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Abstract

The effects' caffeine has on attention was investigated using a visual vigilance computer task. Fourteen university students (mean age = 21) received class research for participating on three separate occasions; orientation, caffeine condition (2mg per kg. of body weight), and placebo condition (2mg per kg. of body weight of Quinine). In both sessions the substances were added to 20ml of diet, caffeine-free Pepsi. There was at least one day between each session. All sessions were conducted in the morning and caffeine was restricted from 12:00 midnight the night before the session. When compared with placebo, caffeine did not significantly decrease response time. There was no correlation found between decreased response time from the placebo to caffeine condition when compared to attention rating scores on The Adult Attention Deficit Disorders Evaluation Scale. There was a significant difference found between a valid and non-valid cued condition and a 100ms and 800ms non-cued condition within the task.

Caffeine Effects on Different Types of Attention

Introduction

Attention Deficit Hyperactive Disorder (ADHD) has recently become one of the most diagnosed disorders of childhood. It's rare to find somebody who has never heard of this disorder or doesn't have an idea of some of the characteristics linked to it. Teachers have become so familiar with ADHD that many are making recommendations that children be taken to doctors because they feel the child fits diagnostic requirements. In turn, practitioners are relying heavily on teacher ratings of child behavior to help them diagnose ADHD. Is this disorder actually becoming more prevalent or is it being misdiagnosed because of a lack of precise clinical guidelines?

ADHD is treated in many different ways. Behavioral Therapy, Bio-Feedback, stimulant medications, and caffeine are only a few treatments currently used for this disorder. The majority of the research that has been done on treatment shows stimulant medication to be the most effective in reducing the behaviors associated with ADHD. The stimulant medication most often used for ADHD is Methylphenidate (Ritalin). Current methylphenidate prescriptions for kids are said to be anywhere between 6-9 million. Since stimulant medication is a controlled substance and has various side effects alternative treatment options should be considered before implementing this drug. One possible alternative could be caffeine. Although past research has shown caffeine not to be as effective in decreasing problem behaviors linked to ADHD, it does provide a stimulant that has less side effects than the ones currently used for this disorder. Research shows that caffeine is effective in increasing attention, which is one of the deficits associated with ADHD.

Research that has been done on ADHD, as well as many other disorders of childhood, often use clinically referred patients. These patients sometimes exhibit symptoms that are more severe than a general population with a disorder. People are

usually referred to clinics only after other sources such as parents, teachers and school psychologists have not been able to remedy problem behavior. This should be kept in mind when interpreting results that are obtained from participants referred to clinics. Especially important is generalizing successful treatment results in severe cases to those who exhibit only mild forms of the disorder.

Also, behavioral questionnaires are a very common theme found in treatment studies on ADHD. These questionnaires require parents and teachers to rate a child on how frequently they see them engage in certain activities or behaviors. They are usually filled out before and after treatment. The success of the treatments depends on a significant decline in the problem behaviors after treatment has been implemented. These questionnaires are very helpful when assessing the outward behavior a child exhibits such as hyperactivity, distractibility and some forms of attention. But, they do not specifically show how different treatments interact with the attention process.

There is a brief overview of ADHD and literature comparing schedule II stimulants (commonly prescribed for ADHD treatment) and caffeine on behavioral outcomes of children with ADHD. Selective and focused attention will be discussed in the context of how they are seen in the ADHD child. Also, the effects of caffeine (both physically and psychologically) are reviewed below to show what role it plays in attention and how this could be applied to specific aspects of ADHD symptoms. The purpose of this review is to identify gaps in past research specifically on the ADHD, Predominantly Inattentive. Many of the findings reviewed here are being used in treatments for all three types of ADHD even though they are beginning to be seen as possibly different disorders.

Attention Deficit Hyperactive Disorder

The cluster of ADHD symptoms and theories surrounding them has not changed much through the years. These changes are best reflected through a review of the Diagnostic and Statistical Manuals published throughout the years. In the DSM II this group of symptoms was labeled "hyperkinetic reaction of childhood". The description

shown was: "This disorder is characterized by overactivity, restlessness, distractibility, and short attention span, especially in younger children; the behavior usually diminishes in adolescence. If the behavior is caused by organic brain damage, it should be diagnosed under the appropriate non-psychotic organic brain syndrome" (American Psychiatric Association, 1968). The disorder was basically seen as something children would grow out of. This also recognized that it might be linked to brain damage. In the DSM-III a distinct list of the three main symptoms were given as well as cutoff scores for each (American Psychiatric Association, 1980) to better enable practitioners to correctly diagnose this disorder. It also received a new name, Attention Deficit Disorder (ADD). There were now 2 subtypes of this disorder, ADD with hyperactivity and ADD without hyperactivity. As more research continued to be done a larger gap emerged between the two sub-types as shown in the DSM-III-R. In the DSM-III-R this disorder was referred to as ADHD and the 3 major symptoms formed one composite score (American Psychiatric Association, 1987). ADD without hyperactivity was listed as a separate disorder without diagnostic criteria available. As more research became available the two separate disorders or symptoms began to be seen again as a single dimension. The DSM-IV combined them and referred to the disorder as ADHD with different subtypes (American Psychiatric Association, 1994). Two lists were used, one containing attention problems and the other containing hyperactive and impulsivity problems. The three subtypes were: Predominantly Inattentive, Predominantly Hyperactive-Impulsive and Combined. To meet the criteria for Predominately Inattentive sub-type a person must meet six of the criteria listed under Inattention. Predominantly Hyperactive-Impulsive sub-type is met when six or more of the behaviors are exhibited from the hyperactive-impulsive list. The third subtype, Combined, is met when at least six criteria from both scales are present in the person. Also, these symptoms must have been present for at least 6 months for any of the subtypes to be diagnosed. Although there are more specific criteria in the DSM IV, the same core symptoms from the DSM II continue to serve as classification symptoms

associated with the disorder.

Recent research evidence indicates there are different types of attention problems in ADHD subtypes (Posner, 1988; Barkley, 1990). The types of attention deficits involved in these subtypes may provide a deeper understanding of the processes that are involved in this disorder. This could lead to more distinct diagnostic criteria. There are three subtypes of ADHD: Predominantly Inattentive, Predominantly Hyperactive and Combined. In ADHD Combined, sustained attention and distractibility are the problem whereas attentional problems in ADHD Predominantly Inattentive are characterized by "daydreaming, "spacing out", being "in a fog"; being easily confused, starring frequently, and being lethargic, hypoactive, and passive" (e.g. see Barkley, DuPaul & McMurray, 1990; Layhey & Carlson, 1992). Barkley (1997) believes that the attention problems seen in ADHD, Combined is due to behavioral poor inhibition and self-regulation, and that ADHD, Predominantly Inattentive is from "a deficiency in focused or selective attention" (Barkely, 1997). Since this is a fairly recent topic there has not been many other studies done or finished at this point to better understand these differences.

There are currently many different forms of treatment available for ADHD. The most successful and widely used treatments are schedule II stimulants. There are a lot of studies showing stimulants to be effective in decreasing ADHD symptoms such as the one by Huestes, Arnold & Smeltzer (1975). They compared the effects of Mehtylphenidate, d-Amphetamine and caffeine on children with Minimal Brain Dysfunction. Sixteen boys were randomly placed in four different treatment conditions, one for each drug and a placebo. Each treatment condition lasted two weeks with questionnaires given before the new treatment started and at the end of the treatment. These questionnaires consisted of Behavioral checklists that were given to parents and teachers that asked about specific behaviors associated with ADHD symptoms. These checklists asked questions about the frequency in which the child engaged in hyperactive behaviors. A Psychiatrists Target Symptom Rating checklist was used by a psychiatrist to

measure specific behaviors associated with ADHD that may be present in the child during visits. They found that Mehtylphenidate and d-Amphetamine were both significantly better than caffeine on the Hyperkinetic Rating Scale by parents, Psychiatrists Target Symptom Rating, Parent Symptom Checklist, and Teacher Behavior Checklist. When the boys were in the D-Amphetamine condition there was a significant reduction in hyperactive ratings on the Teachers Hyperkinetic Rating Scale when compared to the caffeine condition. This study also found no significant reduction on any of the behavior checklists during the caffeine treatment when it was compared to placebo condition. Once again this study had a small sample size (16). They felt that caffeine might have had some type of effect if the sample size was larger (Huestis, et al., 1975).

A study by Garfinkel, Webster, and Sloman (1975) also found Methylphenidate to be superior to caffeine in the treatment of Minimal Brain Dysfunction. They used 8 male subjects who were enrolled at the child and Adolescent Service, Clarke Institute of Psychiatry. They were rated by child care workers on Conner's 5 factors (aggressivity, inattentiveness, anxiety, hyperactivity, and sociability). Methylphenidate was significant over caffeine on total score, aggressivity, and hyperactivity, but was only significantly better than placebo on inattentiveness and sociability. Caffeine was not significant on any of the five factors. This was a very controlled study, but one must keep in mind that this was some of the most extreme cases of MBD because they were inpatients at this clinic (they were allowed to go home in the evening, but were not able to go to regular classrooms). Most children with ADHD are not this severe, making these results difficult to generalize to the majority of the ADHD population.

Schnackenberg (1973) substituted methylphenidate for caffeine in eleven boys with Minimal Brain Dysfunction who had previously responded negatively to methylphenidate. He had teachers fill out the Rating Scale for Hyperkenesis while the boys were still on Methylphenidate, during a three-week holiday from any drug, and then while the subjects were drinking 2 cups of coffee per day (250-300mg of caffeine). He

found that ratings on both Methylphenidate and caffeine were significantly lower than the no drug condition. There was no significant difference between methylphenidate and caffeine on the Rating Scale. The side effect the boys had while on methylphenidate (anorexia, Insomnia, weight loss and no weight gain) disappeared while the boys were in the caffeine treatment. These finding are not consistent with much of the literature available comparing the effectiveness of these two substances on ADHD symptoms. These results could have something to do with the fact that all these children had previously responded negatively while on methylphenidate. Because of this their parents may have been influential in helping to change their behavior. This study also used one behavioral checklist, filled out only by teachers, to compare the group.

Caffeine

Caffeine has not been shown to be effective in the control of hyperactive behaviors. However, because of its stimulant effects it does affect attention. Caffeine is a natural stimulant used by millions of people every day. Coffee, soda, and chocolate, which are commonly used, are only a few of the ways caffeine gets into our diet. It is also available in liquid and pill form and found in many herbal supplements. Caffeine "alters blood flow, slightly increasing heart rate but also constricting the blood vessels to the brain, thereby decreasing the blood flow to the brain" (Kalat, 1998). It also inhibits the neurotransmitter Adenosine which is how it increases arousal (Rainie, Grunze, McCarley, & Green, 1994). Benowitz (1990) found that the half-life of caffeine is 4 to 6 hours. The psychological effects of caffeine are shown by an increased arousal (Zwyghuizen-Doorenbos, et al., 1990), and a decrease in fatigue (Fine et al., 1994), and an increase in reaction time (Battig & Buzzi, 1986).

Many studies have demonstrated that caffeine increases alertness and vigilance. Zwyghuizen-Doornbos et al. (1990) did a study to assess alerting effects, tolerance and conditioning effects of caffeine. Twenty-four men participated in a three-day hospital stay while receiving various tests throughout this time. One of these was an auditory

vigilance task, which measured reaction time (RT) and accuracy. Caffeine was found to significantly improve both RT and accuracy. One interesting finding on conditioning was on the last day when they gave a placebo administration to both the caffeine and placebo group. The caffeine group performed just as well as they did on day 1 and still did better than the placebo group. Being in a controlled environment makes sure there was nothing else to interfere with the study. But some people may not have been their "natural" self; leading to different conclusions than what might have been seen if they were allowed to sleep in their own beds and then tested in their "natural" environment.

A study by Kerr, Sherwood and Hidmarch (1991) tested results of alcohol, caffeine, and tobacco separately and combined on the same standardized psychological measures within one controlled study. Caffeine was found to enhance choice reaction time, compensatory tracking task, and a short-term memory task. The Choice Reaction Time measured sensory reaction to a critical stimulus. The Compensatory Tracking Task has been shown to be similar to driving a car because advanced motor activity is needed in response to the processing of complex visual stimuli (In a study from Hindmarch et al., 1983 cited in Kerr et al., 1991). To assess short-term memory they used a test from Sternberg (1966, 1975) that measures reaction time on high speed scanning and retrieval from short-term memory. Caffeine was not significant over placebo in this study on a critical flicker fusion task. This task, used by Hindmarch (1982), "provides an index of the state of arousal of the central nervous system and allows accurate prediction of mental alertness and cognitive potential." One implication of the results indicate that because of the non-significant finding that caffeine may have a more specific action of information processing. This study had a small sample size (10 subjects), which may not allow for a generalization because large individual differences may account for skewed results. But, they did rule out possible confounding effects by selecting 5 smokers and 5 non-smokers because some studies have shown nicotine to improve attentiveness (Levin, 1992; Warburton, et al., 1992).

Lorist, Snel, and Kok (1994) found that caffeine effects show up more in fatigued subjects when they are compared to subjects that are well rested. To rule out possible fatigue effects a study done by Battig and Buzzi (1986) used a reinforced information-processing task. They used 20 female subjects that were matched for extreme extroversion and introversion to also rule out any possible personality effects. The rapid Information -Processing task they used required subjects to press a button every time 3 even or odd integers were presented. Integers are presented on the screen at the rate of 100 per minute. The program was set up so that after each correct response the digits would come at a faster rate (up to a possible 150 digits per minute) and after each incorrect response it would slow down (to a possible 30 digits per minute). Caffeine was shown to significantly improve subject performance averages on this task as well as their maximum performances. It did not however effect their minimal performance. They also found that caffeine improves performance above a mere restoration of fatigue and they did not find any evidence to suggest that there are any different effects of caffeine between extroverts and introverts. But, overall they did find large inter-individual variability in the subjects responses to caffeine, which they said could be because of "particular sub-scales of extroversion such as impulsivity and sociability" (In the study of Anderson & Ravelle, 1982; Keister & McLaughlin, 1972; Revelle et al., 1980, cited in Battig and Buzzi, 1986).

These and many other studies with caffeine have shown it to significantly improve performance over placebo on many different types of attention tasks. But most of the studies comparing caffeine to schedule II stimulants for the treatment of ADHD have not. This conflict may arise because many of the measures used in these types of studies are different. Published caffeine studies have tended to use more direct measures of attention, such as computerized tasks that measure performance. Whereas many ADHD treatment studies use objective measures, such as checklists that are filled out according to how well the child looks like their paying attention. When considering this, along with

recent literature about the Predominantly Inattentive sub-type of ADHD, it seems that there needs to be research focusing directly on measures of attention when evaluating treatments for this disorder. The purpose of this pilot study is to measure the effects of caffeine on selective and sustained attention. My hypothesis is that caffeine effects will be greater for people who score higher on the Self Rating Scale (more attention problems) than those who score lower (less attention problems) when measured on a Rapid Information Processing task with distracters and a cued version of the Posner task. If this experiment confirms the hypothesis further studies could be needed to specifically target populations diagnosed with the Predominantly Inattentive sub-type of ADHD. This could lead to further explorations of a safer drug treatment for this disorder.

Method

Participants

This study consisted of 8 females and 6 males with a mean age of 21 and range of 2-51, that are currently enrolled in Psychology 102 and 396 at Southern Illinois University. The Psychology 102 students fulfilled class requirements by participating and the 396 students received class credit for participating in the study. Only those who are regular caffeine users and who are not currently on any other psychoactive substances will be included.

Instruments Used

The Adult Attention Deficit Disorders Evaluation Scale: This scale was produced by Stephen B. McCarney and Paul D. Anderson (1996) to provide a measure of the characteristics associated with Attention Deficit Hyperactive Disorder. The questions on this scale are consistent with diagnostic criteria for ADHD from the DSM IV. There are two scales, one for Hyperactivity/Impulsivity and another for attention. A self-report version of the scale will be used for this study in order for participants to rate themselves

on these items. The rating system is as follows: (0) Do not engage in the behavior, (1) One to several times per month, (2) One to several times per week, (3) One to several times per day, (4) One to several times per hour. Only the attention scale will be used in this study.

Posner Computer task: This task will measure the amount of time it takes the participant to respond to a stimulus. The participant is told to stare at the center of the IBM personal computer screen. First the word BLINK will be shown in the center of the screen. Then, about .o4 seconds after this disappears a cross hair will appear followed by an arrow or a blank. About .04 seconds after this an asterisk will be shown in the right or left visual field, which is the target stimulus. The subject will press the button that corresponds to side in which they see the asterisk appear in. There are four different conditions that will precede the asterisk: valid, invalid, non-cued .01 seconds, and non-cued .08 seconds. The valid condition will be when the arrow points in the direction where the asterisk will appear. The invalid is when the arrow points the opposite direction of where the asterisk will appear. In the two non-cued conditions there will be no arrow preceding the asterisk. In the non-cued .01 condition there will be a lapse of .01 seconds after the cross hair and before the asterisk appears. The non-cued .08 condition will be the same except time lapse will be .08 seconds before the asterisk is shown. This task will run for approximately 13 minutes.

LED: This task will measure attention with and without distracters. It is a rapid information task, which will show one integer in the center of the computer screen at a rate of one every .06 seconds. After three consecutive odd or even integers are shown the subject is asked to push a button. Distracters will be randomly shown in either the left or right visual field for .06 of a second. These distracters will be negative, positive, and neutral pictures. This task will run approximately 12 minutes.

Caffeine: The drinks given to the participants will be 200ml of sugar-free, caffeine-free Pepsi. During the caffeine treatment 20 ml of distilled water and 2mg per

kg of body weight of caffeine will be added to the Pepsi. In the placebo group 20ml of distilled water and 2mg per kg of body weight of quinine will be added to the Pepsi. This will be done to so that the taste will not be distinguishable to the subjects.

Procedures

There will be three experimental sessions. The first session will be the orientation session, lasting about 1 hour. They will be given a brief introduction to the experiment after which they will be given an informed consent. After the participants have read and signed the consent they will be given a questionnaire that asks about their: caffeine consumption, drug and nicotine use, eyesight and weight. Once this is completed they will practice the LED and the Posner computer tasks. Before the participants leave they will be scheduled for their next two experimental sessions and reminded to refrain from any substances containing caffeine after 12pm the night before both of their next experimental sessions. There will be no precautionary measures taken to assure that the participants refrained from caffeine. To stress the importance of abstinence from caffeine the participants will be called and reminded of this the night before each experimental session. One to four days later they will return for their second experimental session, which lasts approximately 2 hours. Within the first 5 minutes they will drink the caffeine/non caffeine soda. After this the participant fills out The Adult Attention Deficit Disorders Evaluation Scale. Once this is complete the participant is free to work on their homework until exactly 45 minutes has passed since they began drinking the soda. At this time a bathroom break is given which will take up to 10 minutes, leaving them at least 5 minutes to sit quietly before they are to begin their computer task. Between the two tasks subjects will be given a chance to have a ten-minute break. At the end of the session they will be reminded of their next session date and once again to refrain from any caffeine substances after 12pm the night before this session. One to four days later the participants will return for their third and final session. The same procedure will be followed as in the second session except that if they received caffeine in the second

session they will now receive no caffeine in their soda and if they receive no caffeine in their second session, they will now receive caffeine in their soda. The computerized tasks will also be switched for order from the first session to their second session. At the end of the session they will be debriefed about the experiment.

Statistics

A multivariate ANOVA was conducted on the participants' average response times (RT) in all of the conditions from the first and second experimental sessions. The RT scores were taken from the following types of response conditions: valid left visual field (LVF), valid right visual field (RVF), invalid LVF, invalid RVF, non-cued 100ms LVF, non-cued 100ms RVF, non-cued 800ms LVF, and non-cued 800ms RVF. The overall average change in RT time between the two conditions, were correlated with the participants responses on attention scale of The Adult Attention Deficit Disorders Evaluation Scale.

Results

Multivariate ANOVAS were used to analyze all the conditions of the task as within subjects factors. Gender was given as the only between subjects factor because of the small sample size. This analysis found no main effect for caffeine. There was a significant four-way interaction involving caffeine. Females were found to improve more with caffeine than males when a stimulus was presented in the left visual field, $F(1,12) = 5.250$, $p < .05$.

There were also some significant findings between the task conditions. Subjects responded faster to stimuli in the Valid condition than in the Invalid condition, $F(1,12) = 114.813$, $p < .05$. The same was also true for the Non-Cued condition. Subjects responded faster to the No-Cue 800ms condition than they did in the No-Cue 100ms condition, $F(1,12) = 181.298$, $p. < .01$.

The response times in the caffeine condition were subtracted from the placebo

condition to get the overall change in response time between the two for each condition (table 2). Then the mean change across all conditions for each participant was then correlated with the attention scores from The Adult Attention Deficit Disorders Evaluation Scale (table 1, Figure example 1). A decrease with caffeine is shown as a positive number and a negative number indicates the subjects' RT increased with caffeine. There was no correlation found between RT decreases with caffeine and a subjects self-reported attention score.

Table 1

Mean RT Decrease from Placebo to Caffeine across All Conditions

Mean Decrease	Attention Score
44.21	15
4.33	40
39.09	15
-22.64	14
-35.21	2
-3.61	7
-48.03	11
28.1	21
-19.94	24
3.43	38
15.21	12
16.63	25
35.6	51
4.07	19

Note. Negative numbers indicate RT increases with caffeine.

Figure 1

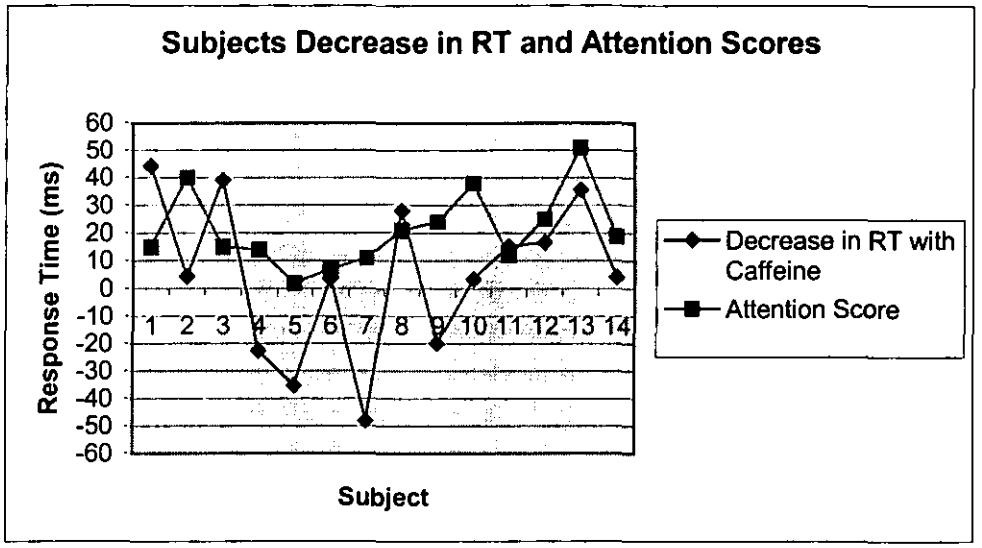

Table 2

Mean Decrease in Response Time with Caffeine

Cued Condition

	Valid		Invalid	
Subject	Left Visual Field	Right Visual Field	Left Visual Field	Right Visual Field
1	68.31	46.83	59.25	0
2	-14.48	14.4	42.67	5.25
3	54.25	56.82	7.83	15.79
4	-53.46	-51.04	-32.3	7.5
5	-19.96	-49.2	-18.42	-29.25
6	-0.64	-34.37	17.67	18.58
7	-32.96	-43.88	-25.16	-29.25
8	20.52	60.7	-3.33	9.17
9	-10.77	10.86	-11.67	21.83
10	3.27	9.81	-6.83	2.75
11	.12	5.56	12.25	13.33
12	-1.81	0.06	67.5	4.91
13	31.48	23.85	11.58	35.83
14	1.67	7.06	-25.03	23.67

Note: negative numbers indicate increases RT in caffeine condition.

(Continued) Table 2

Mean Decrease in Response Time With Caffeine

Non-Cued Condition

	100ms		800ms	
Subject	Left Visual Field	Right Visual Field	Left Visual Field	Right Visual Field
1	32.46	61.87	42.67	42.2
2	-7.6	-23.47	11.47	6.4
3	81.07	-25.29	49.75	72.52
4	45.47	-26.73	-57.27	-13.27
5	-51.53	-50.8	-5.2	-55.53
6	25.87	2.8	-5.47	-52.13
7	-83.53	-74.4	-53.33	-41.73
8	48.87	30.53	-13.33	71.73
9	-130.13	-43.53	-2.13	5.87
10	18.4	22.47	-15.87	-6.6
11	51.87	11.47	25.73	1.33
12	26.87	16.07	-2.53	21.93
13	66.13	35.53	31.4	48.97
14	35.93	30.2	19.37	12.93

Note: negative numbers indicate increases RT in caffeine condition.

Discussion

The results obtained in this study do not support the hypothesis that people who report higher attention problems have greater decreases in RT with caffeine than compared to those who report less attention problems. There was an overall decrease in RT with caffeine but it was not significant, which does not agree with some of the literature available on caffeine and its effects of decreasing RT (Battig & Buzzi 1986; Kerr, Sherwood & Hidmarch, 1991; &Zwyghuizen-Doornbos et. al., 1990). There was a large variability between subjects in RT with caffeine, which is consistent with what Battig & Buzzi (1986) found. Because of the small sample size, this large variability could account for the non-significant finding with caffeine. Also, there was no test done to assure that the subjects refrained from caffeine before the sessions. Another aspect that should have been included is the amount of caffeine that the regular caffeine users consumed on a daily basis. People who consume unusually high doses of caffeine may not have been effected by the moderate dose that was given during the sessions due to

tolerance.

There was only one score that fell one standard deviation below the mean on The Adult Attention Deficit Disorders Evaluation Scale (attention sub-scale), which does not give an adequate representation of low attention scores. More subjects in this range of scores were needed to adequately test the hypothesis proposed in this study. If this study was replicated it should be done specifically on subjects that were diagnosed with the ADHD sub-type Predominantly Inattentive, and compared to those who score very low on attention problems. With this a clear distinction of people with different attention levels could then be compared in respect to the effects of caffeine.

This study showed that caffeine does improve attention for some. Therefor, caffeine should not be ruled out for the alleviation of symptoms of Predominantly Inattentive ADHD because it may be able to help a select group of people. Unfortunately this study cannot show who will or will not benefit from caffeine, but just that it could possibly help alleviate attention problems for a variety of people. Further study needs to be done on the differences between people and their reaction to caffeine to address this problem.

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