5-2000

Effects of Caffeine and Lateralized Emotional Distractors on Vigilance Performance

Tara L. Worley
Southern Illinois University Carbondale

Running head: EFFECTS OF CAFFEINE & INDUCED AFFECT ON VIGILANCE

Effects of Caffeine and Lateralized Emotional Distractors on Vigilance Performance

Tara L. Worley

Southern Illinois University at Carbondale

Faculty Advisor's Signature ______________ Date 5-8-00

Abstract

Caffeine is the most popular psychotropic drug (Smith & Tola, 1998) and is known to be used for its stimulating effects (Benowitz, 1990) as well as its enhancing effects on sustained attention (Smith, 1994, & Rusted, 1994). Effects of caffeine on attention and performance tasks have been studied quite extensively. Results have varied, but caffeine has generally been found to enhance attention and improve performance. An aspect yet to be studied is the effects of caffeine on vigilance performance given emotionally distracting stimuli. The focus of this paper is on the effects of caffeine on vigilance performance as well as hemispheric differences and lateralization of affect and task performance.

Effects of Caffeine and Lateralized Emotional Distractors on Vigilance Performance

Consumption

Caffeine is the most widely consumed psychotropic drug (Smith & Tola, 1998). A psychotropic drug is defined as a substance that causes changes in behavior or functioning of the mind (Berube et al., 1995). An estimated 80% of adults in the United States drink coffee or tea daily. In addition, some consume other caffeinated foods. The average intake of an individual is 4 mg/kg per day; however, several exceed 15 mg/kg per day (Smith & Tola, 1998). The most prevalent exposure to caffeine is from tea, but coffee is consumed the most; coffee is higher than tea in caffeine content by 60 to 70% (Lundsberg, 1998).

Coffee accounts for about 75% of caffeine ingestion. Tea accounts for about 15%, and soda accounts for about 10% of ingestion. Chocolate, foods, and medications account for very little intake. However, in 1980, several thousand over-the-counter and prescription medications were estimated to contain caffeine. These included pain relievers, such as Excedrin, Anacin, and Midol; stimulants, such as NoDoz and Vivarin; diet pills, such as Dexatrim; and decongestants, such as Dristan. Stimulants and diet pills contained the highest amounts of caffeine, averaging up to 200 mg per dose (Lundsberg, 1998). High amounts of caffeine can lead to potential harm or abuse. In fact, the DSM-IV (Diagnostic and statistical manual of mental disorders) includes Caffeine Intoxication under the category of Substance Abuse Disorders (American Psychiatric Association, 1994).

Caffeine Metabolism

Humans absorb about 99% of administered caffeine, mainly through the small intestine but also through the stomach. Absorption does not seem to be dependent on age, sex, genetics, disease, or other drug consumption. However, it may depend on weight; obese people tend to have a higher absorption rate (Arnaud, 1998). Absorption also depends on the pH of the caffeine solution as it enters the stomach. After 20 minutes, 9% is absorbed at a pH level of 2.1; 14% is absorbed at a pH level of 3.5; 22% is absorbed at a pH level of 7.0. In other words, the more acidic the caffeine solution is, the longer absorption takes (Spiller, 1998). Peak plasma concentration is reached between 15 and 120 minutes after oral ingestion (Arnaud, 1998). About 35% of caffeine binds to plasma protein (Spiller, 1998).

Caffeine increases an individual's metabolic rate. Catabolism, which is the process of larger molecules breaking down into smaller molecules, is part of metabolism. After catabolism, most of the caffeine remains in the body; small amounts are excreted in urine. An important note to make is that females on oral contraceptives have more caffeine left in the body than females not on contraceptives (Spiller, 1998). The International Olympic Committee considers caffeine concentrations higher than 12 mg/l of urine to be disqualifying (Arnaud, 1998). This exemplifies how small the normal amount excreted actually is.

<u>Physiological Effects of Caffeine</u>

Caffeine produces physiological effects within several systems of the body. In relation to the neural and endocrine systems, caffeine acts as an antagonist to adenosine receptors. Adenosine inhibits the release of dopamine and glutamate; therefore, caffeine enhances the release of dopamine and glutamate. Thus, a stimulating effect occurs. A chronic presence of caffeine increases the number of adenosine receptor sites. In turn, tolerance for caffeine increases (Spiller, 1998).

Within the cardiovascular system, caffeine modifies the contractility of the heart and blood vessels. Caffeine causes blood vessels to constrict, which increases blood pressure and decreases blood flow to the brain. Headaches due to caffeine withdrawal, or wearing off effects, are caused by the vasodilation of cerebral blood vessels. Caffeine may also lead to increases in cholesterol levels of heavy consumers (Spiller, 1998).

Caffeine also affects the respiratory and skeletal muscular systems. Caffeine stimulates respiration. It also affects muscle contractility; a common side effect of caffeine is tremor, or jitteriness. Muscles become highly active; as a result, they may start twitching. Another common effect is a decrease in steadiness, such as hand steadiness (Spiller, 1998).

Finally, caffeine causes changes in the gastrointestinal and renal systems. Caffeine stimulates the secretion of gastric fluids as well as the secretion of the pancreatic hormone. In addition, it induces contraction of the gall bladder. Common adverse effects are acid indigestion, heartburn, and abdominal pain. Caffeine also produces a diuretic effect. This is due to an increase in renal blood flow. Caffeine similarly enhances the release of renin, an enzyme that digests protein and raises blood pressure, from the kidneys (Spiller, 1998).

Caffeine and Vigilance

Aside from its physiological effects, caffeine has also been accredited for improving various performance tasks due to stimulation. Controversy over actual effects of caffeine has been researched. The concern is whether or not caffeine actually improves performance or if it just decreases fatigue and restores function. If caffeine only restored function, then performance levels should not improve after taking a sufficient dosage needed to restore normal levels of arousal. However, studies have shown that larger amounts of caffeine after normal alertness have improved performance. Therefore, researchers have concluded that caffeine does more than just restore function; it improves performance (Warburton, 1998, Smith, 1998, & Lane & Phillips-Bute, 1998).

Vigilance, for example, requires both alertness and sustained attention and has been found to be enhanced by caffeine (Warburton, 1995,1998, Stelt & Snel, 1998, & Smith, 1998). The Rapid Visual Information Processing (RIP) task is a vigilance task that requires subjects to attend to digits appearing in the center of the computer screen and respond with a button push when either three even or three odd digits appear consecutively. Warburton has used the RIP task and has found caffeine to improve not only response time but also accuracy in vigilance. He also concluded that performance improves with a high dose of caffeine (Warburton, 1995, 1998). Using a different type of vigilance task, which required subjects to push a button when they detected a rectangular stimulus, Fine et al. similarly found that caffeine improves performance. Both accuracy and response time improved; however, researchers suggested that higher caffeine consumers may show less improvement in accuracy than lower caffeine consumers (Fine et al., 1994).

Caffeine deprivation also has effects on performance. Common symptoms of withdrawal are headache, nausea, decreased alertness, irritability, fatigue, stress, negative mood, anxiety, muscle tension, nervousness, lack of concentration, confusion, and depression (Streufert et al., 1995). In terms of vigilance, caffeine deprivation has been shown to create deficits in performance, reducing not only the speed of response but also the accuracy of detecting targets (Lane & Phillips-Bute, 1998). Thus, regular caffeine consumers who miss their normal intake may experience negative symptoms of deprivation as well as a decline in cognitive performance ability. Aside from physical effects, people may have difficulty concentrating; therefore, they might make more mistakes than usual in their daily tasks. For example, if a bank teller misses his or her routine morning coffee, he or she might make several errors in financial transactions throughout the day because of lower concentration levels.

Brain Asymmetry

The human brain is made up of two hemispheres: the left hemisphere and the right hemisphere. Although these two hemispheres interact with one another, certain specializations may exist within each hemisphere. This is commonly referred to as lateralization or brain asymmetry. As Hellige points out, "there are a great many cognitive and behavioral asymmetries in human beings, many of which can be attributed to hemisphere or brain asymmetries" (Hellige, 1993).

Within the brain, information is transferred via the corpus callosum from one hemisphere to the other. More specifically, information is transferred from the hemisphere of reception to the hemisphere initiating a response. Response latency to signals presented in the ipsilateral visual field is faster than latency for signals presented in the contralateral field (Beaumont, 1997).

Beaumont proposed three theories of how information transfer may take place. First, there may be a single crossing. If this were true, a response would be expected in a matter of microseconds. However, responses usually take milliseconds. Therefore, the single crossing explanation is not well supported. Another possibility may be that there are numerous crossings that occur across the corpus callosum from the receiving hemisphere to the responding hemisphere. This would account for a longer response time. However, it does not seem feasible that numerous crossings would occur in one direction. The best explanation is that there are numerous crossings and recrossings between the hemispheres (Beaumont, 1997).

Asymmetry may still be accounted for if the transfer of information involves a sequential pattern. That is, transfer crossings and recrossings do not occur in a random order. They may follow a particular criterion. If individual crossings occurred at random, then all the crossings in general would be very chaotic and nonsystematic. Thus, the information involved would probably result in just as much disorganization into thought. Another possibility, or added feature, may be that load association is involved. That is, perhaps chunks of information are sent together rather than in any random manner. In addition, load association may be relevant to both the transmission and the reception of information (Beaumont, 1997). This best explains not only the delay period but also the specialization taking place, while still allowing the information transfer to be organized.

Lateralization

In particular, the left hemisphere (LH) is associated with specific specializations. It is associated with sequential and temporal information as well as verbal and analytic information. The LH's primary functions are thought to be for speech, language, verbal abilities, writing, body orientation, complex motor functioning, and vigilance. Most people, whether left or right-handed, are LH dominant for language (Dean & Reynolds, 1997). In addition, the LH is associated with positive affect (Hellige, 1993). For example, participants watching television programs eliciting positive emotion have shown more electrophysiological activity in the LH (Davidson et al., 1979, Davidson, 1988, 1992, & Fox, 1991).

The right hemisphere (RH) is associated with simultaneous, holistic, visual, nonverbal, imagery, and spatial reasoning information. Its primary functions are thought to be for depth and tactile perception, nonverbal sound recognition, visual constructive performance, pattern recognition, nonverbal memory, and facial recognition (Dean & Reynolds, 1997). In addition, the RH is associated with negative affect (Hellige, 1993). For example, participants watching television programs eliciting negative emotion have shown more electrophysiological activity in the RH (Davidson et al., 1979, Davidson, 1988, 1992, & Fox, 1991).

More recent research has also found greater activity in the right hemisphere for negative affect versus neutral affect (Kayser et al., 1997). However, this study failed to consider positive affect, so the results are not assuredly conclusive. In contrast, Hagemann et al. concluded that positive affect-related slides resulted in more right hemispheric activity, and negative affect-related slides resulted in more left hemispheric activity (Hagemann et al., 1998).

A final, important aspect is that regardless of the original form of input, people can have some control over how information is processed. Individuals are able to generate visual or verbal modes that interface with hemispheric functions (Dean & Reynolds, 1997). For example, if a person receives a word as the original input, he or she may associate a picture of that word in his or her mind. Conversely, if the original input is in the form of a picture, the person may associate words with the picture. Therefore, the processing of information may not be entirely dependent upon the form of input. This could also interfere with emotional components as well. Thus, it may be difficult to determine exactly why brain activity is stronger in one area over another.

The purpose of this study was to evaluate the effects of caffeine and emotional distractors on vigilance performance. The Rapid Information Processing (RIP) task was used as the vigilance task. In addition to the digits appearing in the center of the screen, emotional distractors appeared laterally to the left or right or the screen. In accordance with past literature (Warburton, 1995, 1998, Fine et al., 1994), caffeine was expected to improve performance, both reaction time and accuracy. Although there is published literature on the effects of emotional distractors during a vigilance task, it was expected that the distractors would impair performance. In addition, hemispheric differences were anticipated; lowest performance levels were expected to occur in the placebo condition when positive emotional distractors appeared in the RH. Finally, no gender differences were expected.

Method

Participants

The study consisted of 14 students (6 males and 8 females) from Psychology classes at a Midwestern university. Twelve participants were Caucasian, one was Asian, and one was African American. Age ranged from 18-35 with a mean of 21 (median=19). Participants were screened for eligibility using the following criteria: regular caffeine consumers, non-smokers, normal or corrected-to-normal vision. None of the included participants evidenced health problems, current depression, medication or illicit drug, or pregnancy. Each participant was given an informed consent prior to beginning the project as well as a debriefing form after completing the project and received either course credit or extra credit for their participation.

Materials

One standardized questionnaire was used in the project: Feeling State Questionnaire (FSQ) (Gilbert et al., 1992). The FSQ states measures such as happiness, alertness, relaxation, drowsiness, irritability, attentiveness, and jitteriness. In addition to the standardized questionnaire, demographic information and caffeine condition guess and attribution information were collected. The demographic questionnaire included items such as age, sex, ethnicity, height, weight, marital status, year in school, and GPA. The guess and attribution questionnaire was used to determine which condition (caffeine or placebo) participants thought they had and why.

The RIP task (Warburton, 1998) was used to measure vigilance based on response rate and accuracy. During this task, single digits were presented in random order in the center visual field. Each digit was presented centrally for 600 ms. Target sequences in this task were three consecutive odd or even digits, which participants responded to with a button push. This task had a duration of about 12 minutes.

Lateral Emotional Distractors (LED) were used during the RIP task. Pictures were presented in the left visual field (LVF) or the right visual field (RVF) and were designed to serve as distractors with emotional content during the vigilance task. Half (24) of these distractors were presented in the LVF and half were presented in the RVF. Twelve of the distractors occurred twice, once in each visual field. Positive, negative, or neutral pictures appeared simultaneously with a digit and for the same duration. Pictures were chosen from the International Affective Picture Series (Lang et al., 1995) as well as from sets of pictures developed by The Integrative Neuroscience Laboratory at Southern Illinois University at Carbondale. The pictures occurred in 48 of the 96 target sequences of the vigilance task (RIP). Pictures were presented with the second digit of the target sequence.

Insert Figures 1-3 here

Participants were instructed to ignore the pictures and attend to the digits occurring in the center of the screen. Participants were told to push a button as quickly as possible after they detected a series of three consecutive even or odd digits.

A caffeine-free and sugar-free soft drink (Caffeine Free Diet Pepsi®) was used to administer the caffeine condition or the placebo condition. The caffeine condition consisted of 2 mg of anhydrous caffeine per kg of body weight mixed with distilled water and added to 200 ml of the soft drink. The placebo condition consisted of quinine mixed with distilled water added to 200 ml of the soft drink.

Design and Procedure

The study was conducted over three separate sessions. The first day was an orientation session lasting approximately one hour. In this session, participants were screened for qualifications of the experiment. Participants were given an overview of their sessions, and they were given an informed consent form, which they signed in order to comply to participate in the study. Participants also filled out a demographic questionnaire. Subjects' visions were checked and their weights were measured. Carbon monoxide (CO) levels were also measured using breath samples; this was done to ensure that participants were not smokers. All of the participants yielded CO levels consistent with non-smokers. Participants were then given a practice sheet of the RIP task. Before beginning the tasks, participants were measured 1 m from the screen. First, participants practiced the RIP task (about 4 min). Then, subjects were given instructions for the LED task (RIP with distractors). After completing the LED task, subjects were allowed to ask questions about the study before scheduling their experimental sessions.

The next two sessions were the experimental sessions, each lasting approximately two hours. Subjects were asked to abstain from caffeine, alcohol, and over-the-counter medications after midnight prior to each session. Subjects were asked to report any caffeine, alcohol, or drug consumption over the past 24 hours once they arrived for the experimental sessions. However, there was no direct measure, such as blood sampling, to determine whether or not subjects actually complied with directions; this constraint was due to lack of financial resources necessary to cover the cost of analyses.

Shortly after arriving, participants filled out the FSQ questionnaire. Then, the caffeine condition or the placebo condition was administered. Half of the subjects were given caffeine on the first experimental session and half were given the placebo. The conditions were reversed on the second experimental day. After the condition was administered, there was a 1-hour waiting period before beginning the LED task in order to allow the caffeine to concentrate into the bloodstream. During this waiting period, participants filled out trait questionnaires and researchers measured their CO levels. At 45 min, participants were given a restroom break. After returning, participants were measured 1 m from the screen. The second FSQ questionnaire was given just before beginning the task.

The LED task started no earlier than 1 hour after administration of the caffeine or placebo condition. The LED task lasted approximately 12 min. After completing the task, participants filled out the FSQ questionnaire as well as the guess and attribution questionnaire. After completing both experimental sessions, participants were given debriefing forms and researchers answered any questions they had about the study. Finally, subjects were thanked for their participation and given either course credit or extra credit.

The administration of the caffeine condition or the placebo condition was double-blinded; neither the researcher nor the participant knew which condition was being given. Lab personnel not associated with this study mixed the caffeine and placebo solutions. The solutions were in four bottles: two contained caffeine and two contained the placebo. The bottles were labeled in a manner unrevealing of content. Two bottles were labeled "A" and two were labeled "B." The researcher extracted the necessary amount of the solution and added it to the soft drink.

Hypotheses and Expected Results

The purpose of the proposed research study was to assess hemispheric differences in the effects of caffeine and affect on vigilance performance. In particular, the LH was the focus, since positive affect and sequential information is associated with the LH (Dean & Reynolds, 1997, Hellige, 1993). It was hypothesized that positive emotional distractors presented in the right visual field (RVF) would impair performance the most because these distractors would be competing for resources with the sequential information in the LH. In addition, caffeine was expected to improve vigilance performance using the RIP task (Warburton, 1995, 1998). Therefore, caffeine was predicted to act as a modulator between the conditions, lessening the impairments due to competing resources. In other words, the placebo condition should not have increased or decreased performance levels, but caffeine should have improved performance. Because of the complexity of the task, caffeine was not predicted to be the primary contributor to performance. Finally, no gender differences were expected.

Statistical analyses were conducted using SPSS Professional version 10 software. A within-subjects multifactorial analysis was used to calculate the variances of several dependent variables. Most importantly, it was expected that reaction time (RT) would be significantly shorter in the caffeine condition than in the placebo. In addition, the caffeine condition was also expected to have significantly higher levels of accuracy (AC). In particular, performance was expected to be higher in the target sequences without distractors. In the target sequences with distractors, caffeine was expected to significantly improve performance as opposed to the placebo. Overall, the lowest level of performance, in terms or RT and AC, was expected to occur when positive distractors appeared in the RVF in a target sequence; therefore, RT was expected to be slowest in this condition, and AC was expected to be lowest in this condition. No gender differences were anticipated.

Results

For all analyses, two criteria for performance were used: RT and AC. Because some people did not respond to any target sequences in a given condition, the RT's for the same experimental session, the same valence, but the opposite hemisphere were substituted for the missing values.

Reaction Time

A mixed design, 2 (Caffeine Condition) x 2 (Visual Field) x 3 (Distractor Valence) x 2 (Gender), was used for the RT analyses. Tests of sphericity were insignificant, indicating that the assumption of homogeneity of covariance was met for the F test. No significant main effects were found for RT. However, the Caffeine Condition x Valence interaction was significant, $F(2,24)=4.99$, $p<.05$. Interference of distractors impacted RT depending on whether participants consumed caffeine or placebo. A significant Linear x Linear trend was found for Caffeine Condition x Valence, $F(1,12)=25.37$, $p<.05$. In addition, Caffeine Condition x Valence x Gender was also significant, $F(2,24)=6.13$, $p<.05$. Therefore, gender differences were observed. A Linear x Linear trend was significant for Caffeine Condition x Valence x Gender, $F(1,12)=16.77$, $p<.05$.

Analyses of simple, main effects were conducted using univariate tests. The simple effect of gender on RT was significant in the placebo condition when negative distractors were presented in the LVF, $F(1,12)=8.62$, $p<.05$. The simple effect of gender on RT was also significant in the caffeine condition when positive distractors were presented in the RVF, $F(1,12)=5.42$, $p<.05$.

Pairwise comparisons showed that males had a significantly faster RT in the placebo condition when negative pictures appeared in the LVF than when neutral pictures appeared in the LVF, $p<.05$. Females were significantly faster in the placebo condition when positive pictures appeared in the RVF than when neutral pictures appeared in the RVF, $p<.05$. Females were also significantly faster in the caffeine condition when negative pictures appeared in the LVF than when neutral pictures appeared in the LVF, $p<.05$. This finding was also significant for the RVF, $p<.05$.

A mixed 2 (Caffeine Condition) x 2 (Distractor Condition) x 2 (Gender) repeated measures analysis was performed to determine the effects of No Distractors or Distractors on RT. No significant effects of Caffeine Condition, Distractor Condition, or Gender were found.

Insert Figures 4-9 here

Accuracy

A mixed design, 2 (Caffeine Condition) x 2 (Visual Field) x 3 (Distractor Valence) x 2 (Gender) was used for the AC analyses. Tests of sphericity were insignificant, indicating that the homogeneity of covariance was met for the F test. A main effect was found for caffeine condition, $F(1,12)=5.00$, $p<.05$; the trend was Linear. A significant Quadratic x Linear trend was found for Valence x Visual Field, $F(1,12)=5.68$, $p<.05$.

Analyses of simple, main effects of gender were conducted using univariate tests. No simple, main effects of gender were found for AC.

Pairwise comparisons show that females were significantly more accurate in the caffeine condition than in the placebo when positive pictures appeared in the RVF, $p<.05$. Males were significantly more accurate in the placebo condition when positive pictures appeared in the LVF than when neutral pictures appeared in the LVF, $p<.05$. Females were significantly more accurate in the placebo condition when negative pictures appeared in the LVF than when neutral pictures appeared in the LVF, $p<.05$.

A mixed 2 (Caffeine Condition) x 2 (Distractor Condition) x 2 (Gender) repeated measures analysis was performed to determine the effects of No Distractors or Distractors on AC. No significant effects of Caffeine Condition, Distractor Condition, or Gender were found.

Insert Figure 10-17 here

Feeling States Questionnaire

Individual mixed 2 (Caffeine Condition) x 2 (Before Task/After Task) x 2 (Gender) repeated measures analysis of variance was performed for each item in the FSQ. For Happiness, a significant effect was found for before vs. after task, $F(1,12)=7.34$, $p<.05$. Happiness was higher before the LED than after. A significant effect was also found for Tense, $F(1,12)=6.66$, $p<.05$. Tension was significantly higher after the LED task than before. A difference in Drowsiness was also observed, $F(1,12)=5.74$, $p<.05$. Drowsiness was also higher after the LED than before. Another significant effect was found for Interested, $F(1,12)=5.84$, $p<.05$. Participants reported significantly less interest after the LED task than before. The Enthusiastic item was also significant, $F(1,12)$, $p<.05$. Enthusiasm decreased after the LED task. No significant Caffeine x Before/After interaction was found. For Inspired, another significant effect was found, $F(1,12)=8.14$, $p<.01$. Less inspiration was reported after the LED task than before. Finally, after combining all anxiety-related items to form one total Anxiety score, a significant effect was observed, $F(1,12)=8.13$, $p<.05$. Anxiety significantly increased after the LED task.

Guesses and Attributions

A chi-square analysis was performed to determine how well participants guessed which caffeine condition they had in each experimental session. Participants accurately guessed which condition they had in both experimental sessions. In the first experimental session, 11 subjects guessed the correct condition, $\chi^2(1,N=14)=5.60$, $p<.05$. Everyone in the placebo condition guessed placebo. Only 4 subjects in the caffeine condition guessed caffeine. In the second experimental session, 11 subjects guessed the correct condition, $\chi^2(1,N=14)=4.67$, $p<.05$. Six subjects in the placebo condition guessed placebo, and 5 subjects in the caffeine condition guessed caffeine. In both experimental sessions, 7 participants were in the placebo condition and 7 were in the caffeine condition.

Insert Figures 18-19 here

Discussion

Caffeine was expected to improve vigilance (Warburton, 1995, 1998, Fine et al., 1994). Distractors presented in the target sequences of the LED task were expected to impair performance. Because positive affect and sequential information is associated with the LH (Dean & Reynolds, 1997, Hellige, 1993), positive emotional distractors presented in the RVF were expected to impair performance the most. No gender differences were expected.

These results do not support the hypothesis that the least performance level would be observed in the placebo condition when positive distractors were presented in the RVF. The least RT performance for both males and females occurred during the placebo condition when negative distractors appeared in the RVF. There was a significant improvement in this condition with caffeine but only in females. The least AC performance for both males and females occurred during the placebo condition when neutral distractors appeared in the LVF. This condition did improve with caffeine, but the improvement was not significant for males or females.

In relation to positive distractors appearing in the RVF, there were some significant findings. For RT, females were significantly faster in the placebo condition when positive pictures appeared in the RVF. The caffeine condition is opposite of what was expected. For AC, females were significantly more accurate in the caffeine condition when positive distractors were presented in the RVF. This finding is consistent with hypotheses; caffeine did lessen the impairment of lesser accuracy when positive pictures appeared in the RVF even though this was not the least impairment.

Distractors in target sequences were expected to significantly impair performance over target sequences without distractors. In addition, caffeine was expected to improve vigilance. Again, these hypotheses were not supported. No significant effects of caffeine condition or distractor condition were found for RT or AC. This could indicate that participants really were ignoring the pictures well overall. However, they were not always ignoring the pictures because significant effects were found within several distractor conditions.

Overall, caffeine was expected to improve vigilance for RT and AC. Caffeine condition was significant for AC but not RT. Caffeine improved accuracy, which is consistent with previous research (Warburton, 1995, 1998, Fine et al., 1994). Unlike past findings (Warburton, 1995, 1998, Fine et al., 1994), however, caffeine did not significantly improve RT.

No gender differences were expected. However, main gender effects were found for RT. There was a simple effect of gender in the placebo condition when negative distractors appeared in the LVF. Another gender effect occurred in the caffeine condition when positive distractors appeared in the RVF. It is not clear as to why main gender effects were found for RT. No significant main gender effects were found for AC.

Results yielded several supplementary findings for both RT and AC. For RT, males were significantly faster in the placebo condition when negative pictures were presented in the LVF than when neutral pictures were presented in the LVF. It is plausible that they were ignoring the negative pictures because they were so aversive. It is also possible that the neutral pictures were actually more appealing, making them more of a distractor than the affective pictures. The neutral pictures are not typical pictures people are exposed to; generally, people are exposed to affective-type pictures. Therefore, the neutral pictures may have been more interesting to look at. Also, the neutral distractors were presented twice as much as positive or negative distractors, which could have also contributed to the results. Another possible explanation is that negative pictures presented in the LVF were creating an arousal effect, which facilitated performance. Females performed faster in the placebo condition when positive distractors occurred in the RVF than when neutral pictures appeared in the RVF. Again, it is possible that participants were ignoring affective pictures more than neutral pictures. Finally, for RT, females were faster in the caffeine condition when negative pictures appeared in the LVF than when neutral pictures appeared in the LVF. Again, negative distractors in the LVF could have been initiating arousal. Females could have been ignoring the negative pictures, too. However, there seems to be a distracting trend for neutral pictures appearing in the LVF; this could be an indication of an association of neutral affect with the RH.

For AC, females were more accurate in the caffeine condition when positive pictures appeared in the RVF. As expected, implications are that positive pictures were more distracting in the placebo condition when they appeared in the RVF. This was only found in females, though. Males were more accurate in the placebo condition when positive distractors were presented in the LVF than when neutral distractors were presented in the LVF. Perhaps males did not like to look at the positive pictures, or as mentioned earlier, there could be some association between neutral affect and the RH. Females were more accurate in the placebo condition when negative distractors occurred in the LVF than when neutral distractors occurred in the LVF. Again, females could have been ignoring the negative pictures, or there may be an affective RH association for neutrality.

Mood changed significantly after performing the LED task. Symptoms of caffeine withdrawal (Streufert et al., 1995) are closely related to mood after the LED task was performed. After the task, happiness, interest, enthusiasm, and inspiration decreased while tension, drowsiness, and total anxiety increased. These findings possibly indicate that the LED task was difficult and stressful. Even though there was no punishment for doing poorly, mood changed significantly. Another possibility is that the negative pictures affected mood negatively. Perhaps participants were not ignoring negative pictures completely; they may have just looked at the negative distractors for a lesser amount of time than positive or neutral distractors. In turn, the negative pictures still could have potentially affected mood.

Participants were also accurate in guessing which caffeine condition they had in both experimental sessions. They were more accurate in guessing the placebo condition than the caffeine condition. Participants may have been feeling deprivation effects, even though deprivation was short-term, which could have allowed them to perceive that they did not have their normal morning caffeine intake.

The biggest constraint was low sample size. The data was difficult to interpret because there were no general trends. It seems reasonable that a larger sample size might result in not only more significant findings but also more clearly defined trends. Also, time was somewhat of a constraint. Some participants performed poorly on the LED task; participants probably needed more time to practice the LED task before starting the experimental sessions. Some of the effects may have been, in part, due to the difficulty of the task. If performance is asymptotical, then significant effects can be more easily attributed to manipulation rather than difficulty of the task.

This study is one of the first to study emotional distractors on vigilance. Although other studies similar to this one are in progress, there is little data to compare our results with. Considering how many significant findings were discovered in this study, many of which are not fully understood, it is essential to continue research based upon distractibility. In particular, future research needs to focus on hemispheric differences of affective distractors on cognitive performance so that we can better understand how distractibility interferes with performance ability.

References

American Psychiatric Association. (1994). Diagnostic and statistical manual of mental disorders (4th ed.). Washington, DC: American Psychiatric Association.

Arnaud, M. J. (1998). Pharmocokinetics and metabolism of caffeine. In J. Snel & M. M. Lorist (Eds.), Nicotine, caffeine, and social drinking: Behaviour and brain function (pp. 153-165). Australia: Harwood Academic Publishers.

Beaumont, J. G. (1997). Future research directions in laterality. Neuropsychology Review, 7 (3), 107-126.

Benowitz, N.L. (1990). Clinical pharmacology of caffeine. Annual Review of Medicine, 41, 277-288.

Berube, M.S. et al. (1995). Webster's II new college dictionary. Boston: Houghton Mifflin Company.

Davidson, R. J., (1988). EEG measures of cerebral asymmetry: Conceptual and methodological issues. International Journal of Neuroscience, 39, 71-89.

Davidson, R. J., (1992). Emotion and affective style: Hemispheric substrates. Psychological Science, 3, 39-43.

Davidson, R. J., Schwartz, G. E., Saron, C., Bennett, J., & Goleman, D. J. (1979). Frontal versus parietal EEG asymmetry during positive and negative affect. Psychophysiology, 16, 202-203.

Dean, R. S., & Reynolds, C. R. (1997). Cognitive processing and self-report of lateral preference. Neuropsychology Review, 7 (3), 127-142.

Fine, B. J., Kobrick, J. L., Lieberman, H. R., Marlowe, B., Riley, R. H., & Tharion, W. J. (1994). Effects of caffeine or diphenhydramine on visual vigilance. Psychopharmacology, 114, 233-238.

Fox, N. A. (1991). If it's not left, it's right. American Psychologist, 46, 863-872.

Gilbert, D. G., Meliska, C. J., Williams, C. & Jensen, R. A. (1992). Subjective correlates of smoking-induced elevations of peripheral beta-endorphin and cortisol. Psychopharmacology, 106, 275-281.

Hagemann, D., Naumann, E., Becker, G., Maier, S., & Bartussek, D. (1998). Frontal brain asymmetry and affective style: A conceptual replication. Psychophysiology, 35, 372-388.

Hellige, J. B. (1993). Hemispheric Asymmetry: What's Right and What's Left. Cambridge: Harvard University Press.

Kayser, J, Tenke, C., Nordby, H., Hammerborg, D., Hugdahl, K., & Erdmann, G. (1997). Event-related potential (ERP) asymmetries to emotional stimuli in a visual half-field paradigm. Psychophysiology, 34, 414-426.

Lane, J. D., & Phillips-Bute, B. G. (1998). Caffeine deprivation affects vigilance performance and mood. Physiology & Behavior, 65 (1), 171-175.

Lang, P.J., Bradley, M. M., & Cuthbert, B. N. (1995). International Affective Picture System (IAPS): Technical Manual and Affective Ratings. NIMH Center for the Study of Emotion and Attention.

Lundsberg, L. S. (1998). Caffeine consumption. In G. A. Spiller (Ed.), Caffeine (pp. 199-224). Boca Raton: CRC Press.

Rusted, J. (1994). Caffeine and cognitive performance: Effects on mood or mental processing? Pharmacopsychoecologia, 7 (2), 49-54.

Smith, A. (1994). Caffeine, performance, mood and states of reduced alertness. Pharmacopsychoecologia, 7 (2), 75-86.

Smith, A. P. (1998). Effects of caffeine on attention: Low levels of arousal. In J. Snel & M. M. Lorist (Eds.), Nicotine, caffeine, and social drinking: Behaviour and brain function (pp. 215-227). Australia: Harwood Academic Publishers.

Smith, B. D., & Tola, K. (1998). Caffeine: Effects on psychological functioning and performance. In G. A. Spiller, Caffeine (pp. 251-299). Boca Raton: CRC Press.

Spiller, G. A. (1998). Basic metabolism and physiological effects of the methylxanthines. In G. A. Spiller (Ed.), Caffeine (pp. 225-231). Boca Raton: CRC Press.

Stelt, O., & Snel, J. (1998). Caffeine and human performance. In J. Snel & M. M. Lorist (Eds.), Nicotine, caffeine, and social drinking: Behaviour and brain function (pp. 167-183). Australia: Harwood Academic Publishers.

Streufert, S., Pogash, R., Miller, J., Gingrich, D., Landis, R., Lonardi, L., Severs, W., & Roache, J. D. (1995). Effects of caffeine deprivation on complex human functioning. Psychopharmacology, 118, 377-384.

Warburton, D. M. (1998). Caffeine, nicotine and attentional performance. In J. Snel & M. M. Lorist (Eds.), Nicotine, caffeine, and social drinking: Behaviour and brain function (pp. 245-256). Australia: Harwood Academic Publishers.

Warburton, D. M. (1995). Effects of caffeine on cognition and mood without caffeine abstinence. Psychopharmacology, 119, 66-70.

Figure Captions

Figure 1. Positive affect-related distractor.

Figure 2. Neutral affect-related distractor.

Figure 3. Negative affect-related distractor.

Figure 4. Reaction Time: Caffeine Condition x Visual Field (Neutral Distractors).

Figure 5. Reaction Time: Caffeine Condition x Visual Field (Females).

Figure 6. Reaction Time: Caffeine Condition x Valence (Females).

Figure 7. Reaction Time: Valence x Caffeine Condition (Right Visual Field).

Figure 8. Reaction Time: Valence x Gender (Right Visual Field).

Figure 9. Reaction Time: Valence x Gender (Caffeine Condition).

Figure 10. Accuracy: Caffeine Condition.

Figure 11. Accuracy: Caffeine Condition x Visual Field (Positive Distractors).

Figure 12. Accuracy: Caffeine Condition x Visual Field.

Figure 13. Accuracy: Caffeine Condition x Visual Field (Negative Distractors).

Figure 14. Accuracy: Caffeine Condition x Visual Field (Males).

Figure 15. Accuracy: Caffeine Condition x Valence (Males).

Figure 16. Accuracy: Valence x Caffeine Condition (Left Visual Field).

Figure 17. Accuracy: Valence x Gender (Left Visual Field).

Figure 18. Guess x Actual Condition (Experimental Session 1).

Figure 19. Guess x Actual Condition (Experimental Session 2).

Figure 1

Figure 2

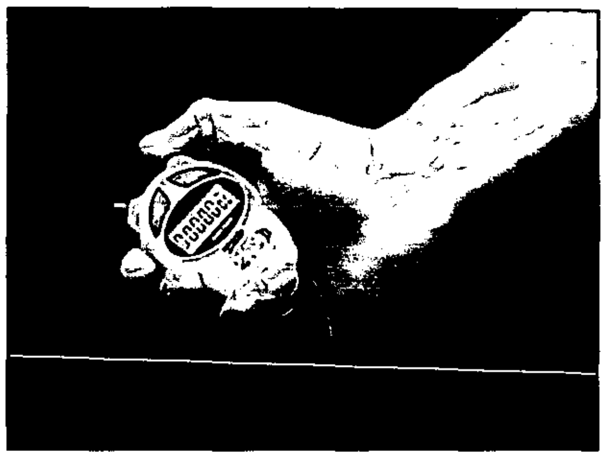
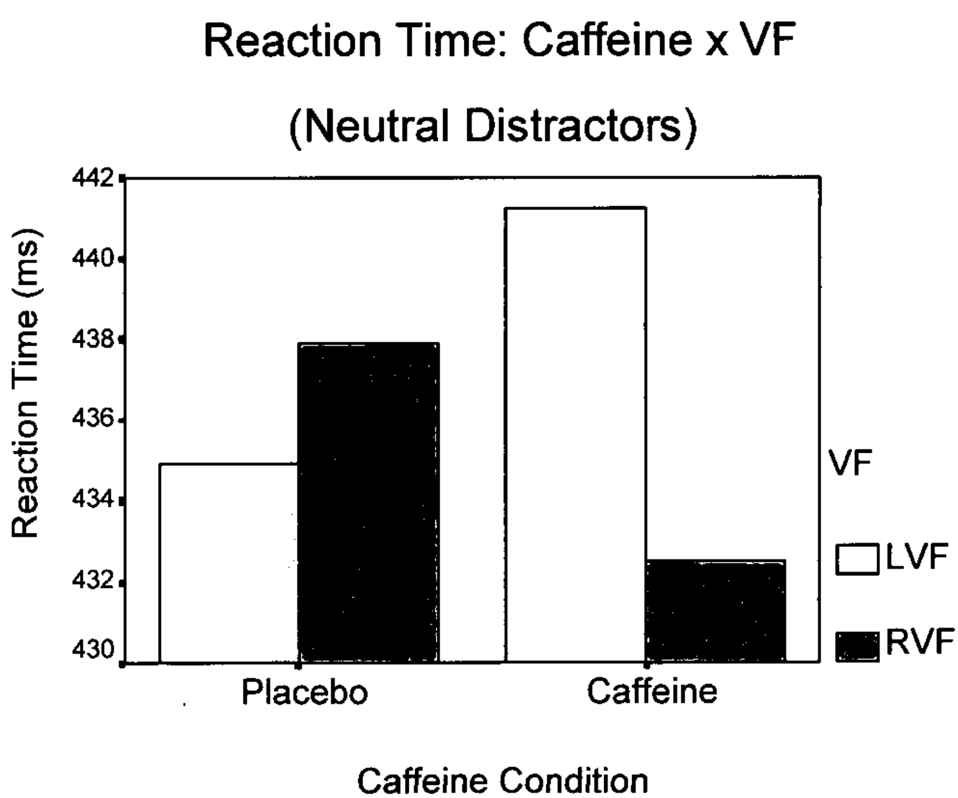
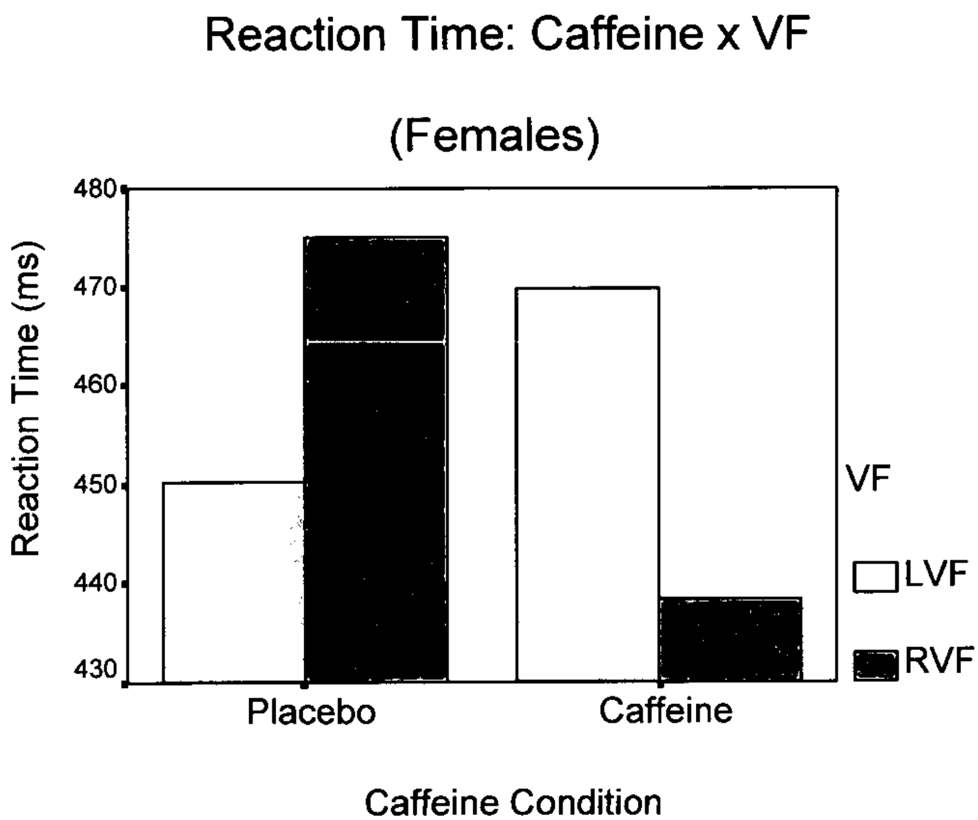
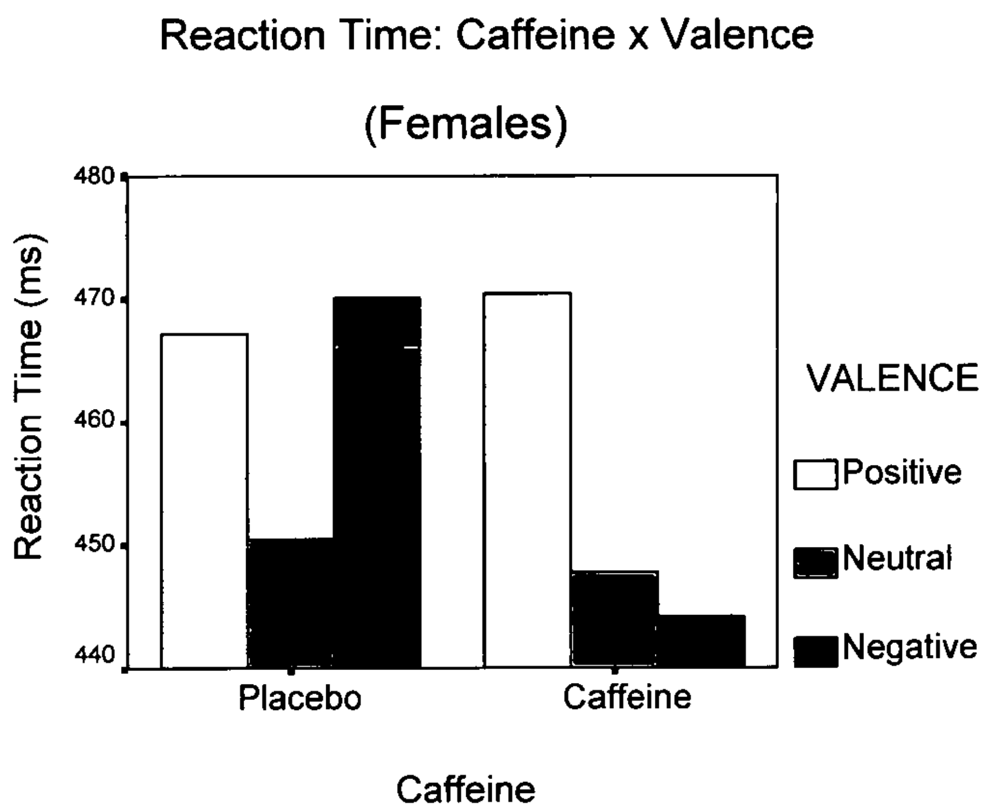
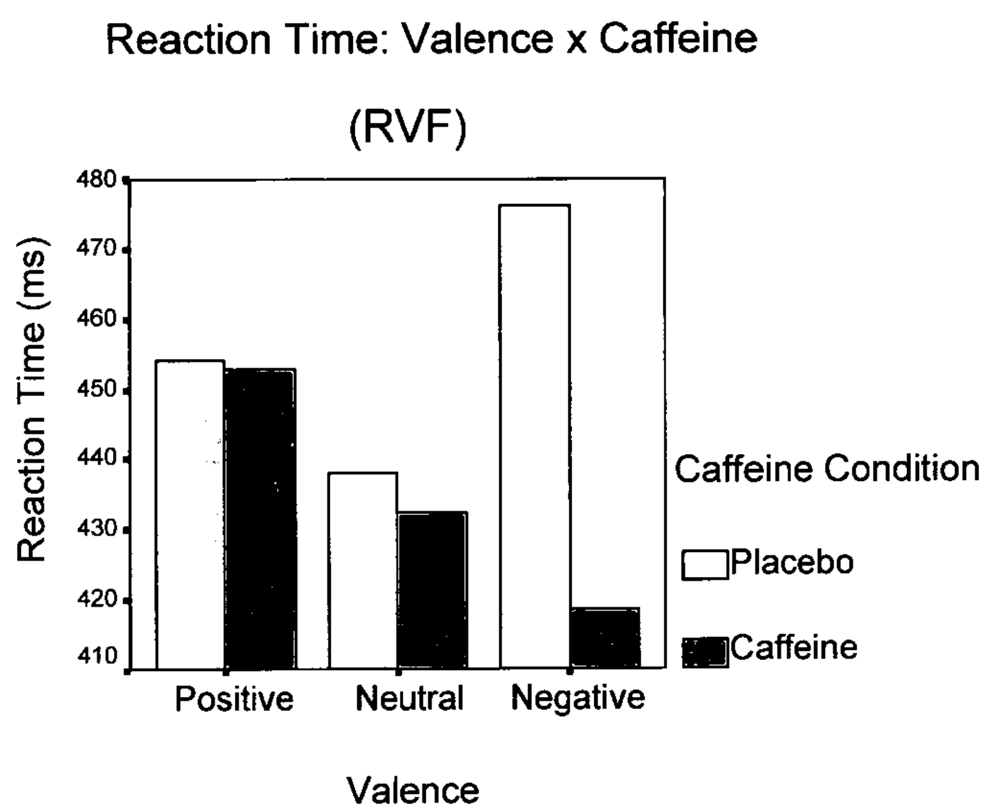


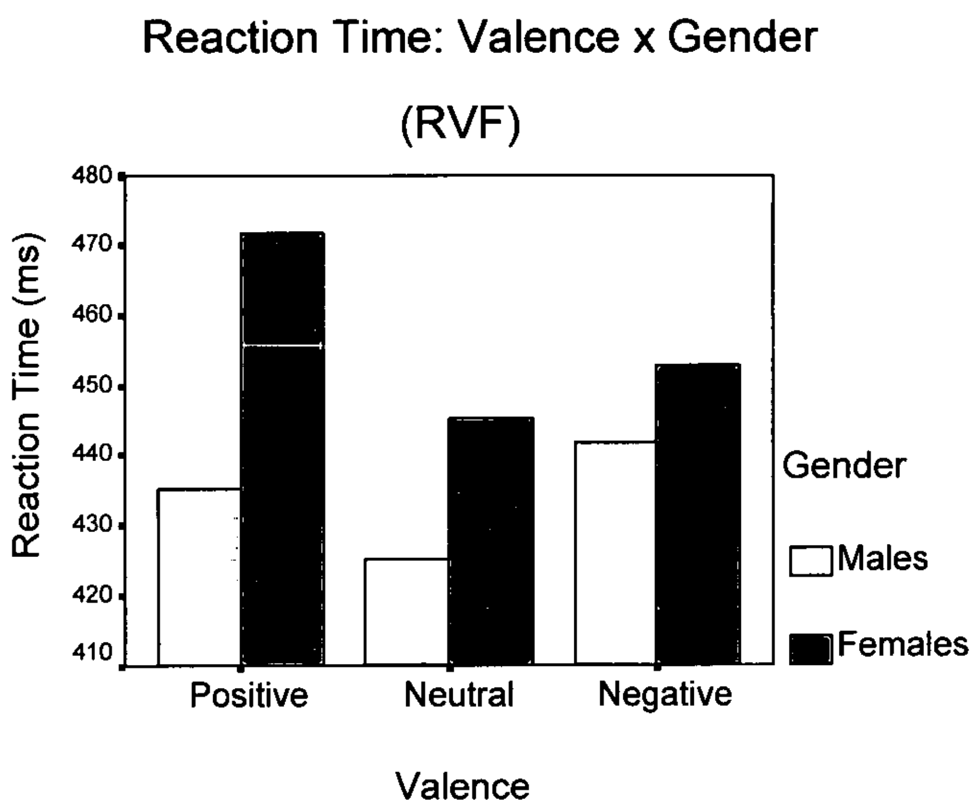
Figure 3


Reaction Time: Caffeine x VF
(Neutral Distractors)
Reaction Time (ms)
442
440
438
436
434
432
430
Placebo
Caffeine
Caffeine Condition
VF
LVF
RVF

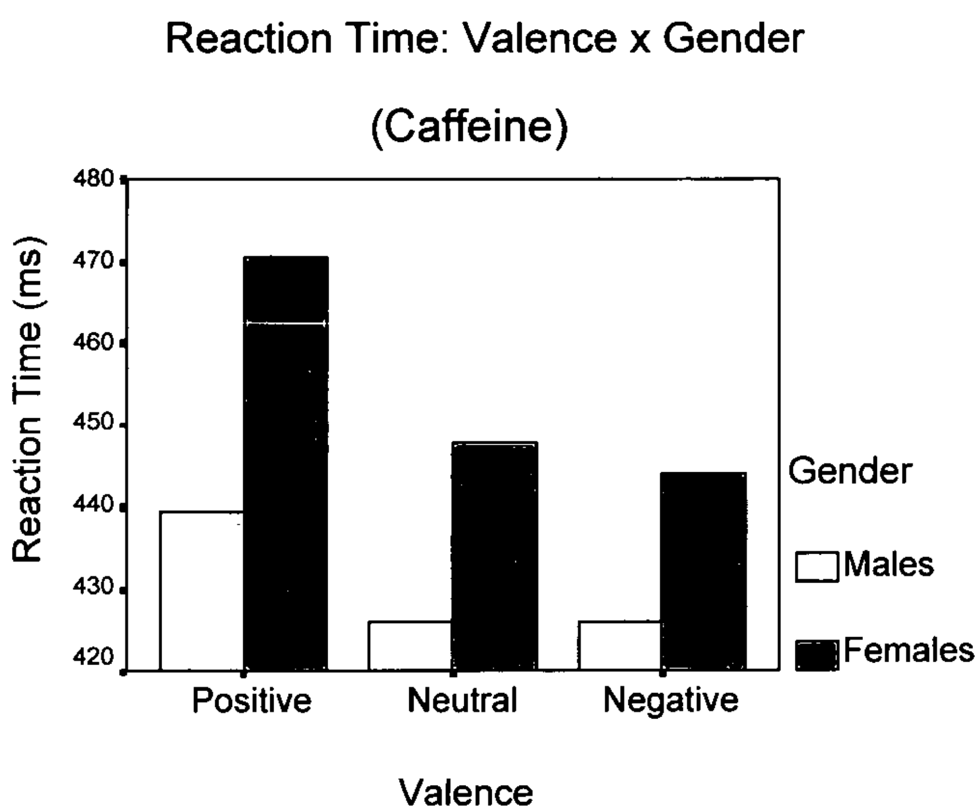

Reaction Time: Caffeine x VF
(Females)
Reaction Time (ms)
480
470
460
450
440
430
Placebo
Caffeine
Caffeine Condition
VF
LVF
RVF

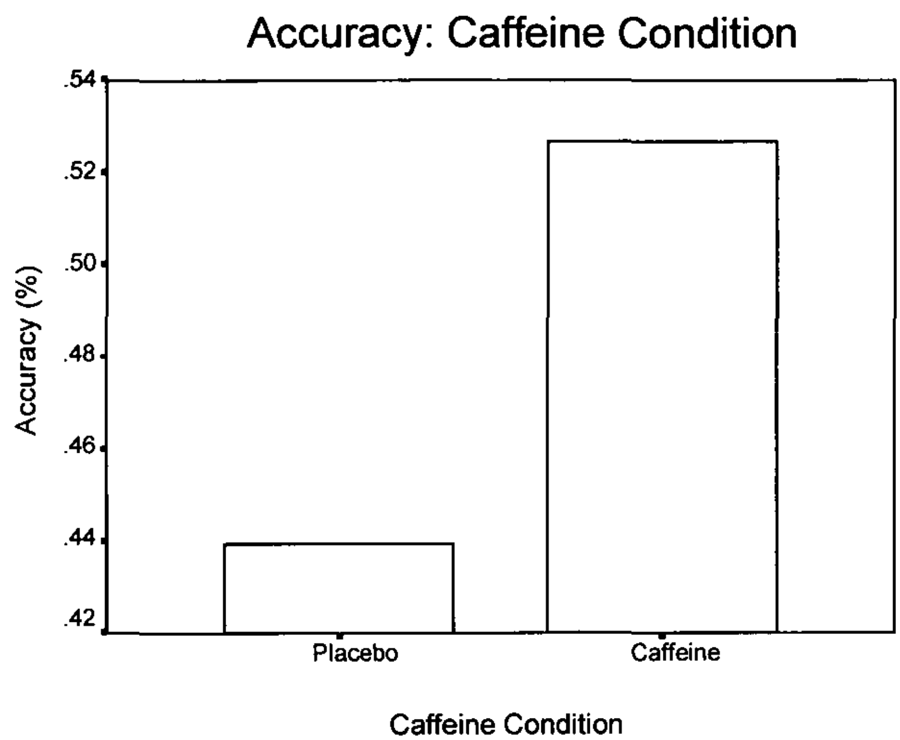

Reaction Time: Caffeine x Valence
(Females)
Reaction Time (ms)
480
470
460
450
440
Placebo
Caffeine
Caffeine
VALENCE
Positive
Neutral
Negative

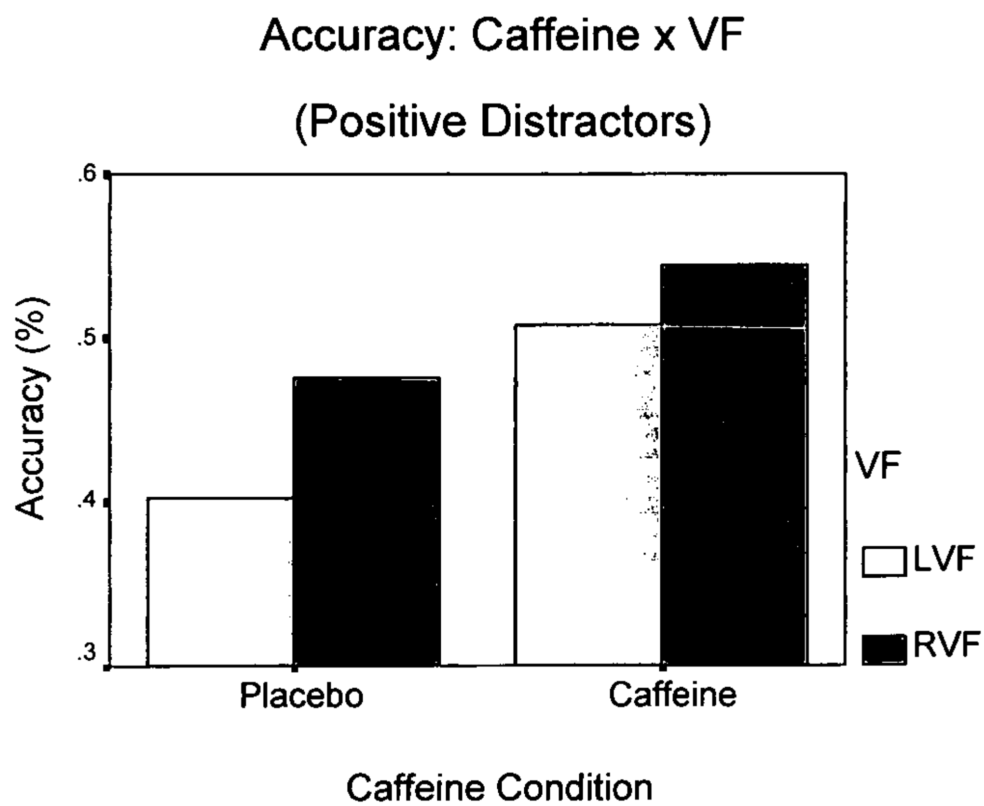

Reaction Time: Valence x Caffeine
(RVF)
480
470
460
450
440
430
420
410
Reaction Time (ms)
Positive
Neutral
Negative
Valence
Caffeine Condition
Placebo
Caffeine

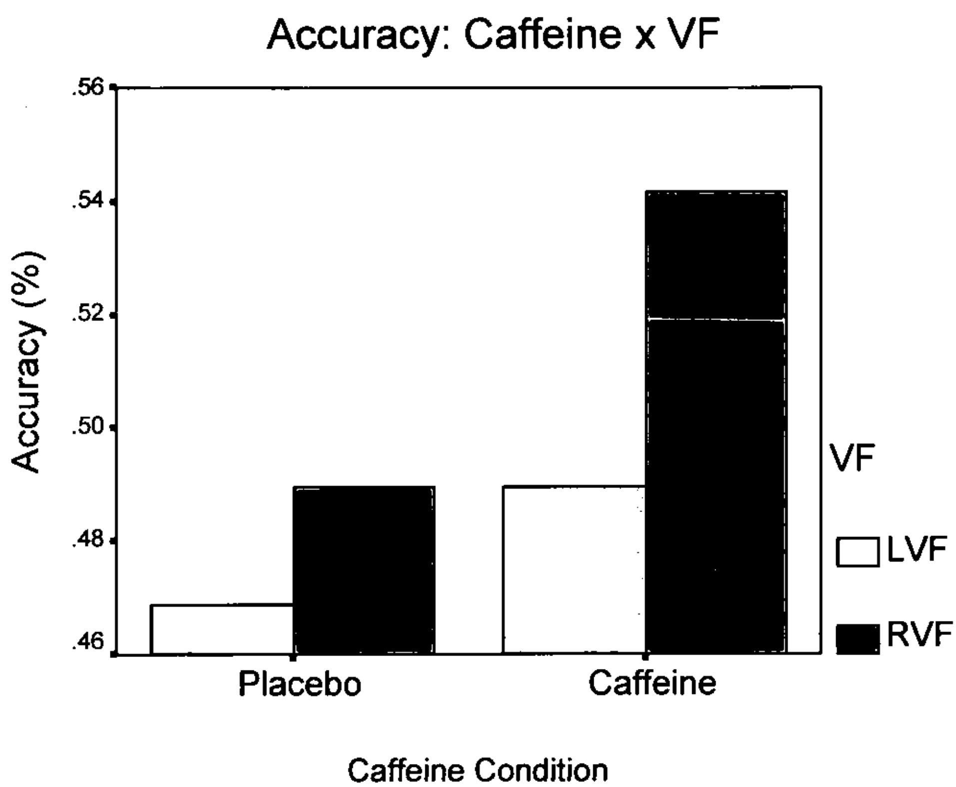


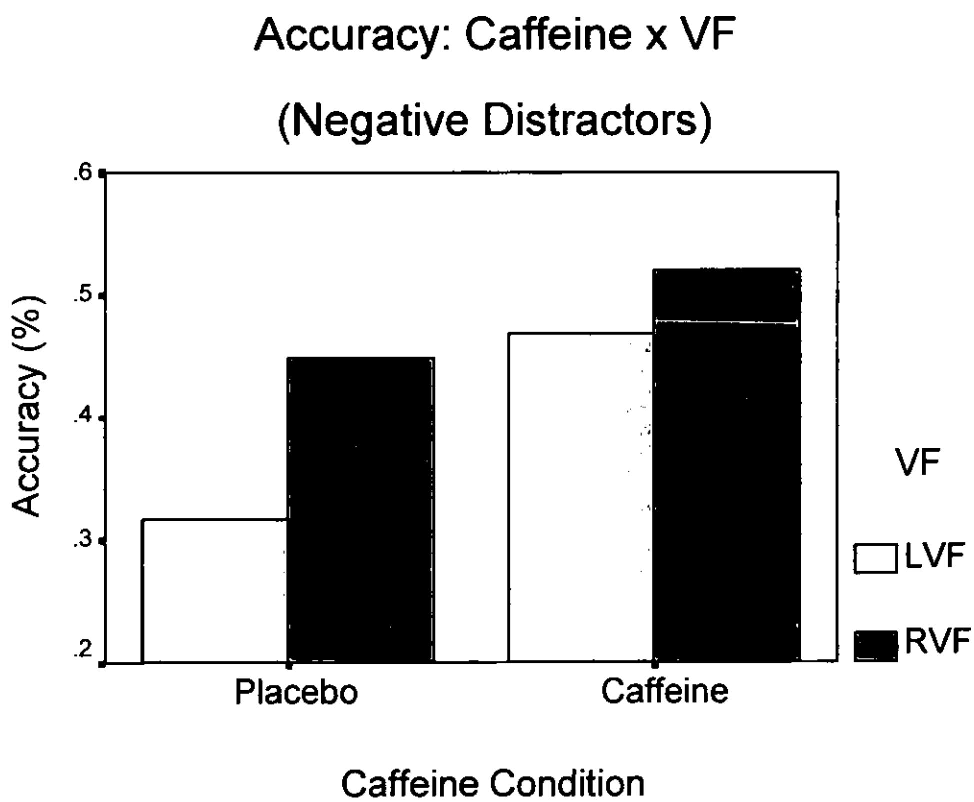
Reaction Time: Valence x Gender
(RVF)
Reaction Time (ms)
480
470
460
450
440
430
420
410
Positive
Neutral
Negative
Valence
Gender
Males
Females


Reaction Time: Valence x Gender
(Caffeine)
Reaction Time (ms)
480
470
460
450
440
430
420
Positive
Neutral
Negative
Valence
Gender
Males
Females


Accuracy: Caffeine Condition
.54
.52
.50
.48
.46
.44
.42
Accuracy (%)
Placebo
Caffeine
Caffeine Condition


Accuracy: Caffeine x VF
(Positive Distractors)
.6
.5
.4
.3
Accuracy (%)
Placebo
Caffeine
Caffeine Condition
VF
LVF
RVF


Accuracy: Caffeine x VF
Accuracy (%)
.56
.54
.52
.50
.48
.46
Placebo
Caffeine
Caffeine Condition
VF
LVF
RVF


Accuracy: Caffeine x VF
(Negative Distractors)
.6
.5
.4
.3
.2
Accuracy (%)
Placebo
Caffeine
Caffeine Condition
VF
LVF
RVF

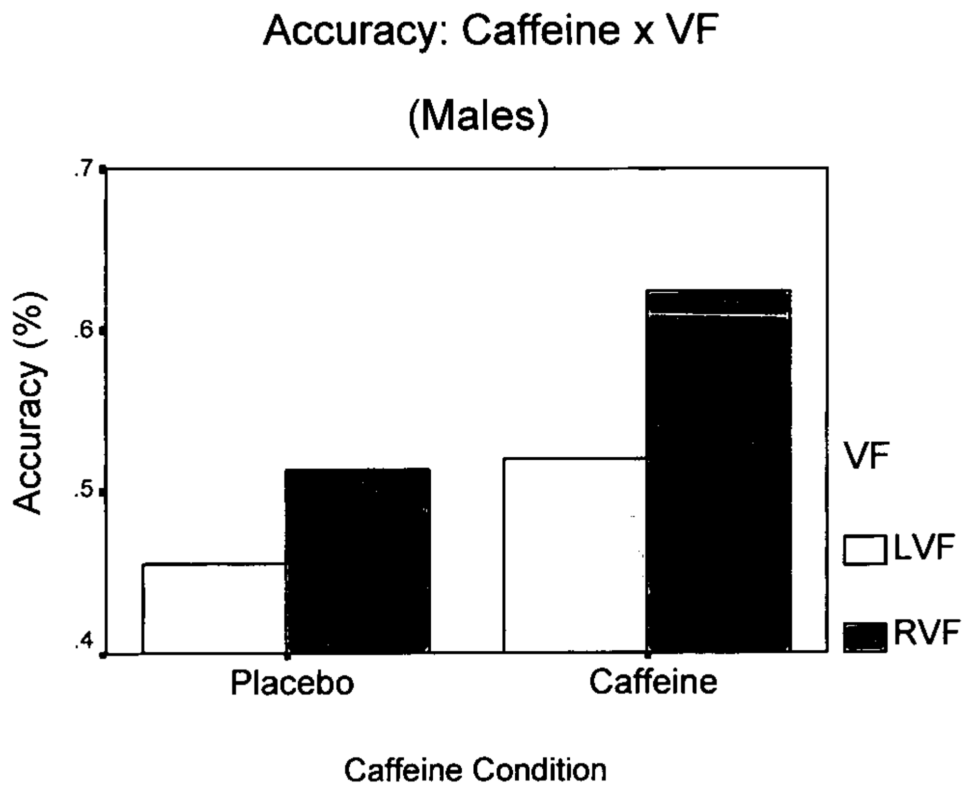
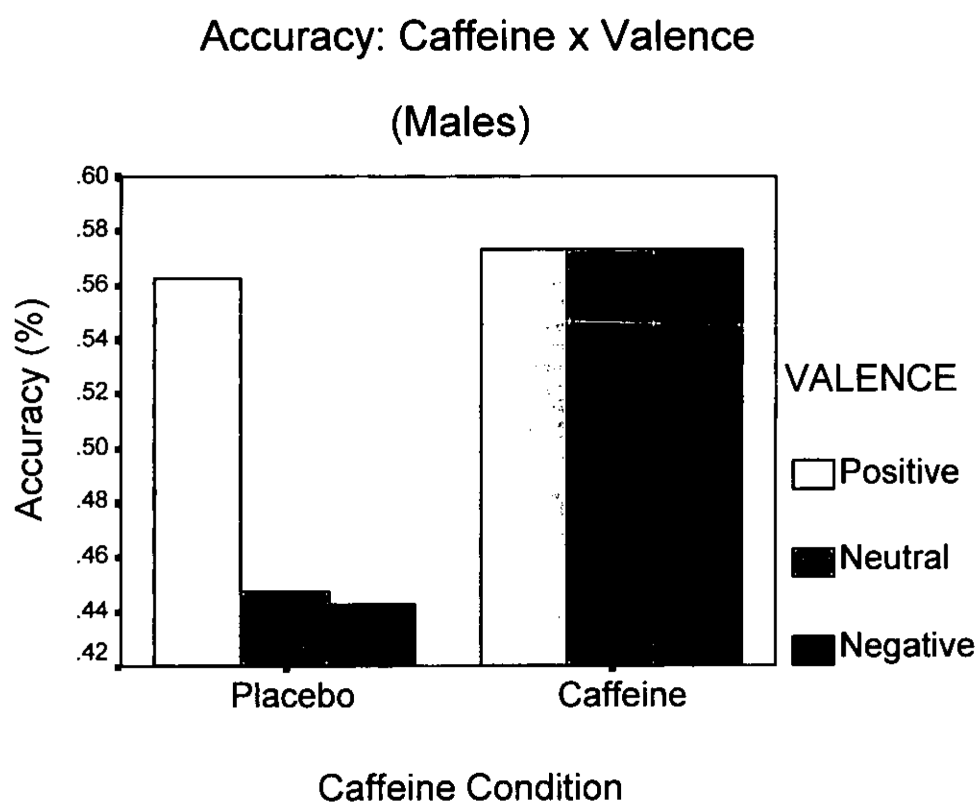
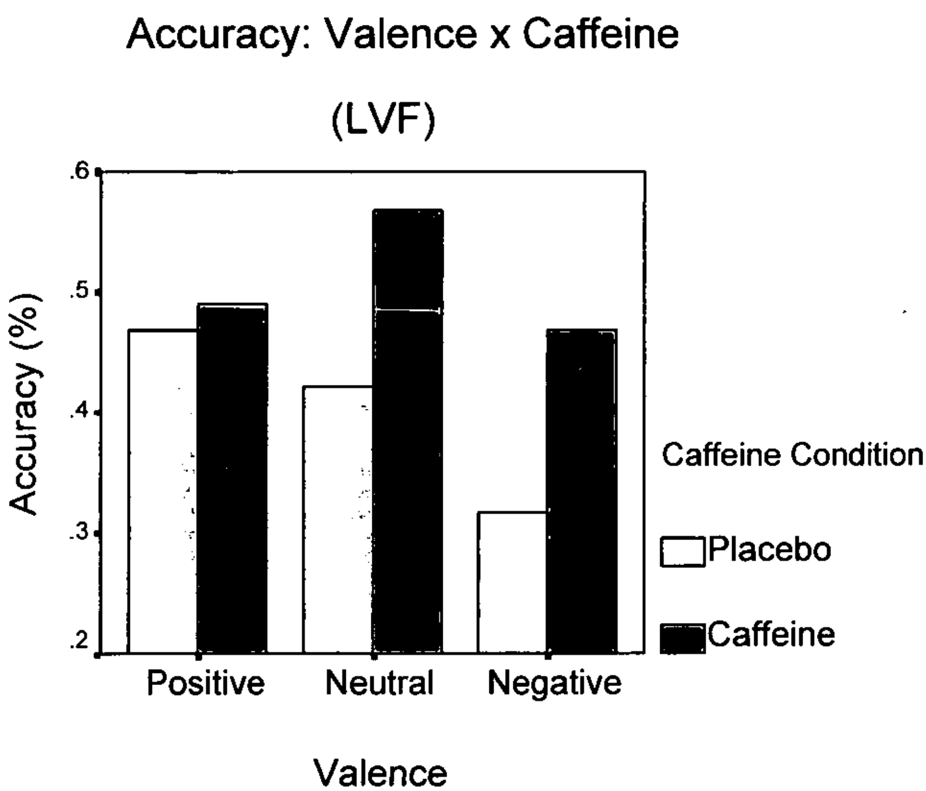
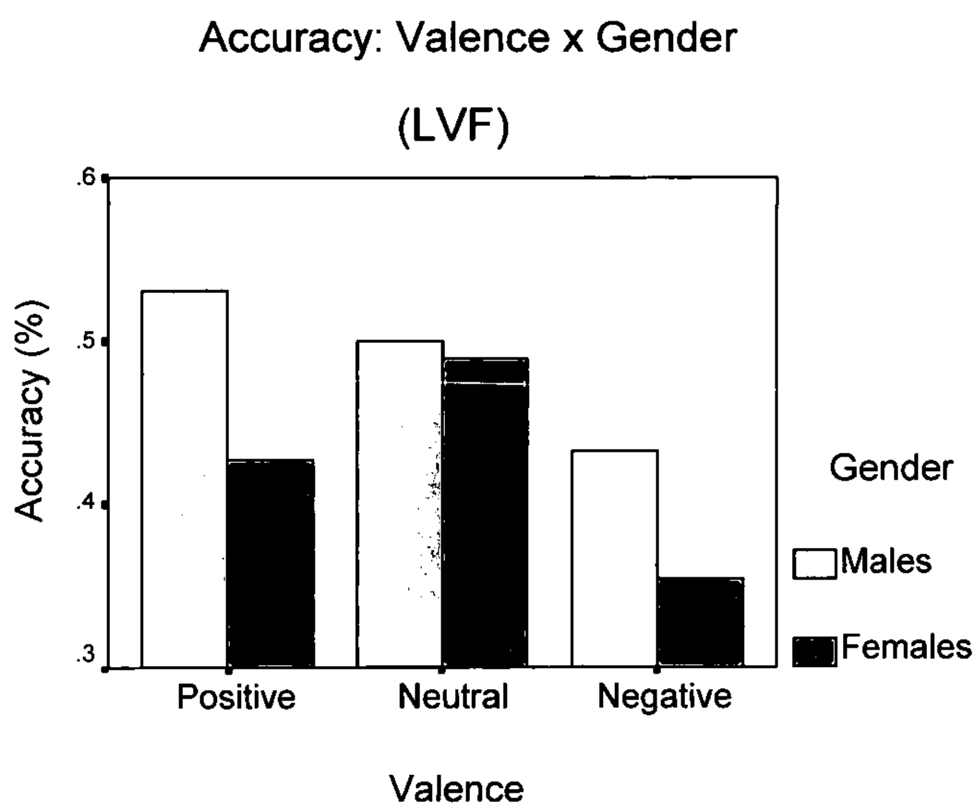
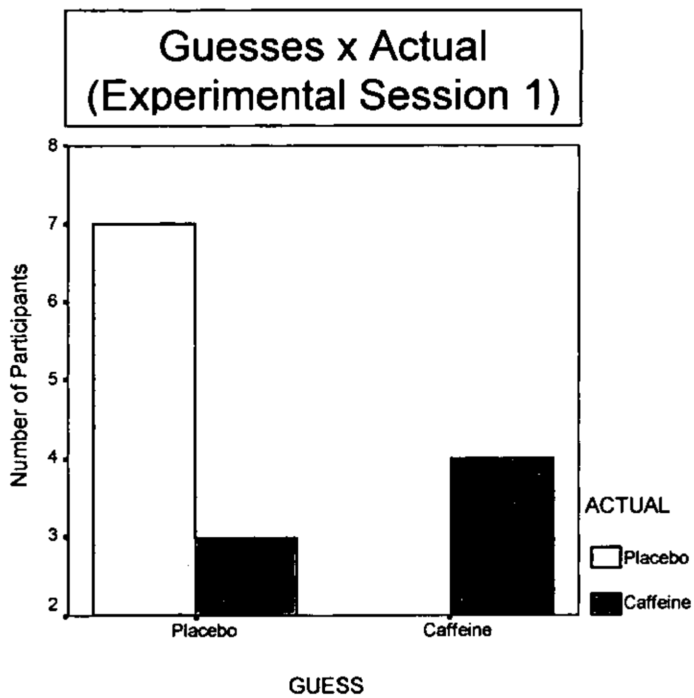

Accuracy: Caffeine x VF
(Males)
Accuracy (%)
.7
.6
.5
.4
Placebo
Caffeine
Caffeine Condition
VF
LVF
RVF

Figure 15

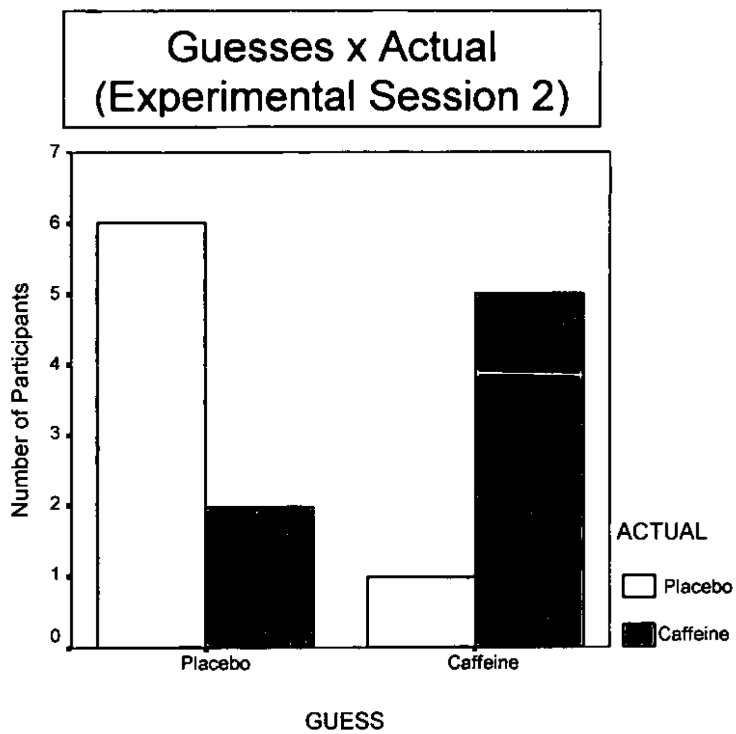

Accuracy: Caffeine x Valence
(Males)
.60
.58
.56
.54
.52
.50
.48
.46
.44
.42
Accuracy (%)
Placebo
Caffeine
Caffeine Condition
VALENCE
Positive
Neutral
Negative


Accuracy: Valence x Caffeine
(LVF)
.6
.5
.4
.3
.2
Accuracy (%)
Positive
Neutral
Negative
Valence
Caffeine Condition
Placebo
Caffeine


Accuracy: Valence x Gender
(LVF)
.6
.5
.4
.3
Accuracy (%)
Positive
Neutral
Negative
Valence
Gender
Males
Females



Guesses x Actual
(Experimental Session 1)
Number of Participants
8
7
6
5
4
3
2
Placebo
Caffeine
GUESS
ACTUAL
Placebo
Caffeine


Guesses x Actual
(Experimental Session 2)
Number of Participants
7
6
5
4
3
2
1
0
Placebo
Caffeine
GUESS
ACTUAL
Placebo
Caffeine