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J Camosun Psyc Res. (2023). Vol. 5(1), pp. 56-77.
Submitted Fall 2022; accepted June 2023.

What Makes Caffeine So Addictive?

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ABSTRACT

In this paper, we sought to understand what makes caffeine so addictive, so that we could learn why it's so hard to quit. Previous research has found that possible factors which determine whether caffeine becomes addictive include the amount of caffeine consumed, the expected pleasure from caffeine, and the degree of withdrawal symptoms when suddenly not drinking caffeine. In our first (correlational) study, we tested the strength of these relationships by examining naturalistic daily changes in their variables longitudinally over a period of one week. We measured the amount of caffeine consumed by self-reporting the number of cups of coffee that were consumed each day, and measured the expectation of pleasure before drinking coffee, withdrawal symptoms, and caffeine addiction each on a subjective scale from 0-10. Based on the strength of correlation found between the amount of caffeine consumed and caffeine wanting, we then conducted a second (experimental) study to test for a causal relationship between these two variables. Over a period of one week, we used a within-subjects design and randomly assigned participants each day to either a caffeinated condition or a non-caffeinated condition using a double-blind procedure and measured the effect this manipulation had upon wanting caffeine. Data pooled across participants in our correlational study showed that caffeine wanting was significantly correlated with the amount of caffeine consumed but not with its expected pleasure or the degree of withdrawal symptoms. However, data pooled across participants in our experimental study showed the opposite pattern: increasing caffeine consumption significantly decreased the amount of caffeine wanting in comparison to the consuming decaffeinated control condition. This finding means that the more caffeine that is consumed the wanting for caffeine will decrease. This result sheds light on further research to be conducted between caffeine consumption and wanting of caffeine.

1. Introduction

1.1 Research Problem

Caffeine withdrawal often causes people to become irritable and tired. People often crave coffee and caffeine in the morning and throughout the day. People often think that it would be easy to control these urges, although it can become very difficult to quit. When people miss a day after being used to drinking it on a daily basis; it often leads to withdrawals, making them more dependent on the substance. We wish to know what makes caffeine so addictive and why it can be so hard to quit.

1.2 Literature Review

One factor previously found to predict the reason why it is so hard to quit caffeine is that the more caffeine an individual consumes the more they want caffeine no matter how much they like it.For example, in a study of 56 German students who were either low/no coffee drinkers (<1 cup daily), or heavy coffee drinkers (3< cups per day) by Koranyi et al. (2020), researchers examined the dissociation between wanting and liking coffee. Wanting vs. liking coffee was assessed using two versions of the Implicit Association Test (IAT) that had been developed for either assessing wanting for coffee (W-IAT) or liking of coffee (L-IAT). The L-IAT test was comprised of 8 pictures, four coffee-related stimuli and four juice-related stimuli, which participants had to assign to either a “coffee” category or a “juice” category. The W-IAT test was modified slightly, so participants had to assign stimuli of either letters or numbers to their respective categories of either “I want” in which case participants were incentivized with a small monetary reward for every correct and fast answer or “I don’t want” which was not incentivized, after being shown stimuli of either coffee or juice. Participants were split up based on their reported average coffee consumption (heavy or low/no coffee drinkers) and answered both versions of the IAT test. Heavy coffee consumers were found to have an increased want for coffee but were similar to low/non-coffee consumers in liking coffee. Based on these results, the researchers suggested that individuals with high coffee consumption crave coffee more than those who do not drink a lot of coffee, despite how much they like it.

Another factor previously found to predict the reason why caffeine is so hard to quit is that making people feel good is the reason for the intense cravings and intentions for caffeine. Such cravings and intentions are associated with positive reinforcement expectations that, in turn, increase caffeine cravings. For example, in a study of 189 caffeine consumers who completed a caffeine craving questionnaire based on the Smoking Impulsivity Questionnaire (QSU) during one of five naturally occurring periods of coffee abstinence by West & Roderique-Davies (2008), voluntary participants in the study were university students during lectures and workshops at the University of Glamorgan. Participants must complete a questionnaire containing caffeine consumption, demographic details, the Leeds Dependence Questionnaire (LDQ) and the Caffeine Craving Questionnaire (QCC) in order at the beginning or end of the lecture or workshop. The researchers used the Leeds Dependency Questionnaire (LDQ) to assess participants' self-rated dependence on caffeine. Participants were asked to "think about the last week" and responded on a 4-point scale including "never," "sometimes," " often," and "nearly always." Scores are from "0" for the lowest dependency to "30" for the highest dependency. The 32-item Caffeine Craving Questionnaire (QCC) used by the researchers was derived from the Smoking Stimulus Questionnaire (QSU), in which the items "smoke(ing)" and "cigarettes" were replaced by the word caffeine. Participants were asked to respond based on their level of agreement with each problem statement, on a scale from 1 (strongly disagree) to 7 (strongly agree), with responses such as "nothing is better than drinking coffee now" and "I would if I Now I can drink some caffeine and I'll be more focused." Before analyzing all the data from the QCC, the researchers applied a skew method to rotate the principal components to produce the "cleanest" factors and used an independent-

sample t-test and ANCOVA for data analysis. The analysis was performed, and the expected feelings of caffeine were measured through a three-factor solution consisting of including Factor 1, reflecting strong desire, intention and positive reinforcement; Factor 2, reflecting mild/general positive and negative reinforcement; Factor 3, Reflecting negative reinforcement based on function/mood. Based on these results, the researchers suggested that the anticipation of being very pleasant and strong cravings increase intentions for caffeine consumption. This is consistent with significantly higher cravings, intentions, and desires for caffeine consumption among participants who self-reported more frequent daily caffeine use.

A third factor previously found to predict the reason why it is so hard to quit caffeine is because the withdrawal can display physical and psychological annoyances when suddenly no longer taking the drug. For example, in an experimental study done on 87 daily coffee drinkers (6 days a week) that reported their daily caffeine use of 525 mg by Juliano et al. (2019), researchers examined the psychological influences from caffeine withdrawal over a 2 day study. This was done by giving participants a cup of coffee that was either caffeinated or decaffeinated (distilled water). Participants were randomly assigned to groups and were told they were receiving 'caffeinated' coffee for the day and were either given the caffeinated coffee or the decaffeinated coffee. On the second day both the groups were given decaffeinated coffee with an added 280 mg caffeine. To measure for the types of withdrawal symptoms (fatigue, low motivation, headaches, nausea and flu-like feelings) participants were asked to fill out three questionnaires, regarding their exposure to caffeine (brand, serving, types of caffeine), withdrawal symptoms they experience (0-5 scale) whether or not they would consume the coffee again (0-10 rating scale). After completing the questionnaires participants then completed the Rapid Visual Information Processing test (RVIP) which was used to measure the participants attention and cognitive performance from consuming the caffeinated or decaffeinated coffee. The participants viewed numbers on the screen and were told to press the mouse button on the computer quickly when they saw odd or even numbers three consecutive times. Based on these results, the researchers suggested that those that were given decaffeinated coffee showed an increase of reporting flu-like symptoms (nausea, fatigue, headaches) and also showed poor cognitive performance. These individuals also reported much lower scales on the coffee rating questionnaire than participants that were given caffeinated coffee and reported higher scales on the rating questionnaire. Those with the lower scales on the coffee rating questionnaire also reported that they more likely to consume coffee again, indicating that there were signs of withdrawal related to their measure of addiction.

1.3 Hypotheses

Based on the above literature review, we predicted the following hypotheses:

- Hypothesis #1: If coffee consumption increases then caffeine wanting will increase.
- Hypothesis #2: If the expected pleasure from drinking coffee increases then caffeine wanting will increase.
- Hypothesis #3: If withdrawal symptoms increase then caffeine wanting will increase.

2. Methods

2.1 Participants

The three authors of this paper served as the participants in its studies. The participants ranged in age from 19-49 years old, with an average age of 19 years, and included females. The participants were all undergraduate students at Camosun College who completed the current studies as an assignment for Psyc 245 ("Drugs and Behavior") and were grouped together due to their mutual interest in caffeine addiction. Each of the three participants reported consuming caffeine on a daily basis.

2.2 Correlational Study Methods

We first performed a correlational study to test concurrently all of our hypotheses by examining naturalistic daily changes in their variables longitudinally. Each participant kept a study journal with them at all times over this study's one-week period in order to record self-observations of the following three variables: (1) coffee consumption, (2) expect the pleasure of drinking coffee, (3) withdrawal symptoms, and (4) caffeine addiction/wanting.

Amount of coffee consumption - To measure coffee consumption, we devised a questionnaire which included questions about how many cups of coffee were consumed each day (see Appendix A for a complete list of items used in this questionnaire). Each group member self-reported the number of cups of coffee (1 cup = 237mL) that were consumed by the end of each day for a week (7 days).

Anticipated pleasure before drinking coffee - To measure the pleasure expected from drinking coffee, we designed a questionnaire on the level of pleasure expected before drinking coffee (see Appendix A for a full list of items used in this questionnaire). Everyone did this by self-reporting on a scale of 0-10 how much pleasure they expected before drinking coffee (0 being none, 10 being extreme symptoms). Each team member self-reported their expected caffeine-induced pleasure for a week (7 days) before drinking their first cup of coffee each day. Each of us kept track of our signs through a daily questionnaire report.

Withdrawal symptoms - To measure withdrawal symptoms, we created a questionnaire containing questions on how extreme our withdrawal symptoms were (see Appendix A for a complete list of items used in this questionnaire). This was done by each of us self-reporting our symptoms once a day in the morning before we consumed caffeine on a scale of 0-10 (0 being not at all and 10 being extreme symptoms). Symptoms of headaches, fatigue and flu-like symptoms were measured before we consumed caffeine for the day. We each kept track of our symptoms by reporting them on the questionnaire daily for a span of one week (7 days).

Caffeine addiction - To measure caffeine addiction, we created a questionnaire with a series of questions regarding how much we craved caffeine (see Appendix A for a complete list of items used in the questionnaire). This was done by each participant self-reporting how much each participant craved caffeine once a day for each day on a scale of 0-10 (0 being no cravings at all and 10 being extreme). We kept track of our carvings by reporting them on the questionnaire daily for a span of one week (7 days).

2.3 Correlational Study Planned Analyses

To assess the strength and statistical significance of associations between variables predicted by our three hypotheses, we performed Pearson product-moment

correlations of their predictor variables coffee consumption, expect the pleasure before drinking coffee, and withdrawal symptoms with their outcome variable increase of caffeine addiction. For testing Hypothesis #1, we correlated coffee consumption by analyzing how many cups of coffee we consumed each day. For testing Hypothesis #2, we correlated the expectation of pleasure before drinking coffee on a scale of 0-10 to get data from the questionnaire we devised every day. For testing Hypothesis #3, we correlated withdrawal symptoms using a scale of 0-10 to be able to derive a numerical value from the questionnaire we created. We performed all of the above correlations separately for each participant as well as using data pooled across all of the participants. For the correlations using pooled data, in addition to using the raw data, we also performed correlations after we had first transformed the data from each participant into *z*-scores in order to standardize differences in averages and variability seen between the participants in their data and thus make them more comparable. A correlation coefficient was considered statistically significant if the probability of its random occurrence (*p*) was $< .05$ (i.e., less than 5% of the time expected by chance alone).

2.4 Experimental Study Methods

Based on the strength of the correlation between the amount of caffeine, along with the wanting for caffeine found in our correlational study, we then chose to conduct an experimental study to test for a causal relationship between these two variables from Hypothesis #1.

We manipulated the independent variable, caffeine amount, over a one-week period by randomly assigning participants each day to either a caffeinated coffee condition or a decaffeinated coffee condition using a double-blind procedure. Participants consumed Starbucks caffeinated Pike Place coffee on experimental days (3 days) and on control days (3 days) participants consumed Starbucks Pike Place decaf coffee for a total of 6 days. To indicate whether or not participants would be consuming caffeinated or decaffeinated coffee for the day, they randomly drew a card with either yes (caffeinated) or no (decaffeinated) on it. After consuming the coffee for the day participants self-reported on a scale of 0-10 their craving on a questionnaire created (see Appendix B) daily for 6 days.

Participants were randomly assigned to the experimental or control group each day to control for order effects. In order to use the double-blind procedure and control for placebo effects, participants were unaware of which condition they were receiving. This was maintained by having the participants' friends or family members draw the corresponding card (yes or no) to perform the manipulation of the caffeinated or decaffeinated coffee. The friend or family member then secretly recorded what condition was performed which was then shared at the end of the day after the participants completed the self-reported questionnaire for analysis purposes of the dependent variable. Following this procedure reduced the experimenter expectancy effects on the dependent variable.

2.5 Experimental Study Planned Analyses

To assess the statistical significance of differences seen in wanting of caffeine on caffeinated experimental days vs. decaffeinated control days, Student's *t*-tests were performed. We performed t-tests separately for each participant as well as using data pooled across all of the participants. For the *t*-tests using pooled data, in addition to using the raw data, we

also performed *t*-tests after we had first transformed the data from each participant into *z*-scores in order to standardize differences in averages and variability seen between the participants in their data and thus make them more comparable. An average difference between conditions was considered statistically significant if, using a one-tailed distribution (i.e., to determine if there is a difference between groups in a specific direction), the probability of its random occurrence (p) was < .05 (i.e., less than 5% of the time expected by chance alone).

3. Results

3.1 Correlational Study Results

As shown in Table 1, both anticipated pleasure and the amount of caffeine were significantly correlated with wanting of caffeine. The amount of caffeine consumed and wanting of caffeine was significantly correlated for one participant (r = .96, p = .0002). They were also significantly correlated using pooled raw data (r = .57, p = .007; see Figure 1) as well as using pooled standardized data (r = .44, p = .001; see Figure 2). Two participants had statistically significant results for the anticipated pleasure of caffeine (r = .97, p = .00004; r =-0.76, p = .04) and were also significantly correlated with wanting of caffeine using pooled raw data (r = .51, p = .01 see Figure 3) but not with pooled standardized data (r = .13, p = .58; see Figure 4). In contrast, withdrawal symptom severity and wanting of caffeine were not statistically significant using pooled raw data or pooled standardized data (all r ≥ -.02, all p ≥ .91; see Figure 5 & 6). Although, two individual participants had statistically significant correlations between withdrawal symptom severity and wanting of caffeine (r = .85, p = .01; r = -.91, p= .002). Based on the comparison of the correlation coefficients using pooled raw data and pooled standardized data, caffeine amount showed the strongest correlation with wanting of caffeine.

3.2 Experimental Study Results

As shown in Table 2, there was a large difference in the wanting of caffeine between the caffeinated and decaffeinated coffee conditions (see Table 2). This difference was statistically significant using the pooled raw data shown (t = 5.36, p = 0.00003; in Figure 7) and using the pooled standardized data (t = 5.66, p = 0.00002; see Figure 8).

4. Discussion

4.1 Summary of Results

Based on previous research, we hypothesized that an increase in three variables would be followed by an increase in wanting of caffeine: the amount of caffeine consumption (Hypothesis #1), the anticipated pleasure of having caffeine (Hypothesis #2), and the severity of withdrawal symptoms (Hypothesis #3). Data pooled across participants in our correlational study supported the predicted relationship with caffeine amount (Hypothesis #1) but not with anticipated pleasure or withdrawal symptom severity (Hypotheses #2 & #3). However, in contrast to our correlational study, findings from our experimental study showed that an increased caffeine amount actually decreases caffeine wanting instead of increasing it.

4.2 Relation of Results to Past Research

The hypothesis that if coffee consumption increases then craving or wanting for coffee will tend to increase is supported and consistent with past research on caffeine addiction. Based on the group's findings, there is a significant correlation between caffeine amount and wanting of caffeine using pooled raw data and pooled standardized data as seen in Figures 1 and 2. In past research, participants who reported drinking more caffeine daily (3+ cups) also had a greater desire for caffeine (Koryani et al., 2020). Similarly, this study's methods involved participants self-reporting the amount of caffeine consumed on a daily basis. The results in the current study are significant, although in the opposite direction as increasing coffee consumption actually decreased wanting of coffee. The differences in results could be due to a smaller sample size and/or differences in methodologies. In past research, participants were split up based on self-reported caffeine consumption. They were asked to answer two versions of an Implicit Association Test to determine the differences between wanting and liking in each participant. This method was not used in the current study, instead, researchers developed a questionnaire to test all hypotheses at once with no manipulation which could be the cause for statistical inconsistencies. The current study's results along with past research suggest that there is a link between the amount of caffeine consumed and wanting for caffeine. The current statistical and nonstatistical results shed light on explanations for caffeine addiction and directions for further research.

The results of the experimental study using a double-blind procedure to determine the relationship between caffeine amount and wanting of caffeine revealed similar results to past research. In past research, participants who reported drinking heavier amounts of caffeine daily also had a higher overall wanting of caffeine (Koryani et al., 2020). In the current study, participants who reported having caffeinated coffee reported having lower cravings of coffee that day. These results from the current study are significant in both pooled and standardized raw data (Figures 7&8). Although there are methodological differences between the current study and past research. In past research, participants were split up based on average coffee consumption (high and low consumption) and then asked to complete two versions of the questionnaire. In the current study, participants were all consumers of caffeine already, then each day were either given caffeinated or decaffeinated coffee and reported which condition they got at the end of the day. These differences could be limiting to the current study's results as the two studies were not outright testing the same hypothesis. Another limiting factor for the current study was sample size; the sample size in this experimental study was three individuals which means it may not generalize to the population. However, despite the differences in the methods, the results from the current experimental study were significant, which can shed some light on future directions of research. If caffeine consumption is a determining factor on how much an individual craves caffeine, then future research can explore ideas such as why people begin consuming caffeine in the first place or how an individual can quit caffeine more easily.

The hypothesis that if the pleasure of drinking coffee increases, then caffeine addiction will tend to increase is irrelevant to past research on caffeine addiction. Overall the results were not consistent with past research. According to the group's

findings, only two participants had a significant correlation between expected caffeine pleasure and caffeine craving. This suggests that the relationship between anticipated pleasure and wanting of caffeine is unlikely since the correlation between the hypotheses was not significant based on the pooled standardized data. In past research, anticipatory caffeine sensations were measured as reflecting intense desire, intention, and positive reinforcement of pleasure and intense craving, predicted to increase intention to consume caffeine (West & Roderique-Davies, 2008). Again, the study's methodology involved participants self-reporting on a scale of 0-10 how they expected to be with their daily cup of coffee before consuming caffeine versus how much coffee they consumed. However, the results were not significantly correlated using the pooled standardized data compared to past studies, which may be due to methodological differences. In past research, participants were asked to respond on a scale of 1 (strongly disagree) to 7 (strongly agree) based on how much they agreed with each question statement, with responses such as "There is nothing better than drinking coffee right" Good It's "now" and "If I could drink some caffeine right now, I'd be more focused" (West & Roderique-Davies, 2008). Current data of the participant's recalled response and the actual amount of caffeine intake were not significantly correlated. Our related research results cannot establish a relationship that exists between anticipated pleasure and caffeine wanting based on the pooled data. The present statistical and non-statistical results shed light on explanations for caffeine addiction and directions for further research.

The results of an experimental study using a double-blind procedure showing the relationship between caffeine amount and caffeine wanting were similar to the past studies. Past research concluded that cravings for the caffeine element would be more pronounced in the absence of caffeine (West & Roderique-Davies, 2008). In this study, decaffeinated coffee and caffeinated coffee were randomly ingested using a double-blind procedure. Participants self-reported their want for caffeine when receiving decaffeinated coffee compared with caffeinated coffee much higher, as shown in Figures 7 and 8. However, this study has some limitations in that it did not assess participants' prior caffeine wants and was conducted on a short number of days. Caffeine user types may also have been underrepresented. Therefore, the study's findings may not generalize to the caffeine consumer population. However, studies have revealed a relationship between caffeine amount and caffeine wanting, which may increase an individual's chances of becoming addicted relative to predicting the frequency and amount of caffeine intake.

For the hypothesis that if withdrawal symptoms increase then caffeine addiction will tend to increase does not relate to past research on caffeine addiction. Based on the group's findings only two of the participants showed significant correlation with withdrawal severity and the wanting of caffeine. Withdrawal symptoms showed no significant correlation in pooled data and standardized data across the other hypotheses. In past research participants that reported signs of withdrawal in the form of flu-like symptoms (headaches, fatigue and nausea) were more likely to report that they would consume coffee again on questionnaires (Juliano et al., 2019). Similarly, in the group's findings the two participants that reported their symptoms on a scale of 0-10 before consuming caffeine also reported an increased wanting of caffeine. However, the results were not statistical compared to the past research

conducted, which could have been due to methodological differences. In the past study participants were either given caffeinated or decaffeinated coffee and then completed the Rapid Visual Information Processing test (RVIP) to test for how quickly participants could respond to numbers on the screen. This procedure was not used by the researcher's, instead a self-reporting questionnaire was created to test all of the hypotheses at once correlationally with no manipulation which may have been the cause of any discrepancies. Future studies on caffeine withdrawal could perhaps suggest new findings if self-reporting questionnaires are effective or not in measuring caffeine addiction and if there are other methods that can be used to report these types of symptoms accurately. These findings along with previous research do suggest that more individuals need to be educated about caffeine sources and the ability it has to produce physical dependence and addiction (Juliano et al., 2019). The statistical and nonstatistical correlations found in this study shed light on further research and further explanations on caffeine addiction. In the current study we can conclude that hypothesis #1 (the amount of caffeine consumption) was confirmed. The scatter plot in figure 3 presented a positive correlation with the anticipated pleasure from caffeine and wanting of caffeine in the pooled raw data. In the standardized data shown in figure 4, the positive correlation between the two hypotheses was not a reliable measure seen between the participants. With this data, we can also conclude that only hypothesis #1 (amount of caffeine consumption) was statistically significant using pooled standardized data in this study. Further research should be done to investigate correlations between these variables.

Findings from the experimental study performed, using a double-blind procedure to conduct the relationship between the amount of caffeine and wanting of caffeine revealed similar results to past research. Past research has concluded that participants that were given decaffeinated coffee reported greater cravings for caffeine than those given caffeinated coffee (Juliano et al., 2019). Similarly, in the current study, participants that received decaffeinated coffee using the double-blind procedure self-reported much higher wanting for caffeine compared to when administered caffeinated coffee. These findings were statistically significant in both the raw and standardized pooled data as seen in Figures 7 and 8. In relation to past research "caffeine craving, but not coffee craving was also greater among those told they were drinking decaf coffee compared with those told caffeine" (Juliano et al., 2019). This finding was seen in the current study as participants reported at the end of the day which condition they received (caffeinated or decaffeinated coffee) reported significant wanting of caffeine rather than the actual coffee. These results were in the opposite direction of the original prediction of Hypothesis #1 (If coffee consumption increases then caffeine wanting will increase) these significant findings shed light on the relationship between caffeine amount and the wanting of caffeine which can lead to caffeine addiction in individuals. However, there are some limitations to this study as the two studies were testing different hypotheses. The current study was conducted on a small sample size of three participants which may not generalize to the general population of daily caffeine consumers. However, further research should be conducted on different ways individuals can quit caffeine consumption easily.

4.3 Implications of Results

Possible applications from the current findings of caffeine craving, after not consuming any or very little amounts of caffeine can provide further research on addiction. For example, individuals should plan on slowly decreasing the amount of caffeine consumed daily should they be trying to quit rather than quitting cold turkey. Implications can also be made towards further education on caffeine consumption, especially towards young adults.

We originally conducted the current study to determine what makes caffeine very addictive and why it can be so hard to quit. Based on our experimental results, we can recommend that acute effects of day-to-day variations in caffeine intake should overall make it easier to quit. Results from this study can raise new important questions on caffeine consumption and the wanting of caffeine.

References

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Table 1

Correlations for Study Variables

Variables	Participant #1		Participant #2		Participant #3		Pooled raw data		Pooled standardized data	
	r	*n*	*r*	*n*	*r*	*n*	*r*	*n*	*r*	*n*
Caffeine amount & wanting caffeine	*0.18*	*7*	*0.96**	*7*	*0.19**	7	0.64*	21	0.44*	21
Anticipated pleasure of having caffeine & wanting caffeine	0.18	*7*	*0.97**	*7*	*-0.79**	*7*	*0.51**	21	0.13	21
Withdrawal symptoms & wanting caffeine	0.85*	7	-0.91*	7	0.09	7	-0.02	21	0.01	21

Notes. *r* = correlation coefficient, *n* = number of days sampled.

* $p < .05$.

Table 2

Descriptive Statistics for Wanting Caffeine Across Different Caffeine Amount Conditions

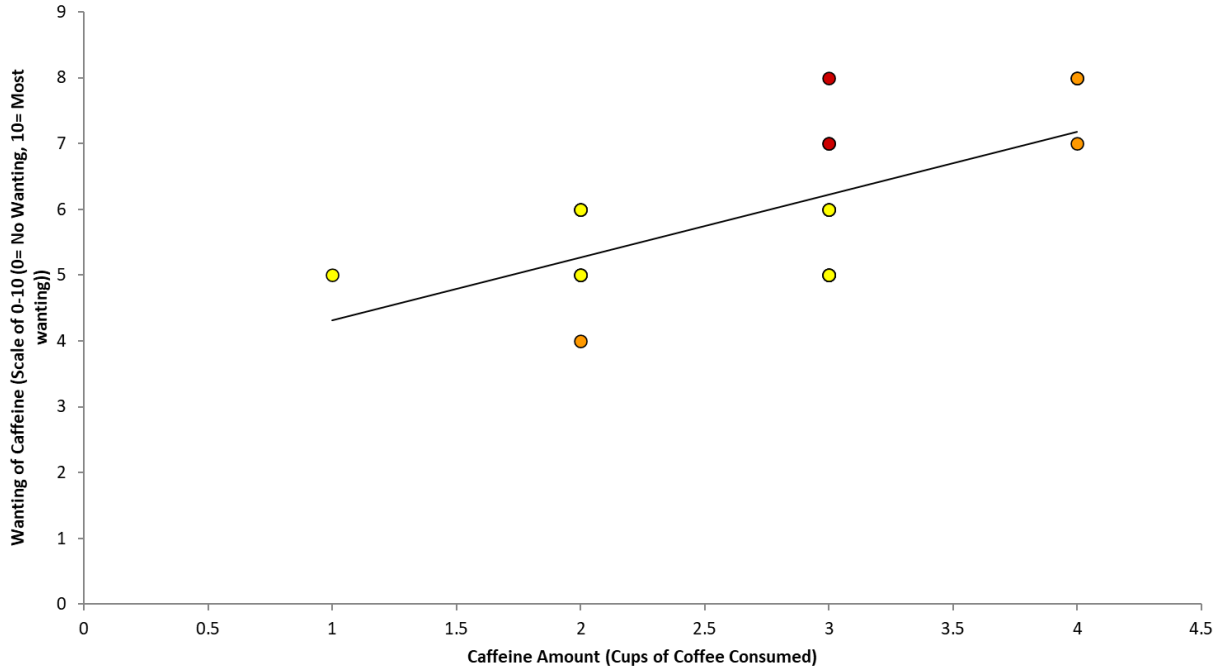
Condition	Statistic	Participant #1	Participant #2	Participant #3	Pooled raw data	Pooled standardized data
Caffeinated Coffee	*M*	4.75	2.25*	4.33*	3.73*	-0.57*
	SD	2.22	0.96	0.58	1.79	0.70
	n	4	4	3	11	11
Decaf Coffee	*M*	6.50	7.00	8.33	7.43	0.89
	SD	0.71	1.41	0.58	1.13	0.39
	n	2	2	3	7	7

Note. *M*, *SD*, and *n*, represent mean, standard deviation, and sample size, respectively. Craving caffeine each day on a scale of 0-10 as DV unit of measurement.

* $p < .05$ for comparison of caffeinated coffee condition with its respective decaffeinated coffee condition.

Figure 1

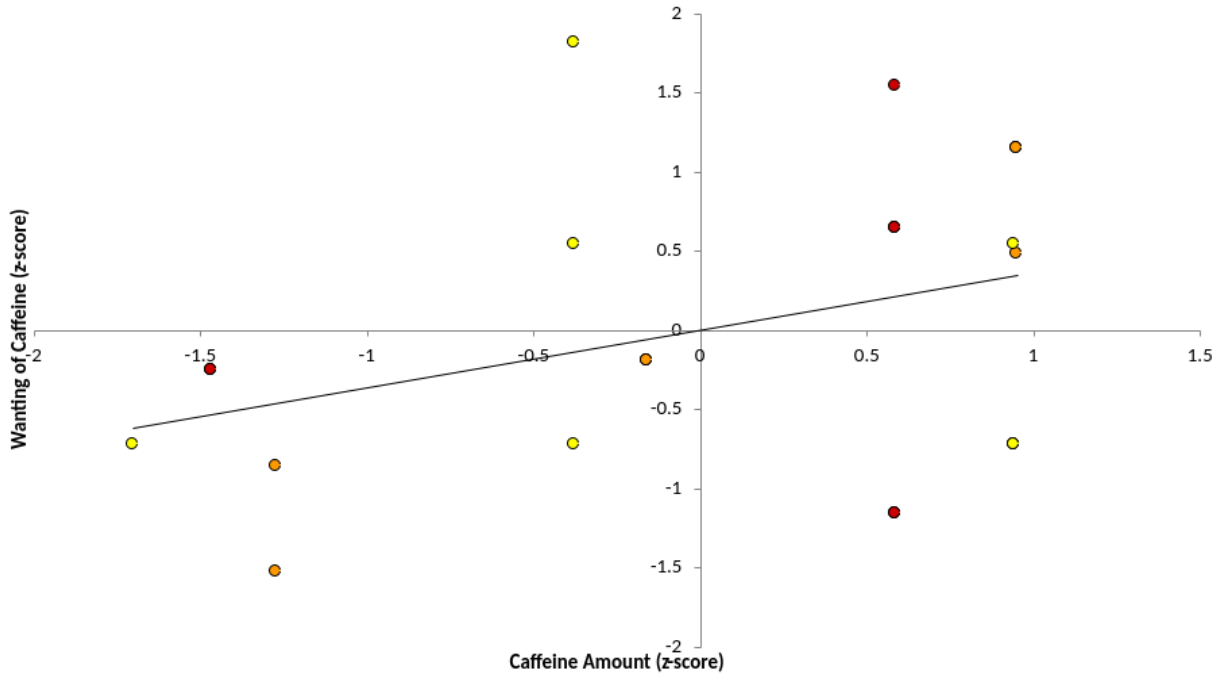
Association Between Caffeine Amount and Wanting Caffeine Using Pooled Raw Data



Notes. Marker colour differentiates participants: red = participant #1, orange = participant #2, and yellow = participant #3. Some data might not be visible in the figure due to overlapping markers.

Figure 2

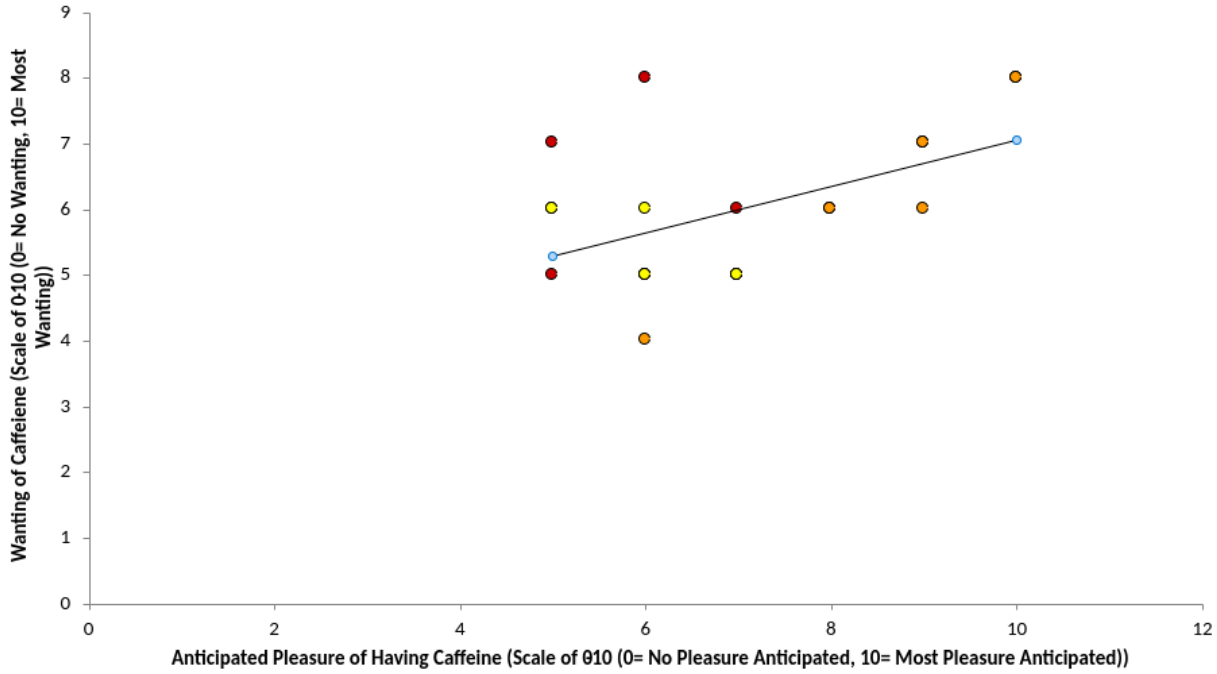
Association Between Caffeine Amount and Wanting Caffeine Using Pooled Standardized Data



Notes. Marker colour differentiates participants: red = participant #1, orange = participant #2, and yellow = participant #3. Some data might not be visible in the figure due to overlapping markers.

Figure 3

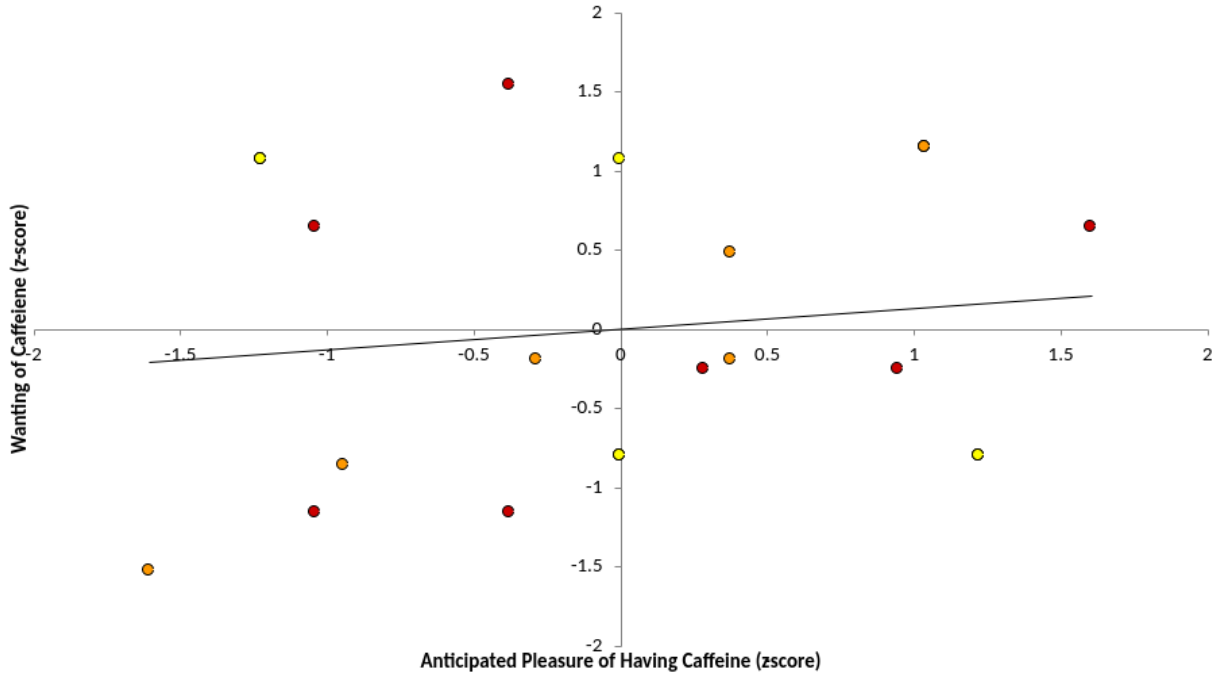
Association Between Anticipated Pleasure From Caffeine and Wanting Caffeine Using Pooled Raw Data



Notes. Marker colour differentiates participants: red = participant #1, orange = participant #2, and yellow = participant #3. Some data might not be visible in the figure due to overlapping markers.

Figure 4

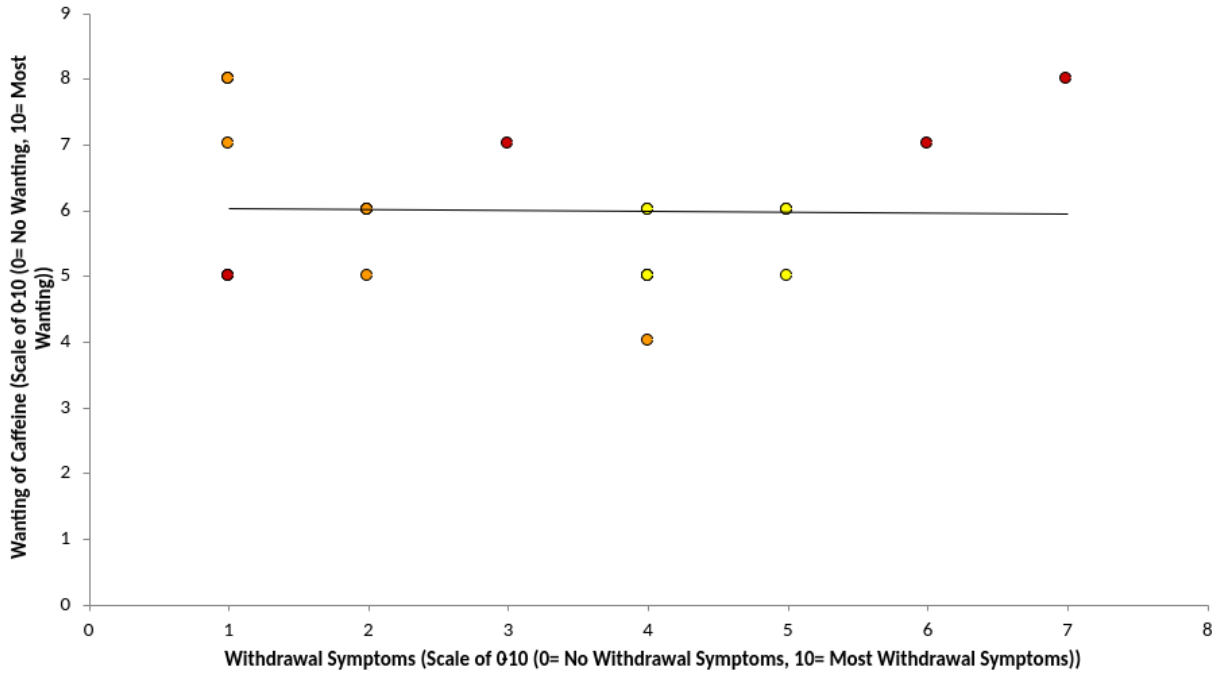
Association Between Anticipated Pleasure From Caffeine and Wanting Caffeine Using Pooled Standardized Data



Notes. Marker colour differentiates participants: red = participant #1, orange = participant #2, and yellow = participant #3. Some data might not be visible in the figure due to overlapping markers.

Figure 5

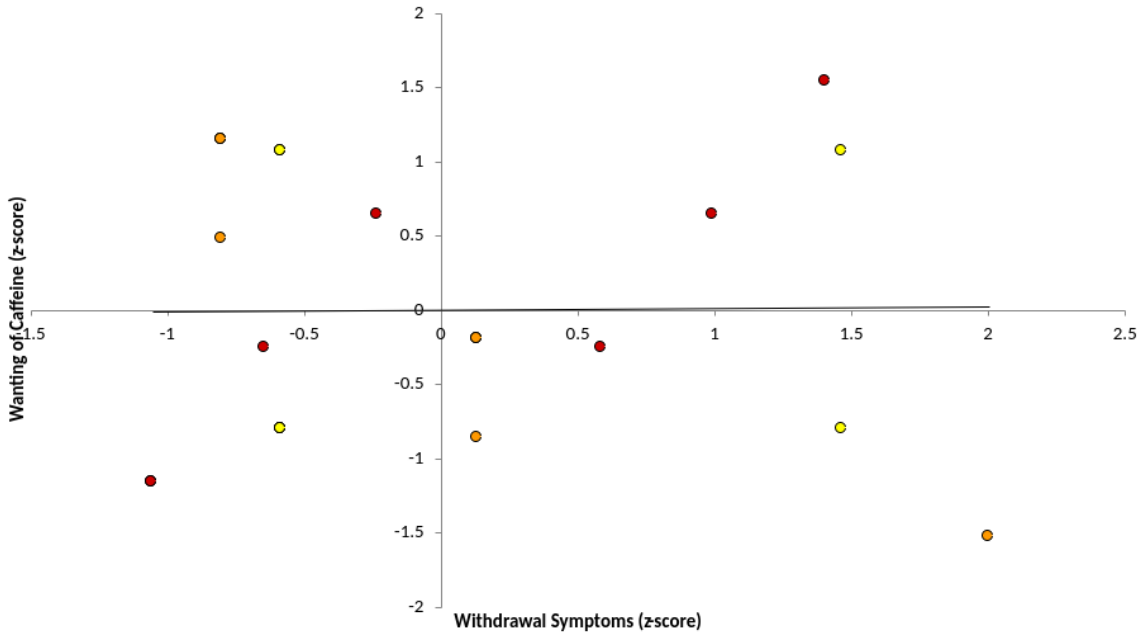
Association Between Withdrawal Symptoms and Wanting Caffeine Using Pooled Raw Data



Notes. Marker colour differentiates participants: red = participant #1, orange = participant #2, and yellow = participant #3. Some data might not be visible in the figure due to overlapping markers.

Figure 6

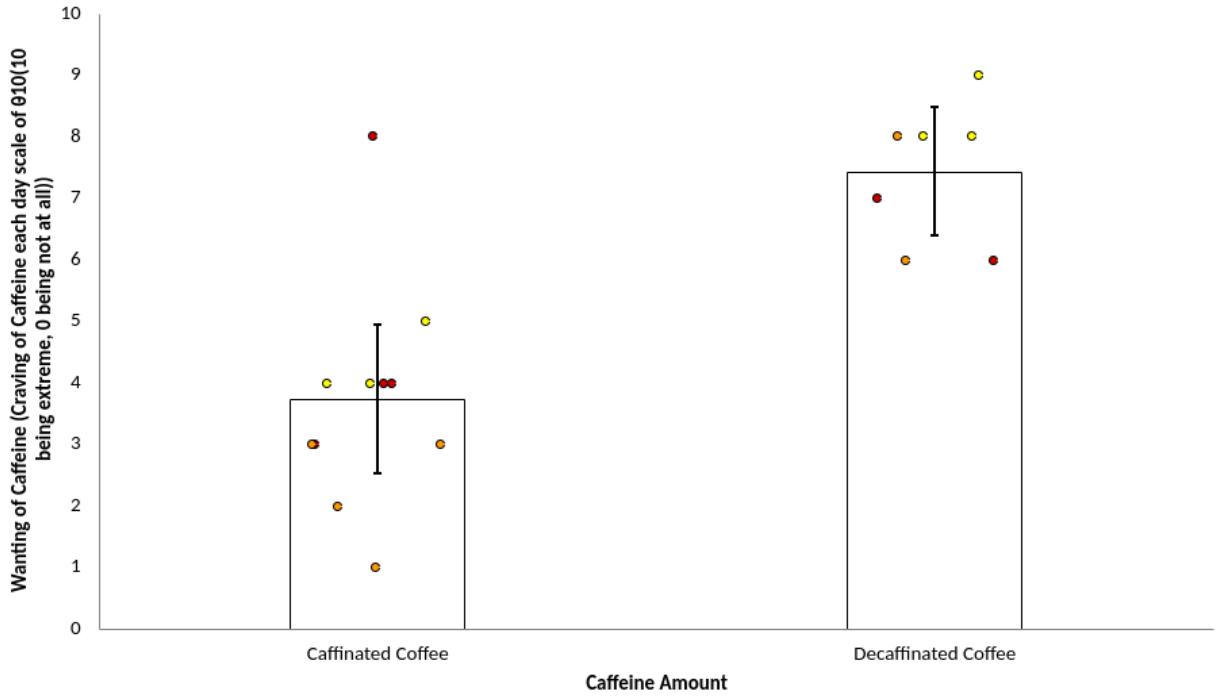
Association Between Withdrawal Symptoms and Wanting Caffeine Using Pooled Standardized Data



Notes. Marker colour differentiates participants: red = participant #1, orange = participant #2, and yellow = participant #3. Some data might not be visible in the figure due to overlapping markers.

Figure 7

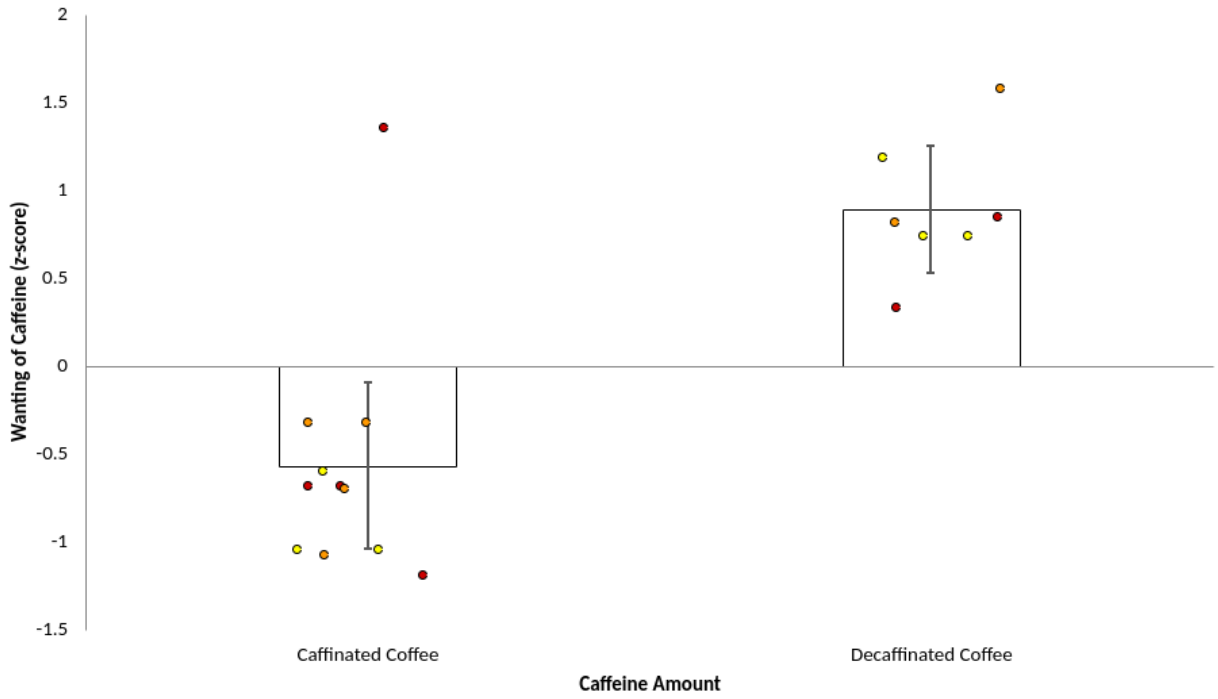
Average Wanting Caffeine Across Different Caffeine Amount Conditions Using Pooled Raw Data



Notes. Wanting of caffeine scores are shown for caffeinated coffee and decaffeinated coffee conditions using pooled raw data from all participants. Errors bars show ± 95% confidence levels. Overlapping scatterplot shows data from each participant. Marker color differentiates participants: red = participant #1, orange = participant #2, and yellow = participant #3.

Figure 8

Average Wanting Caffeine Across Different Caffeine Amount Conditions Using Pooled Standardized Data



Notes. Wanting of caffeine scores are shown for caffeinated coffee and decaffeinated coffee conditions using pooled raw data from all participants. Errors bars show ± 95% confidence levels. Overlapping scatterplot shows data from each participant. Marker colour differentiates participants: red = participant #1, orange = participant #2, and yellow = participant #3.

Appendix A

Questionnaire Created to Measure The Hypotheses

1. How many cups of coffee were consumed by the end of each day (1 cup = 237mL)

2. How much did you crave caffeine each day? (10 being extreme craving, 0 being not at all)

0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10

3. How much pleasure did you anticipate before drinking coffee each day? (10 being extreme pleasure, 0 being none at all)

0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10

4. How extreme were your withdrawal symptoms before drinking coffee each day? (10 being extreme withdrawal symptoms, 0 being none at all)

0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10

Appendix B

Questionnaire Created to Measure Wanting of Caffeine

1. How much did you crave caffeine each day? (10 being extreme craving, 0 being not at all)

0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10