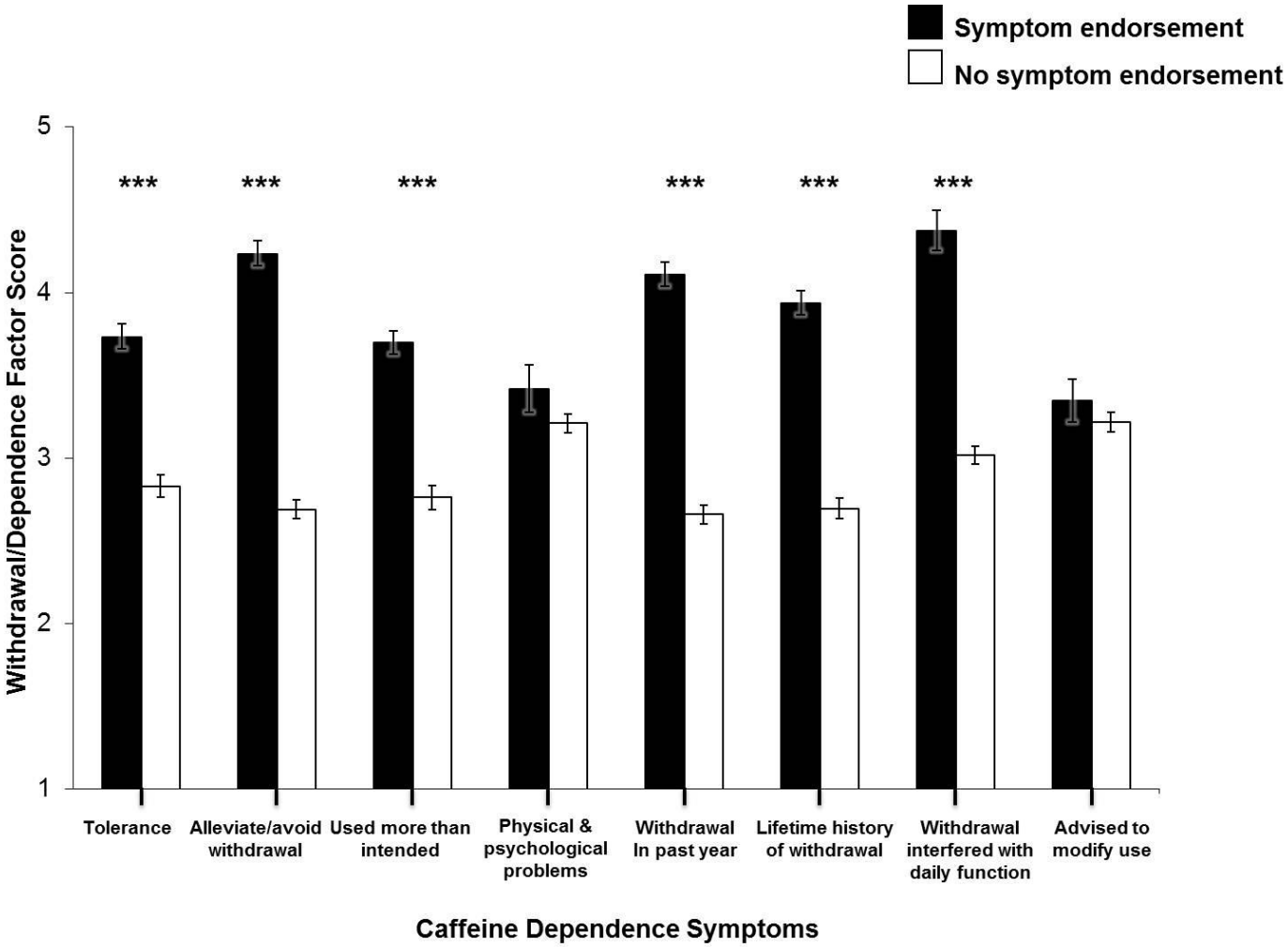

Figure 2. Average Factor (± *SE*) of Withdrawal/Dependence expectancy scale by caffeine dependence symptoms
*** $p < .001$

Table 7

Summary of Caffeine Dependence Related Symptoms by CaffEQ Factors (N = 665)

		CaffEQ Factor				
Dependence Symptom	*n* (% Yes)	Withdrawal/ Dependence	Energy/Work enhancement	Appetite suppression	Social/Mood enhancement	Physical performance enhancement
Tolerance (same amount has less of an effect or need more to get the same effect)	299 (45.6)	***	***	***	***	***
Use of caffeine to alleviate or avoid withdrawal symptoms	235 (35.9)	***	***	**	***	***
Using more caffeine than intended	336 (51.3)	***	***	**	***	***
Problems caused or made worse by caffeine	89 (13.6)	ns	**	ns	*	ns
Caffeine withdrawal symptoms in the past year	263 (40.2)	***	***	*	***	***
Lifetime history of caffeine withdrawal symptoms	288 (44.0)	***	***	ns	***	***
Withdrawal symptoms interfered with daily functioning	108 (16.5)	***	***	**	***	***
Advised by a physician or health provider to cut down or eliminate the use of caffeine	108 (16.5)	ns	ns	ns	ns	ns

Dependence Symptom	*n* (% Yes)	CaffEQ Factor: Anxiety/Negative Physical Effects	CaffEQ Factor: Sleep Disturbance
Tolerance (same amount has less of an effect or need more to get the same effect)	299 (45.6)	*	ns
Use of caffeine to alleviate or avoid withdrawal symptoms	235 (35.9)	*	ns
Using more caffeine than intended	336 (51.3)	ns	ns
Problems caused or made worse by caffeine	89 (13.6)	***	***
Caffeine withdrawal symptoms in the past year	263 (40.2)	*	**
Lifetime history of caffeine withdrawal symptoms	288 (44.0)	ns	**
Withdrawal symptoms interfered with daily functioning	108 (16.5)	**	*
Advised by a physician or health provider to cut down or eliminate the use of caffeine	108 (16.5)	ns	ns

Note. NS indicates no significant difference between groups.
*$p < .05$. ** $p < .01$. *** $p < .001$

Table 8

Correlations Between CaffEQ Factors and other Caffeine-related Variables Controlling for Daily Caffeine Exposure (N = 665)

CaffEQ Factor	Latency to consume caffeine after waking	Severity of withdrawal	Desire to cut down caffeine use	Desire to stop caffeine use	Difficulty stopping caffeine consumption
Withdrawal/Dependence	-.39***	.54***	.14*	.02	.70***
Energy/Work Enhancement	-.18***	.29***	-.03	-.04	.34***
Appetite Suppression	-.09	.16**	.05	.07	.12*
Social/Mood Enhancement	-.18***	.24***	-.01	-.01	.31***
Physical Performance Enhancement	-.17***	.19***	-.03	.00	.17***
Anxiety/Negative Physical Effects	.05	.06	.23***	.35***	-.06
Sleep Disturbance	-.05	.08	.10	.23***	-.07

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

Caffeine Vehicle

One-way ANCOVAs were conducted, controlling for caffeine exposure, to investigate the relationship between caffeine source and expectancy factor scale scores. All ANCOVAs were significant (all p's < .001). Individuals who endorsed expectancies for coffee reported the greatest positive expectancies (e.g., Energy/Work Enhancement and Social/Mood Enhancement) and the greatest expectancies for Withdrawal/Dependence followed by individuals who endorsed expectancies for caffeine in general, and those who endorsed expectancies for soft drinks (Table 9). The findings were less orderly for the negative expectancy factors Anxiety/Negative Physical Effects and Sleep Disturbance, whereas expectancies for coffee were similar to those for caffeine in general but significantly greater than those for soft drinks.

Table 9

Adjusted Means and Standard Errors for CaffEQ Factors Compared Across Caffeine Administration Vehicles (N= 665)

CaffEQ Factor	a.) Coffee (n = 827)	b.) Soft drinks (n = 416)	c.) Caffeine in general (n = 468)	F	η_p^2	Group comparisons
Withdrawal/Dependence	3.5 (.05)	3.2 (.07)	2.8 (.06)	41.31***	.05	a > b > c
Energy/Work Enhancement	4.1 (.04)	3.6 (.06)	3.6 (.05)	35.09***	.04	a > b = c
Appetite Suppression	2.8 (.04)	2.5 (.06)	2.5 (.06)	13.58***	.02	a > b = c
Social/Mood Enhancement	3.1 (.04)	2.7 (.06)	2.7 (.06)	24.70***	.03	a > b = c
Physical Performance Enhancement	2.6 (.04)	2.3 (.06)	2.3 (.06)	11.32***	.01	a > b = c
Anxiety/Negative Physical Effects	2.7 (.04)	2.3 (.05)	2.7 (.05)	19.43***	.02	a = c > b
Sleep Disturbance	3.3 (.05)	2.8 (.07)	3.1 (.06)	19.46***	.02	a = c > b

Note. "=" indicates no significant difference between groups.

***$p < .001$.

CHAPTER 4

DISCUSSION

The primary goal of the current study was to evaluate the hypothesized factor structure of the CaffEQ, a comprehensive measure of expectancies that reflect the known pharmacological properties. The temporal stability of the CaffEQ as well as relationships between the CaffEQ factors and caffeine exposure, frequency of use and variables associated with substance dependence. The factor structure of the CaffEQ was confirmed using CFA from 665 participants and the CaffEQ factors demonstrated good temporal stability with test-retest reliabilities ranging from .82 - .93. In addition, the CaffEQ factors demonstrated adequate internal consistency and construct reliability suggesting that the items making up each subscale have a strong relationship to each other and therefore reflect a common construct. In addition, the CaffEQ factors were significantly associated with the level of daily caffeine exposure, frequency of use and features of substance dependence suggesting that the CaffEQ's has good construct validity and predictive utility. These results suggest that the CaffEQ shows good psychometric properties among a heterogeneous population of caffeine consumers.

As expected, the frequency and quantity of caffeine consumption was associated with the strength of expectancies for caffeine. Caffeine consumption was positively associated with expectancies that caffeine produces Withdrawal/Dependence. Furthermore, as caffeine consumption increased so did positive expectancies that caffeine

produces Energy/Work Enhancement, Appetite Suppression, Social/Mood Enhancement, and Physical Performance Enhancement. Increased caffeine consumption was not significantly associated with negative expectancies for caffeine pertaining to Anxiety/Negative Physical Effects and Sleep Disturbance. This finding is consistent with the expectancy literature for alcohol, tobacco, cocaine, and marijuana showing that drug expectancies can discriminate among individuals with varying patterns of drug use (Brown et al., 1980; Jaffe & Kilbey, 1989; Schafer & Brown, 1991).The CaffEQ should serve to facilitate future research addressing the development of caffeine expectancies and caffeine use patterns.

Caffeine expectancies were also predictive of various criteria relating to the construct of substance dependence, even when controlling for current caffeine consumption. All seven caffeine expectancy scales were significantly greater among participants who reported caffeine withdrawal symptoms in the past year and caffeine withdrawal symptoms interfering with daily functioning. Those endorsing tolerance and using caffeine to alleviate or avoid withdrawal symptoms had higher ratings on all scales except for sleep disturbance. The Withdrawal/Dependence expectancy scale showed the strongest relationships with substance dependence features (Figure 2). One noticeable pattern is that expectancies reflecting the positive effects of caffeine were consistently associated with features of substance dependence whereas this was not the case for negative caffeine expectancies. However, negative expectancies were predictive of one's desire to cut down or stop caffeine consumption. This finding is consistent with findings from a study that manipulated smoking expectancies and demonstrated that greater

negative smoking outcome expectancies were associated with increased motivation to quit smoking (Copeland & Brandon, 2000).

It is possible that the caffeine containing vehicle itself may influence the strength of expectancies as has been observed across various nicotine delivery methods (Juliano & Brandon, 2004). The results of this study support this notion with those endorsing expectancies for coffee having the strongest expectancies for Withdrawal/Dependence and the four positive expectancy scales. This pattern was not as consistent for the negative expectancy factors. One exception was caffeine in general which was similar to coffee and stronger than soft drinks for Anxiety/Negative Physical Effects and Sleep Disturbance. Those reporting expectancies for soft drinks generally reported the weakest expectancies for all factors. This is not too surprising as coffee typically contains significantly more caffeine than soft drinks. Although individuals endorsing expectancies for coffee also had the greatest amount of caffeine consumption, the endorsement of greater expectancies for coffee does not appear to be a simple function of greater caffeine exposure. Even after controlling for caffeine exposure, coffee was associated with the greatest positive expectancies for caffeine.

This study attempted to improve upon previous assessments of expectancies for caffeine by recruiting individuals in various cities across the United States, assessing individuals across a wide range of ages (18-75 years), assessing caffeine expectancies across multiple caffeine vehicles, and including both consumers and non-consumers of caffeine. In addition, this study represents the first attempt to extend the development of a caffeine expectancy instrument beyond exploratory analyses by utilizing CFA to test the

validity of latent variables characterized through exploratory factor analysis. However, some limitations in the present study should be noted. Web-based surveys have an inherent selection bias, limiting access to those with access to computer and internet resources. Nevertheless, it appears that our sample represented a diverse group with a range of ages, caffeine use, geographic location, levels of education, and household incomes.

It should be noted that web-based surveys have an inherent selection bias, limiting access to those with access to computer and internet resources. It appears however that our sample represented a diverse group with a range of ages, geographic location, levels of education, and household incomes. More women than men completed the survey, which is consistent with other web-based studies (Birnbaum, 2000). Future research should attempt to counteract this gender bias. Web-based research is limited in its ability to control for environmental factors during survey administration that may add undue variability to data collected. However, the nature and reliability of our results suggest that respondents answered the questions in a conscientious fashion.

A specific dose effect of caffeine on the strength of expectancies was not examined given the large amount of variability among individuals with respect to dose response effects. The measure was designed to assess expectancies for typical dietary doses of caffeine, although this was not explicitly stated. A different pattern of results may have resulted if individuals were asked to rate their expectancies for a very large dose of caffeine.

Summary and Future Directions

This investigation reveals that adu d a wide range of both positive and negative expectancies about the effects of caffeine that correlate with caffeine use, features of substance dependence, and other important caffeine-related variables such as sleep and anxiety. These results extend expectancy theory to the most commonly used drug in the world by reducing the range of expectancies to seven principal factors that can be explored and categorized with the CaffEQ.

The CaffEQ can be used in future studies that attempt to elucidate why caffeine use is so wide spread. Furthermore, caffeine shares some important features with classic drugs of dependence that make it an ideal model drug for investigating how expectancies relate to drug use patterns and drug dependence processes. It is also a relatively safe drug to administer to research subjects and may be an ideal model for exploring drug expectancies and how they relate to drug use patterns. The CaffEQ will make exploring these relationships possible because it is an improvement over the one-item assessments or one-construct assessments, which have questionable psychometric properties and limited utility. The CaffEQ's factors have good interitem reliability and construct validity. The CaffEQ may be used to explore drug use and the interaction between expectancy and placebo effects since the expectations for caffeine held by participants in research studies may moderate responses and directly influence the experimental outcome of studies, as has been shown with nicotine (e.g., Juliano & Brandon, 2002).

APPENDIX A

SUMMARY OF ANCOVA MODELS FOR CAFFEINE DEPENDENCE

Table A1

Adjusted Means and Standard Errors for Withdrawal/Dependence for Variables Associated with Substance Dependence (N = 665)

Dependence characteristic	No Symptom *M (SE)*	Symptom *M (SE)*	*F*	η_p^2
Tolerance	2.83 (0.07)	3.73 (0.08)	76.15***	.11
Use of caffeine to alleviate or avoid withdrawal symptoms	2.69 (0.06)	4.23 (0.08)	269.03***	.29
Using more caffeine than intended	2.76 (0.07)	3.70 (0.07)	85.08***	.12
Problems caused or made worse by caffeine	3.21 (0.06)	3.42 (0.14)	1.81**	< .01
Caffeine withdrawal symptoms in the past year	2.66 (0.06)	4.11 (0.07)	248.28***	.28
Lifetime history of caffeine withdrawal symptoms	2.70 (0.06)	3.94 (0.07)	170.57***	.21
Withdrawal symptoms interfered with daily functioning	3.02 (0.05)	4.37 (0.12)	103.14***	< .01
Advised by a physician or health provider to cut down/eliminate caffeine	3.22 (0.06)	3.35 (0.13)	0.84	.14

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

Table A2

Adjusted Means and Standard Errors for Energy Enhancement for Variables Associated with Substance Dependence (N = 665)

Dependence characteristic	No Symptom *M (SE)*	Symptom *M (SE)*	*F*	η_p^2
Tolerance	3.53 (0.06)	3.73 (0.07)	76.35***	.10
Use of caffeine to alleviate or avoid withdrawal symptoms	3.64 (0.06)	4.23 (0.08)	48.77***	.07
Using more caffeine than intended	3.57 (0.06)	3.70 (0.06)	41.92***	.06
Problems caused or made worse by caffeine	3.81 (0.05)	3.42 (0.12)	9.80**	.02
Caffeine withdrawal symptoms in the past year	3.62 (0.06)	4.11 (0.07)	49.04***	.07
Lifetime history of caffeine withdrawal symptoms	3.61 (0.06)	3.94 (0.07)	43.59***	.06
Withdrawal symptoms interfered with daily functioning	3.76 (0.05)	4.43 (0.11)	30.10***	.04
Advised by a physician or health provider to cut down/eliminate caffeine	3.86 (0.05)	3.94 (0.11)	0.40	< .01

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

Table A3

Adjusted Means and Standard Errors for Appetite Suppression for Variables Associated with Substance Dependence (N = 665)

Dependence characteristic	No Symptom *M (SE)*	Symptom *M (SE)*	*F*	η_p^2
Tolerance	2.41 (0.07)	2.80 (0.07)	15.74***	.02
Use of caffeine to alleviate or avoid withdrawal symptoms	2.48 (0.06)	2.77 (0.08)	7.81**	.01
Using more caffeine than intended	2.43 (0.07)	2.73 (0.07)	9.93**	.02
Problems caused or made worse by caffeine	2.55 (0.05)	2.80 (0.13)	3.26	.01
Caffeine withdrawal symptoms in the past year	2.49 (0.06)	2.73 (0.08)	6.19*	.07
Lifetime history of caffeine withdrawal symptoms	2.51 (0.06)	2.68 (0.07)	2.97	.01
Withdrawal symptoms interfered with daily functioning	2.52 (0.05)	2.90 (0.12)	8.71**	.01
Advised by a physician or health provider to cut down/eliminate caffeine	2.55 (0.05)	2.75 (0.12)	2.45	< .01

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

Table A4

Adjusted Means and Standard Errors for Social/Mood Enhancement for Variables Associated with Substance Dependence (N = 665)

Dependence characteristic	No Symptom *M (SE)*	Symptom *M (SE)*	*F*	η_p^2
Tolerance	2.71 (0.06)	3.54 (0.07)	78.61***	.11
Use of caffeine to alleviate or avoid withdrawal symptoms	2.81 (0.06)	3.60 (0.08)	67.68***	.10
Using more caffeine than intended	2.79 (0.07)	3.37 (0.07)	37.69***	.06
Problems caused or made worse by caffeine	3.04 (0.05)	3.37 (0.13)	5.70*	.01
Caffeine withdrawal symptoms in the past year	2.78 (0.06)	3.55 (0.07)	69.98***	.10
Lifetime history of caffeine withdrawal symptoms	2.81 (0.06)	3.44 (0.07)	45.15***	.07
Withdrawal symptoms interfered with daily functioning	2.97 (0.05)	3.70 (0.12)	33.69***	.05
Advised by a physician or health provider to cut down/eliminate caffeine	3.02 (0.05)	3.27 (0.12)	2.80	< .01

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

Table A5

Adjusted Means and Standard Errors for Physical Performance Enhancement for Variables Associated with Substance Dependence (N = 665)

Dependence characteristic	No Symptom *M (SE)*	Symptom *M (SE)*	*F*	η_p^2
Tolerance	2.25 (0.07)	2.77 (0.07)	27.48***	.04
Use of caffeine to alleviate or avoid withdrawal symptoms	2.32 (0.06)	2.78 (0.08)	19.46***	.03
Using more caffeine than intended	2.28 (0.07)	2.68 (0.07)	16.29***	.03
Problems caused or made worse by caffeine	2.46 (0.05)	2.61 (0.14)	1.07	< .01
Caffeine withdrawal symptoms in the past year	2.30 (0.06)	2.76 (0.08)	21.17***	.03
Lifetime history of caffeine withdrawal symptoms	2.29 (0.07)	2.74 (0.07)	20.41***	.03
Withdrawal symptoms interfered with daily functioning	2.41 (0.05)	2.88 (0.12)	12.53***	.02
Advised by a physician or health provider to cut down/eliminate caffeine	2.46 (0.05)	2.69 (0.12)	2.96	< .01

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

Table A6

Adjusted Means and Standard Errors for Anxiety/Negative Physical Effects for Variables Associated with Substance Dependence (N = 665)

Dependence characteristic	No Symptom *M (SE)*	Symptom *M (SE)*	*F*	η_p^2
Tolerance	2.36 (0.05)	3.73 (0.07)	4.01*	.01
Use of caffeine to alleviate or avoid withdrawal symptoms	2.38 (0.05)	4.23 (0.08)	3.88*	.01
Using more caffeine than intended	2.36 (0.06)	3.70 (0.06)	3.74	.01
Problems caused or made worse by caffeine	2.31 (0.04)	3.42 (0.12)	72.35***	.10
Caffeine withdrawal symptoms in the past year	2.36 (0.05)	4.11 (0.07)	5.77*	.01
Lifetime history of caffeine withdrawal symptoms	2.37 (0.05)	3.94 (0.07)	3.41	.01
Withdrawal symptoms interfered with daily functioning	2.39 (0.04)	2.71 (0.10)	9.18**	.01
Advised by a physician or health provider to cut down/eliminate caffeine	2.46 (0.04)	2.32 (0.10)	1.86	< .01

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

Table A7

Adjusted Means and Standard Errors for Sleep Disturbance for Variables Associated with Substance Dependence (N = 665)

Dependence characteristic	No Symptom *M (SE)*	Symptom *M (SE)*	*F*	η_p^2
Tolerance	2.95 (0.07)	3.12 (0.08)	2.37	< .01
Use of caffeine to alleviate or avoid withdrawal symptoms	2.95 (0.07)	3.16 (0.09)	3.32	.01
Using more caffeine than intended	2.94 (0.08)	3.11 (0.08)	2.50	< .01
Problems caused or made worse by caffeine	2.93 (0.06)	3.63 (0.14)	19.93***	.03
Caffeine withdrawal symptoms in the past year	2.91 (0.07)	3.20 (0.09)	7.19**	.01
Lifetime history of caffeine withdrawal symptoms	2.89 (0.07)	3.20 (0.08)	7.82**	.01
Withdrawal symptoms interfered with daily functioning	2.97 (0.06)	3.33 (0.13)	6.22*	.01
Advised by a physician or health provider to cut down/eliminate caffeine	3.01 (0.06)	3.16 (0.13)	1.16	< .01

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

APPENDIX B

BASELINE ASSESSMENT

Caffeine Survey Part I

General information

1. How did you find out about this survey?
□ Announcement made in class
□ Friend/acquaintance
□ Flyer
□ E-mail
□ Newspaper ad
□ Web ad
□ Craigslist
□ Other (please specify)

2. Are you a student or employee of American University?
□ No □ Yes, student □ Yes, employee

3. What is your sex?
□ Male □ Female

4. What is your age? _____

5. What race do you consider yourself to be?
□ American Indian or Alaska Native
□ Asian
□ Black or African-American
□ Native Hawaiian or Other Pacific Islander
□ White
□ Other (please specify)

6. Do you consider yourself to be Hispanic/Latino?
□ No □ Yes

7. What state do you live in? _____

8. What is your employment status?
□ Employed full time
□ Employed part time
□ Unemployed
□ Retired
□ Disability
□ Other (please specify)

9. What is the highest level of education that you have completed to date?
□ Grade school or middle school
□ High school or GED
□ Some college technical or vocational training
□ Associate's Degree
□ Bachelor's Degree
□ Some Graduate study
□ Graduate Degree

10. The following questions concern your use of major dietary sources of caffeine (i.e., coffee, tea, caffeinated sodas, caffeinated energy drinks, chocolate and caffeine-containing pills- such as Excedrin, Anacin, Vivarin, No-Doz, Goody's headache powder).

Estimate the number(s) and type(s) of caffeinated products that you usually consume on a typical day. Also estimate the typical serving size and indicate the typical brand name that you use. Also, indicate the number of days per week you use the product. Do not include decaffeinated products.

Use the serving size guide below:
espresso shot = 1.5 oz
small cup = 6 oz
regular cup or small mug = 8 oz
large mug = 12 oz
Starbucks Tall® = 12 oz
Starbucks Grande®= 16 oz
Starbucks Venti® = 20 oz
regular can of soft drink = 12 oz
regular bottle of soft drink = 16 or 20 oz
2 liter bottle of soft drink = 67.6 oz
Big Gulp® = 32 oz
Super Big Gulp® = 44 oz
Double Gulp® = 64 oz

a. Coffee (roasted or ground)
Number of Servings per day: _____
Usual serving size in ounces: _____
Usual brand: _____
Number of days per week: _____

b. Coffee (espresso)
Number of Servings per day: _____
Usual serving size in ounces: _____
Usual brand: _____
Number of days per week: _____

c. Coffee (instant)
Number of Servings per day: _____
Usual serving size in ounces: _____
Usual brand: _____
Number of days per week: _____

d. Hot tea (bag or leaf)
Number of Servings per day: _____
Usual serving size in ounces: _____
Usual brand: _____
Number of days per week: _____

e. Iced tea
Number of Servings per day: _____
Usual serving size in ounces: _____
Usual brand: _____
Number of days per week: _____

f. Soft drinks
Number of Servings per day: _____
Usual serving size in ounces: _____
Usual brand: _____
Number of days per week: _____

g. Energy drinks with caffeine
Number of Servings per day: _____
Usual serving size in ounces: _____
Usual brand: _____
Number of days per week: _____

h. Cocoa and chocolate
Usual brand: _____
Number of days per week: _____
Number of servings per day: _____
Usual serving size in ounces: _____

i. Caffeine-containing medicines (headache, cold, stimulants) or nutritional Supplements
Number of capsules or tablets: _____
Dose of caffeine (if known): _____
Brand: _____ Number of days per week: _____

11. Please feel free to provide any additional information that will assist us to determine your average daily use of caffeine.

_____

_____

12. **CaffEQ Instructions:** We are interested your beliefs about the effects that caffeine has on you. Below is a list of possible effects of caffeine. Using the scale below as a guide, please rate each statement in terms of how LIKELY or UNLIKELY you believe each consequence is for you when you use caffeine.

Base your responses on your caffeinated product of choice. If you use many types of caffeinated products, choose just one to base your responses on, or you may choose to base your responses on "caffeine in general". (You can change your choice after responding to the questions)

Even if you very rarely consume caffeine, please rate how you would expect caffeine to affect you, if you consumed it.

My responses below are based on: (please check one)

- ☐ Coffee
- ☐ Soft Drinks
- ☐ Tea
- ☐ Caffeine containing medications (E.g. Excedrin, No-Doz)
- ☐ Caffeine in general
- ☐ Other (please specify): _____

		Very Unlikely	Unlikely	A little Unlikely	A little Likely	Likely	Very Likely
1	Caffeine picks me up when I am feeling tired	☐	☐	☐	☐	☐	☐
2	Conversations are better when using caffeine	☐	☐	☐	☐	☐	☐
3	Caffeine helps me avoid eating more than I should	☐	☐	☐	☐	☐	☐
4	I am easily stressed after having caffeine	☐	☐	☐	☐	☐	☐
5	Caffeine improves my athletic performance	☐	☐	☐	☐	☐	☐
6	I feel less sleepy after having caffeine	☐	☐	☐	☐	☐	☐
7	Caffeine suppresses feelings of hunger	☐	☐	☐	☐	☐	☐
8	I feel miserable when I do not have my usual caffeine	☐	☐	☐	☐	☐	☐
9	Caffeine improves my mood	☐	☐	☐	☐	☐	☐
10	I would get anxious if I abstained from caffeine	☐	☐	☐	☐	☐	☐

		Very Unlikely	Unlikely	A little Unlikely	A little Likely	Likely	Very Likely
11	Caffeine makes me jittery	☐	☐	☐	☐	☐	☐
12	Workouts are better after having caffeine	☐	☐	☐	☐	☐	☐
13	I would experience caffeine withdrawal	☐	☐	☐	☐	☐	☐
	if I went without caffeine	☐	☐	☐	☐	☐	☐
14	I don't like the way caffeine makes me feel	☐	☐	☐	☐	☐	☐
15	I would feel sick if I went without caffeine	☐	☐	☐	☐	☐	☐
16	Caffeine increases my motivation to work	☐	☐	☐	☐	☐	☐
17	I feel more confident after having caffeine	☐	☐	☐	☐	☐	☐
18	Caffeine at any time of day throws off my sleep	☐	☐	☐	☐	☐	☐
19	Caffeine makes me feel nervous	☐	☐	☐	☐	☐	☐
20	Caffeine makes me feel more alert	☐	☐	☐	☐	☐	☐
21	Even a small amount of caffeine makes me anxious	☐	☐	☐	☐	☐	☐
22	Caffeine improves my concentration	☐	☐	☐	☐	☐	☐
23	Caffeine makes me friendlier	☐	☐	☐	☐	☐	☐
24	I need to have caffeine every day	☐	☐	☐	☐	☐	☐
25	Caffeine makes me sweat	☐	☐	☐	☐	☐	☐
26	Caffeine allows me to skip meals	☐	☐	☐	☐	☐	☐
27	I have a strong desire for caffeine if I do not have my usual amount	☐	☐	☐	☐	☐	☐
28	I have difficulty sleeping after having caffeine	☐	☐	☐	☐	☐	☐
29	Caffeine makes me irritable	☐	☐	☐	☐	☐	☐
30	I often crave caffeine	☐	☐	☐	☐	☐	☐
31	Caffeine helps me work over long periods of time	☐	☐	☐	☐	☐	☐
32	Caffeine makes me feel happy	☐	☐	☐	☐	☐	☐
33	I would be unable to function without caffeine	☐	☐	☐	☐	☐	☐
34	Caffeine makes my heart beat irregularly	☐	☐	☐	☐	☐	☐
35	I would have difficulty starting my day without caffeine	☐	☐	☐	☐	☐	☐
36	Caffeine upsets my stomach	☐	☐	☐	☐	☐	☐
37	I would have trouble giving up caffeine	☐	☐	☐	☐	☐	☐
38	Using caffeine late in the day disrupts my sleep	☐	☐	☐	☐	☐	☐
39	Caffeine helps me to control my weight	☐	☐	☐	☐	☐	☐
40	I would get a headache if I went without caffeine	☐	☐	☐	☐	☐	☐
41	Caffeine improves my attention	☐	☐	☐	☐	☐	☐
42	I feel more sociable after having caffeine	☐	☐	☐	☐	☐	☐
43	I can exercise longer if I have caffeine	☐	☐	☐	☐	☐	☐
44	Caffeine helps get me through the day	☐	☐	☐	☐	☐	☐
45	Caffeine makes me feel more energetic	☐	☐	☐	☐	☐	☐
46	Caffeine decreases my appetite	☐	☐	☐	☐	☐	☐
47	Caffeine late in the day gives me insomnia	☐	☐	☐	☐	☐	☐

Answer the following questions based on your caffeine use (NOT including chocolate)

13. How soon after you wake up do you usually have your first caffeinated product?
□ Within 15 minutes
□ Within 30 minutes
□ Within 60 minutes
□ Within 2 hours More than 2 hours
□ Not applicable

14. In a typical week, how many days do you consume some form of caffeine?
□ 0 □ 1 □ 2 □ 3 □ 4 □ 5 □ 6 □ 7

15. In the past year, how many times have you completely abstained from caffeine for at least 36 hours?
□ None
□ 1 time
□ 2 or 3 times
□ 4 or 5 times
□ Many times
□ Most of the time, I rarely consume caffeine
□ Other (please specify): _____

16. Do you find that you now need to use more caffeine than you did when you first began using caffeine to get the same effect?
□ N/A I don't consume caffeine
□ No
□ Yes, I need to use a little more to get the same effect
□ Yes, I need to use at least twice as much as I used to get the same effect

17. Do you find that the same amount of caffeine has less of an effect on you now than when you first began using caffeine?
□ N/A I don't consume caffeine
□ No
□ Yes, it has a slightly less effect on me than it used to
□ Yes, it has much less of an effect on me than it used to

18. In the past year, how often have you used much more caffeine than you had intended to use that day?
□ Never
□ Rarely (less than 1x a month)
□ Sometimes (at least 1x a month)
□ Often (at least 1x a week)
□ Always (almost every day)

□ Other (please specify): _____

19. In the past year, have you used caffeine to prevent or alleviate caffeine withdrawal symptoms?
□ No
□ Yes

20. In the past year, have you experienced caffeine withdrawal symptoms?
□ No
□ Yes, please describe your symptoms: _____

21. Have you ever experienced caffeine withdrawal symptoms? (more than one year ago)
□ No
□ Yes, please describe: _____

22. In general, how would you rate your caffeine withdrawal symptoms on a scale from 1 to 10 with 1 being "very mild" and 10 being "extremely severe"
□ N/A □ 1 very mild □ 2 □ 3 □ 4 □ 5 □ 6 □ 7 □ 8 □ 9 □ 10 extremely severe

23. Has caffeine withdrawal ever interfered with your ability to perform your normal daily activities?
□ N/A I have never experienced caffeine withdrawal
□ No
□ I am not sure
□ Yes, please describe: _____

24. How difficult would it be for you to completely stop your caffeine use on a scale from 1 to 10 with 1 being "not at all difficult" and 10 being "extremely difficult"
□ N/A I don't consume caffeine
□ 1 not at all difficult □ 2 □ 3 □ 4 □ 5 □ 6 □ 7 □ 8 □ 9 □ 10 extremely difficult

25. Please rate your desire to stop your caffeine use from 1 "no desire at all" to 10 "very strong desire"
□ N/A I don't consume caffeine
□ 1 no desire at all □ 2 □ 3 □ 4 □ 5 □ 6 □ 7 □ 8 □ 9 □ 10 very strong desire

26. Please rate your desire to cut down your caffeine use from 1 "no desire at all" to 10 "very strong desire"
□ N/A I don't consume caffeine
□ 1 no desire at all □ 2 □ 3 □ 4 □ 5 □ 6 □ 7 □ 8 □ 9 □ 10 very strong desire

27. What is your primary reason for wanting to cut down or stop your caffeine use? (or if you have already cut down or stopped, what was your primary reason?)

□ N/A I don't consume caffeine
□ None, I don't want to cut down or stop my caffeine use
□ Doctor or health provider advised you to
□ Your family or friends asked you to
□ It costs too much
□ You believe that it is not good for your health
□ It causes unpleasant side effects
□ Pregnancy
□ You are tired of being dependent on caffeine
□ Other (please specify): _____

28. In the past year, has your use of caffeinated products caused or made worse any physical, medical, or psychological problems?
□ No
□ Yes, please describe: _____

29. Has a physician or health provider ever advised you to stop or cut down your caffeine use?
□ No
□ Yes, and I followed the advice
□ Yes, and I did not follow the advice
□ If yes, why were you advised to stop or cut down your caffeine use?

30. Would you be interested in receiving assistance to modify your caffeine use?
□ N/A I don't use caffeine
□ No
□ Yes, book/pamphlet
□ Yes, web-based information
□ Yes, counseling
□ Yes, other

APPENDIX C

FOLLOW UP ASSESSMENT

Caffeine Survey Part II

General Information

1. What is your sex?
☐ Male ☐ Female

2. What is your age? _____

3. What state do you live in? _____

4. **CaffEQ Instructions:** We are interested your beliefs about the effects that caffeine has on you. Below is a list of possible effects of caffeine. Using the scale below as a guide, please rate each statement in terms of how LIKELY or UNLIKELY you believe each consequence is for you when you use caffeine.

Base your responses on your caffeinated product of choice. If you use many types of caffeinated products, choose just one to base your responses on, or you may choose to base your responses on "caffeine in general". (You can change your choice after responding to the questions)

Even if you very rarely consume caffeine, please rate how you would expect caffeine to affect you, if you consumed it.

My responses below are based on: (please check one)

- ☐ Coffee
- ☐ Soft Drinks
- ☐ Tea
- ☐ Caffeine containing medications (E.g. Excedrin, No-Doz)
- ☐ Caffeine in general
- ☐ Other (please specify): _____.

		Very Unlikely	Unlikely	A little Unlikely	A little Likely	Likely	Very Likely
1	Caffeine picks me up when I am feeling tired	☐	☐	☐	☐	☐	☐
2	Conversations are better when using caffeine	☐	☐	☐	☐	☐	☐
3	Caffeine helps me avoid eating more than I should	☐	☐	☐	☐	☐	☐
4	I am easily stressed after having caffeine	☐	☐	☐	☐	☐	☐
5	Caffeine improves my athletic performance	☐	☐	☐	☐	☐	☐
6	I feel less sleepy after having caffeine	☐	☐	☐	☐	☐	☐
7	Caffeine suppresses feelings of hunger	☐	☐	☐	☐	☐	☐
8	I feel miserable when I do not have my usual caffeine	☐	☐	☐	☐	☐	☐
9	Caffeine improves my mood	☐	☐	☐	☐	☐	☐
10	I would get anxious if I abstained from caffeine	☐	☐	☐	☐	☐	☐
11	Caffeine makes me jittery	☐	☐	☐	☐	☐	☐
12	Workouts are better after having caffeine	☐	☐	☐	☐	☐	☐
13	I would experience caffeine withdrawal if I went without caffeine	☐	☐	☐	☐	☐	☐
14	I don't like the way caffeine makes me feel	☐	☐	☐	☐	☐	☐
15	I would feel sick if I went without caffeine	☐	☐	☐	☐	☐	☐
16	Caffeine increases my motivation to work	☐	☐	☐	☐	☐	☐
17	I feel more confident after having caffeine	☐	☐	☐	☐	☐	☐
18	Caffeine at any time of day throws off my sleep	☐	☐	☐	☐	☐	☐
19	Caffeine makes me feel nervous	☐	☐	☐	☐	☐	☐
20	Caffeine makes me feel more alert	☐	☐	☐	☐	☐	☐
21	Even a small amount of caffeine makes me anxious	☐	☐	☐	☐	☐	☐
22	Caffeine improves my concentration	☐	☐	☐	☐	☐	☐
23	Caffeine makes me friendlier	☐	☐	☐	☐	☐	☐
24	I need to have caffeine every day	☐	☐	☐	☐	☐	☐
25	Caffeine makes me sweat	☐	☐	☐	☐	☐	☐
26	Caffeine allows me to skip meals	☐	☐	☐	☐	☐	☐
27	I have a strong desire for caffeine if I do not have my usual amount	☐	☐	☐	☐	☐	☐
28	I have difficulty sleeping after having caffeine	☐	☐	☐	☐	☐	☐
29	Caffeine makes me irritable	☐	☐	☐	☐	☐	☐
30	I often crave caffeine	☐	☐	☐	☐	☐	☐
31	Caffeine helps me work over long periods of time	☐	☐	☐	☐	☐	☐
32	Caffeine makes me feel happy	☐	☐	☐	☐	☐	☐
33	I would be unable to function without caffeine	☐	☐	☐	☐	☐	☐
34	Caffeine makes my heart beat irregularly	☐	☐	☐	☐	☐	☐
35	I would have difficulty starting my day without caffeine	☐	☐	☐	☐	☐	☐
36	Caffeine upsets my stomach	☐	☐	☐	☐	☐	☐
37	I would have trouble giving up caffeine	☐	☐	☐	☐	☐	☐

		Very Unlikely	Unlikely	A little Unlikely	A little Likely	Likely	Very Likely
38	Using caffeine late in the day disrupts my sleep	☐	☐	☐	☐	☐	☐
39	Caffeine helps me to control my weight	☐	☐	☐	☐	☐	☐
40	I would get a headache if I went without caffeine	☐	☐	☐	☐	☐	☐
41	Caffeine improves my attention	☐	☐	☐	☐	☐	☐
42	I feel more sociable after having caffeine	☐	☐	☐	☐	☐	☐
43	I can exercise longer if I have caffeine	☐	☐	☐	☐	☐	☐
44	Caffeine helps get me through the day	☐	☐	☐	☐	☐	☐
45	Caffeine makes me feel more energetic	☐	☐	☐	☐	☐	☐
46	Caffeine decreases my appetite	☐	☐	☐	☐	☐	☐
47	Caffeine late in the day gives me insomnia	☐	☐	☐	☐	☐	☐

Answer the following questions based on your caffeine use (NOT including chocolate)

5. In a typical week, how many days do you consume some form of caffeine?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

6. In the past year, have you used caffeine to prevent or alleviate caffeine withdrawal symptoms?

☐ No
☐ Yes

7. In the past year, have you experienced caffeine withdrawal symptoms?

☐ No
☐ Yes, please describe your symptoms: _____

8. Have you ever experienced caffeine withdrawal symptoms? (more than one year ago)

☐ No
☐ Yes, please describe: _____

9. In general, how would you rate your caffeine withdrawal symptoms on a scale from 1 to 10 with 1 being "very mild" and 10 being "extremely severe"

☐ N/A ☐ 1 very mild ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 extremely severe

10. Has caffeine withdrawal ever interfered with your ability to perform your normal daily activities?

☐ N/A I have never experienced caffeine withdrawal
☐ No
☐ I am not sure
☐ Yes, please describe: _____

11. How difficult would it be for you to completely stop your caffeine use on a scale from 1 to 10 with 1 being "not at all difficult" and 10 being "extremely difficult"

☐ N/A I don't consume caffeine
☐ 1 not at all difficult ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 extremely difficult

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