CAFFEINE CONSUMPTION AND ITS EFFECTS TOWARDS YOUNG ADULTS' SHORT-TERM MEMORY RECALL

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Abstract

This quasi-experimental design of the study aimed at determining the effects of caffeine consumption towards young adults' short-term memory recall. This study utilized purposive sampling method wherein a total of 40 young adults from Kiblawan, Davao del Sur were selected as the research respondents of this study. They were divided into two groups: an experimental group and a control group, with the experimental group consuming caffeine. The following statistical tools were employed: The mean was used to determine the pre-test and post-test scores of controls and experimental group. The T-test for Independent Samples was used to address the significant difference between the pre-test mean scores of controls and experimental groups. Sample T-test was employed to assess if there was a significant difference between the pre-test and post-test mean scores of young adults in experimental and control groups. And analysis of covariance (ANCOVA) was utilized to determine significant difference in the post-test mean scores between the control and experimental groups with pre-test means scores of covariates. Results revealed that before the implementation of the interventions, both levels of performance of the groups are categorized below the average level of performance in short-term memory recall, which implies that they were having difficulty to recall the words that were tasked to recall. The result showed that there is an improvement in the short-term memory recall of young adults in the experimental group after being exposed to caffeine. The post-test performance of the control group found to be at the low average level of performance, similarly, the experimental group found to be at the low average level of performance as well. Finally, the study revealed that caffeine consumption has a little amount of effect on the short-term memory recall of the participants.

Keywords: *Caffeine Consumption, Short-Term Memory Recall, Experimental-Quantitative Research, Philippines*

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Statement of the problem in general outlook and its connection with important scientific and practical tasks

Rationale

Human memory is one of the most interesting subjects in psychology. Memory refers to the mental process of encoding, retaining and retrieving information [13]. One of the most interesting and challenging questions in contemporary memory research is the question of improving human memory performance. Many researchers have suggested several variables that contribute to enhance memory retention including psychoactive substances such as caffeine [31, 36].

The concept of memory involves encoding, storing, and retrieving information and can be divided into short-term, long-term, and working memory [23]. Short-term memory comprises information that is stored in our memory for a short period of time [1]. Jonides (2008) claimed that three main steps to storing short-term memory are encoding, maintenance, and retrieval. Encoding is the process of converting perceived information into memory usable form. Maintenance or storage keeps this memory available for use. Lastly, retrieving means bringing that memory to consciousness and remembering it. Furthermore, a variety of reasons for consuming caffeine are reported in the literature including its quantifiable effects on various types of human performance specifically in human cognition when provided in the amounts usually found in meals, beverages, and drugs [19]. Caffeine's cognitive and mood-enhancing benefits have been highlighted as one of the main reasons for its usage [36]. Ultimately, it is essential to consider how caffeine use impacts and integrates into the short-term memory of humans.

Consequently, there are existing studies regarding the influence of caffeine on cognition. Extensive research has found caffeine to be one of the most widely used stimulants, even among adolescents, as it has been linked to better physical performance, greater alertness, and a countermeasure against the effects of sleep deprivation [7, 19]. Olsen (2013) argued that college-age consumers found caffeine to be beneficial in staying awake, getting high grades, concentrating, and being better able to socialize. Caffeine improves information processing, attention, and specific types of memory in multiple cognitive domains [3]. In addition, a study by Van-Duinen, Lorist, & Zijdewind (2005) showed that caffeine improves cognitive performance in tasks in both single and double tasks, as well as in demanding situations that persist. Similarly, Baddeley (2006) suggested that caffeine facilitates performance to some extent on tasks involving working memory, however, it hinders performance on tasks that rely heavily on working memory, rather it appears that caffeine is more likely to improve memory performance in suboptimal alert conditions. Nevertheless, there are only limited evidence that shows caffeine effectively affects memory tasks beyond improved reaction times [45].

Finally, caffeine consumption and cognitive performance have been the subject of numerous studies during the last decades. However, the results and findings of the previous research were sometimes inconsistent and some biases can be observed. This implies that more research is needed to examine cognitive performance with the influence of consuming caffeine in moderate doses. This prompted the researcher to conduct this experiment

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to investigate whether caffeine consumption can increase or improve cognition specifically with short-term memory. The results of this experimental study provide future researchers with an idea of the efficacy of caffeine in enhancing short-term memory recall.

Statement of the Problem

The main objective of this study was to assess short-term memory recall as influenced by the caffeine consumption of young adults residing at Kisulan, Kiblawan, Davao del Sur. Specifically, this study sought to address the following questions:

1. What are the pre-test mean scores of control and experimental groups?
2. What are the post-test mean scores of control and experimental groups?
3. Is there a significant difference between the pre-test mean scores of control group and experimental group?
4. Is there a significant difference between the pre-test and post-test mean scores of participants in the control group?
5. Is there a significant difference between the pre-test and post-test mean scores of participants in the experimental group?
6. Is there a significant difference in the post-test mean scores between the control and experimental groups with pre-test means scores of covariates?

Hypotheses:

The null hypotheses in this study were tested at 0.05 level of significance.

H01: There is no significant difference between the pre-test mean score in the controls and experimental groups.

H02: There is no significant difference between the pre-test and post-test mean scores of participants in the control group.

H03: There is no significant difference between the pre-test and post-test mean scores of participants in the experimental group.

H04: There is no significant difference in the post-test mean scores between the control and experimental groups with pre-test mean scores covariates.

Analysis of latest research where the solution of the problem was initiated

Numerous researchers have investigated the impact of caffeine on memory performance, particularly in short-term memory recall. In this chapter, related literature and studies are reviewed and discussed to establish adequate background needed by the researchers and readers in order to fully understand the variables of the study. Specifically, this chapter strategically presents thoroughly researched and verified information on the concepts surrounding the study variables. For the purpose of the study, the reviewed literature covers 3 categories: Caffeine Consumption, Memory and Factors Affecting Memory, and The Impact of Caffeine in Memory Recall.

Caffeine Consumption

Caffeine consumption has risen dramatically in recent years all around the world. According to Schouten & Romani (2020). Acrylamide in coffee: formation and possible mitigation strategies–a review. Critical reviews in food science and nutrition, 60(22), 3807-3821.), Finland was ranked as the most caffeinated country in 2010, and its citizens drink an average of four to five cups a day. In 2016, National Coffee Association of the United States revealed that people between the ages of 25 and 29 drank about 2.15 cups

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per day, while the coffee consumption of respondents among ages 18 to 24, averaged about 2.7 to 3.2 cups daily. Meanwhile, in the Philippines, total coffee consumption was around 3.3 million 60 kg bags in 2011-2020, reflecting a long-term increase in coffee consumption over the years [20].

Caffeine is a psychoactive stimulant found in coffee, tea, carbonated beverages or soft drinks, chocolate, and a wide range of drugs, including appetite suppressants, diuretics, analgesics, and decongestants; the majority of which are supplied over the counter and have no regulatory supervision [12]. Furthermore, some caffeine sources, such as chewing gum, gel patches for the skin, and "vapor sticks," which are comparable to e-cigarettes, are absorbed more quickly, contributing to their widespread use today [29]. Caffeine is not a nutrient and is not required for a healthy diet, but moderate amounts are generally considered safe [21]. Caffeine consumption of up to 400 mg daily is not associated with adverse health effects in the general healthy adult population, according to the FDA, the European Food Safety Authority, and Health Canada. The table above shows the lists of various caffeine sources with the corresponding amount of caffeine (mg) contained in various foods and beverages.

As shown in the table, a lot of beverages and food contain caffeine in different amounts. Even decaffeinated coffee contains 5 mg of caffeine. Different doses of caffeine had different effects. A healthy range of caffeine consumption would be 1 to 8 cups of tea per day, a brewed coffee intake of 0.3 to 4 cups per day or an energy drink intake of 5 cans based on the average caffeine content of beverages [21]. Various reasons for consuming caffeine have been reported in the literature. Caffeine has many beneficial effects on the brain. It can increase alertness and well-being, improve concentration, improve mood, and limit depression [27]. Moderately short-term intake of a combination of caffeine and caffeic acid effectively enhances brain function by improving antioxidant status, reducing lipid peroxidation, and inhibiting brain-to-brain acetylcholinesterase, adenosine deaminase, and arginase activity. There is evidence that it can be improved [5]. Caffeine works by temporarily releasing all sleep signals (adenosine) from receptors in the brain, giving a person a comfortable sensation of awakening in moderate amount. Dosing up to about 300 mg of caffeine improves a variety of basic cognitive functions with minimal side effects by preventing arousal and loss of attention associated with suboptimal arousal [25].

Samoggia and Riedel (2019) discovered that consumers drink coffee because of its energetic and therapeutic effects. Coffee not only helps to increase attention, but also contributes to faster response times [39]. A small amount of caffeine (32 mg) can have a positive effect on arousal and physical arousal, regardless of whether the subject is resting or not, according to a study by McLellan, Caldwell & Lieberman (2016). Ultimately, the psychostimulant caffeine, when taken in moderation, alters wakefulness and relieves other symptoms associated with depression [36]. However, high doses of caffeine (400 mg and above) are likely to induce anxiety and may affect the performance of sleep deprived, non-caffeine users (23).

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Table 1. Caffeine Content of General Food and Beverages

CAFFEINE CONTENT CHART	
CHOCOLATE	**AVERAGE**
Cocoa Beverage (6 oz)	4 mg
Chocolate Milk (8 oz)	8 mg
Milk Chocolate (1 oz)	7 mg
Semi-sweet chocolate (1 oz)	18 mg
Unsweetened chocolate (1 oz)	25 mg
COFFEE	**AVERAGE**
Brewed (6 oz)	100 mg
Instant (1 rounded tsp)	57 mg
Brewed decaffeinated (6 oz cup)	3 mg
Instant decaffeinated (1 rounded tsp)	2 mg
Cappuccino (4 oz)	100 mg
Espresso (2 oz)	100 mg
Latte (single)	50 mg
Mocha (single)	55 mg
OTHER BEVERAGES (12 oz serving)	**AVERAGE**
Coca-Cola, Diet Coke	46 mg
Mountain Dew	54 mg
Pepsi-Cola, Diet Pepsi	38 mg
Red Bull (8.2 oz)	80 mg
Monster Energy	160 mg
TEA	**AVERAGE**
Brewed, green or black, U.S. brands (3 min)	40 mg
Brewed, imported brands	60 mg
Instant (1 tsp)	30 mg
Iced Tea (8 oz)	25 mg

Source: National Soft Drink Association, US Food and Drug Administration, Bunker and McWilliams, Pepsi, Slim-Fast.

Moreover, a study conducted by Ran et al. (2021) revealed that low consumption of coffee reduced the risk of any cognitive deficit (<2.8 cups/day) or dementia (<2.3 cups/day). Lifelong coffee/caffeine consumption has been associated with prevention of cognitive decline, and reduced risk of developing stroke, Parkinson's disease and Alzheimer's disease [27]. Similarly, Wu and He (2017) content that there is no significant association between the development of cognitive disorders and coffee consumption with small dosage of caffeine (less than 3 cups/day). Caffeine contains antioxidant and neuroprotective effects that could prevent impairment of memory through affecting hippocampus antioxidant mechanisms [30].
In relation with the current study, the many perceived effects of caffeine that lend its appeal to consumers also involve its effects in human cognition, most particularly in short

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term memory. Several studies confirmed that taking caffeine shows a higher level of concentration that helps improve cognitive processes [42]. Based on the results of an experiment conducted in Harvard University, caffeine Increases short-term memory recall of high-school seniors if ingested 30 minutes before the required activity [23]. Besides, numerous studies have shown that caffeine can effectively affect the hippocampal-mediated memory enhancement, thus, helping explicit memory most effectively during non-optimal time of day – early morning [36].

To conclude, the reputed benefits of moderate caffeine intake include improved physical alertness, vigilance, mood and cognitive capacity. Otherwise, overusing caffeine will result in greater risk of anxiety, sleep deprivation, headaches, restlessness and shakiness, and fatigue [13]. However, up to date the impact of caffeine on higher executive skills, complex judgments, emotional judgments, and decision making is unclear and needs further investigation [25].

Short-Term Memory Recall

The human brain has the ability to learn new skills and experiences, store what we have learned, and reuse the stored knowledge. These abilities to store and reuse experiences and skills are informally called the human memory system [11]. According to the first definition of Merriam Webster's dictionary, memory is the ability or process to reproduce or access what is learned, especially through an associative mechanism. Moreover, in today's psychology, memory is defined as the ability to encode, store, and retrieve information [37, 46].

Psychologists have found that memory contains three major categories: working, short term, and long-term [46]. Working memory refers to the brain system or mental work area responsible for temporarily storing and manipulating information [4]. On the other hand, short-term memory, also known as primary memory or active memory, is capable of storing a small amount of information in the head and makes it available for a short period of time [12]. Short-term memory becomes long-term memory in a region of the brain called the hippocampus. In addition, a part of the brain called the cortex stores these long-term memories. Long-term memory can store an unlimited amount of information indefinitely. This is procedural long-term memory, information about activities learned through practice and repetition, or declarative long-term memory, information about facts, rules, events, definitions, and experiences that someone can refer to when needed [18].

Evidence shows that people's memory abilities are affected by multiple variables. First, the memory capacity of humans was shown to decline with age [18, 44]. Therefore, older individuals are expected to perform poorly in working memory tasks compared to younger people [28]. In addition, based on a study by Oren et al. (2017) emotional distractions presented during a working memory task change or affect the performance of the task. Emotional memory enhancement appears to involve the integration of cognitive and emotional neural networks, in which activation of the amygdala enhances the processing of emotionally arousing stimuli while also modulating enhanced memory consolidation along with other memory-related brain regions, particularly the amygdala, hippocampus, MTL, as well as the visual, frontal and parietal cortices [39]. In addition, individuals diagnosed with major depressive disorder (MDD) showed weaker performance

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in the working memory updating domain in which information manipulation was needed when completing a visual working memory task [22]. Essentially, aside from age, and emotion, physical injuries impacting the frontal or parietal lobes would reasonably be damaging to one's working memory. This is supported in studies employing neuropsychological testing to assess cognitive impairments in patients with traumatic brain injury; and poorer cognitive performances especially involving the working memory domains [13, 14, 31].

In addition, a study of Zelano (2016) suggested 5 factors that can influence the functioning of human memory. First, the degree of attention, vigilance, awakening and concentration. Second, interest, motivation, need or necessity. Third, the emotional state and emotional value attributed to the material to be memorized. Fourth, the environment in which the memorization takes place and lastly is the breathing. Findings of this study revealed that natural breathing synchronizes electrical activity in human piriform (olfactory) cortex, as well as in limbic-related brain areas, including amygdala and hippocampus, hence, breathing phase enhances fear discrimination and memory retrieval. Consequently, similar findings were showed in the study of Heck, Kozma, & Kay (2019) which suggested that respiratory phase influence higher-frequency oscillations associated with cognitive functions, including attention and memory, such as the power of γ-rhythms and the timing of hippocampal sharp wave ripples.

Memory measurement is linked to theories about the processes and structures involved in memory, as well as the study's objectives. Memory's content and structure can both be measured [39]. The general methods of assessing memory identified by psychologists are recall, recognition, and relearning. Memory recall is the recall of previously encoded and stored information or events in the brain. When taking an essay test, we rely on our recall memory because the test demands us to generate previously known knowledge [29]. Recognition memory, on the other hand, refers to the ability to differentiate information after experiencing it once more [40]. A multiple-choice test is an example of a recognition memory test, a measure of explicit memory that involves determining whether information has been seen or learned before [13].

Lastly, measures of relearning (or savings) assess how much more quickly information is processed or learned when it is studied again after it has already been learned but then forgotten. The memory of algebra procedures is an example of this. A relearning session can assess how quickly a person can review and recall previously forgotten algebraic procedures [41].

Concludingly, in this current study which seeks to assess the memory recall of young adults, a word list recall was utilized as an instrument for measuring short-term memory capacity of the participants. Two of the most commonly used methods by the neuropsychologists to assess memory functioning among individuals are story memory and list learning tests [14]. In word-list recall experiments, human subjects are requested to retrieve a list of words that were presented to them within a short period of time [20]. Numerous Wordlist Memory (WLM) tests are in use today with varying wordlist features and respective applicability to memory performance [6]. Some well-established and widely used WLM tests of verbal episodic memory include the California Verbal Learning Test-Second Edition (CVLT), the Rey Auditory-Verbal Learning Test

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or simply Auditory Verbal Learning Test, (RAVLT or AVLT) the Hopkins Verbal Learning Test-Revise (HVLT-R), and the International Shopping List Test (ISLT). Ultimately, the wordlist recall method contains key features that provide advantages or disadvantages compared to other memory tests depending on the needs of the study [10].

The Impact of Caffeine Consumption in Memory Recall

Countless experiments have examined the effects of stimulants such as caffeine in human cognitive processes particularly with short-term memory recall. As stated by Adam et al. (2021) aside from cognitive strategies and mnemonic training, the use of stimulants may improve memory processing in healthy adults [17]. In a pilot study assessing the effects of stimulants (caffeine, methylphenidate, modafinil) to cognitive performance, it was shown that caffeine had a positive effect on cognition particularly in sustained attention [31]. In addition, Sherman et al. (2016) claimed that consuming caffeinated coffee results in significantly higher memory performance on an explicit cued–recall task in the early morning, but not in the late afternoon.

The above studies show the positive effect of caffeine in memory however, various studies contradict these. More in-depth research shows that the benefit of caffeine on memory is state-dependent. This means that caffeine only improves memory if it is used both at the time of taking the information in and at the time of recalling the information later (Kłopotek & Dmowski, 2002). In other words, this experiment suggested that if no caffeine is used at the time the information is presented, people perform more poorly if they take caffeine at the time, they need to remember the information. In addition, Lapac, Dela Cruz and Regalado (2018) found out that caffeine content of various caffeine beverages only has a little effect on the test scores of college students but shows no significant changes. Furthermore, in a single-dose, double-blind, within-subject, randomized, placebo-controlled pilot study, a functional magnetic resonance imaging (fMRI) was used to assess drug-dependent memory effects of the substance for encoding and recognition compared to task-related activation under placebo. The findings shows that caffeine led to deactivations in the precentral gyrus during encoding which did not result in any behavioral effect regarding memory recall performance [1].

To wrap, caffeine and short-term memory have long been investigated, and research into the effects of caffeine on short-term memory has yielded varied results. Through defining, describing, and showing previous studies regarding caffeine consumption and short-term memory recall, this research has been proven true. All of the presented related literature and studies are extremely important and relevant to the current study. These literatures and studies have contributed valuable information and data for the theoretical foundation and analysis needed for the data interpretation and findings of the study. However, the prior research findings were oftentimes inconsistent, and some biases were noticeable. Nonetheless, the current study is distinct from other studies which investigated young adults' short-term memory as influenced by caffeine consumption.

Theoretical Framework

This study is anchored on the caffeine and activation theory of Smith et al. (2007), which states that coffee as a stimulant prompts consumer to perform and function more than normal, this includes both mental and physical power boost. In saying so, it draws a positive correlation between caffeine intake and anxiety and student mental alertness. More

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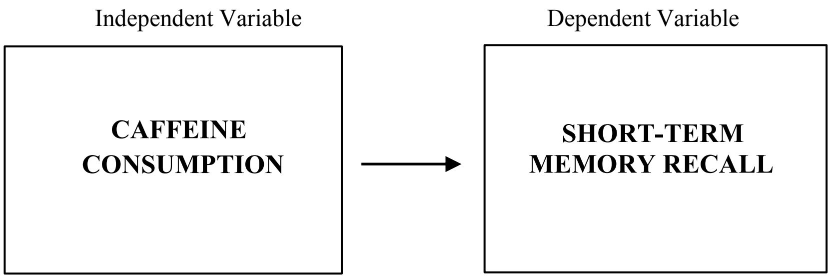
so, this is supported by the preposition of Sherman et al (2016), which states that caffeine intake results in explicit memory enhancement for young adults during their non-optimal time of day.

Conceptual Framework

Shown in Figure 1 is the conceptual paradigm of the study. The paradigm is composed of the independent variable, dependent variable and an arrow which represents whether there is significant relationship between the two variables as well as the thesis of the influence of the independent variable towards the dependent variable.

The independent variable of this study is caffeine consumption of young adults. This serves as the approach to be administered in the experimental class while the dependent variable is short term memory recall of young adults which is the outcome of experimental study. Results in the dependent variable were the basis in determining if the independent variable was effective.

Figure 1. Conceptual framework showing the variables



Source: (McLellan, 2016; and Newton, 2009)

Significance of the Study

This study that aims to assess the effects of caffeine consumption to short-term memory recall will be beneficial to the following constituents: Schools, this research will benefit the school since it will bring new ideas and insights towards how coffee consumption impacts students' short-term memory recall. It would also assist them in developing new strategies to assist students in improving their academic performance. Students, given the prevalence of caffeine usage in today's society, this study will help students understand how caffeine affects their short-term memory recall. Caffeine use improves memory, concentration, and cognitive performance, according to a study published by the University of Ohio group, all of which can help students be more academically successful [30]. Thus, this study enables them to determine if consuming caffeine has indeed an impact on someone's ability to memorize or recall previous inputs. Community, caffeine can improve performance on a number of tasks, sharpen short-term memory, and improve focus, according to a study published by the group of Scandinavian Journal of Medicine and Science in Sports [35]. As a result, the findings of this study could be used to establish strategies and plans for day-to-day living experiences in their individual communities, resulting in more effective efforts Future Researchers, will benefit from this experiment as a

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foundation for future research, particularly investigations on the influence of caffeine consumption on short-term memory recall. Also, this study assists future researchers in updating latest information for further understanding and help them look into consideration the necessary alteration to improve the work.

Definition of Terms

The following are the list of terminologies used in the study. These terms were operationally defined for a better understanding of the key concepts used in the study.

Caffeine - it is a methylxanthine-class central nervous system stimulant that is most typically obtained from coffee beans, but it can also be found naturally in tea and cacao beans [15]. It is a psychoactive stimulant that works by activating the brain and central nervous system, assisting an individual in remaining alert and preventing the onset of drowsiness [42]. This term refers to the experiment's independent variable, which was manipulated to examine the effect it has on the dependent variable.

Memory – it is defined as the processes for gathering, storing, retaining, and retrieving information [9]. This term pertains to the variable where the experiment had focused together with the term caffeine.

Short-Term Memory - also known as "primary or active memory," refers to the ability to store and recall small amounts of knowledge in the mind for a short period of time [35]. This term refers to the type of memory that was being measured in this study.

Memory Recall - a measure of explicit memory that involves remembering the information or events that were previously encoded in the brain [38]. In this study, this refers to the dependent variable of the experiment which was measured to know if there was a causal relationship between the variables.

Aims of paper. **Methods**

In this chapter, the researcher discussed the research design, research locale, the population and sample, the research instrument used, the process of collecting the data and the statistical tools used.

Research Design

This research employed a quasi-experimental research design. According to Thomas (2021), a quasi-experimental design aims to establish a cause-and-effect relationship between an independent and dependent variable wherein subjects are assigned to groups based on non-random criteria. Similarly, quasi-experimental research as a type of experimental research design that involves the manipulation of an independent variable without the random assignment of participants to conditions or orders of conditions [20]. Particularly, this study utilized a pre-test-post-test design, a form of quasi-experimental research design that is used to compare the mean scores of the experimental group and control group [38]. In a pre-test-post-test experimental research design, subjects are given the same assessment measures before and after receiving a treatment or being exposed to a condition, and these measures are examined to see if any changes can be attributed to the treatment or condition [28].

Moreover, the involved variables in this experiment were caffeine consumption served as the independent variable and short-term memory recall which, on the other hand, served as the dependent variable of this study. In this study, the independent variable which is

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caffeine consumption was manipulated in order to monitor or observe the change or impact it could affect to the dependent variable which is the short-term memory recall. In addition, this research involved two groups- the treatment group and the control group. The treatment or experimental group was given a cup of coffee that contained a moderate amount of caffeine. Meanwhile, the members of the control group received a bottle of 240ml water and participated in the pre- and post- intervention assessment.

Research Locale

This study was conducted in the locality of the researcher specifically in Kisulan. Kiblawan, Davao del Sur. Kisulan is a barangay in the municipality of Kiblawan, in the province of Davao del Sur. Its population as determined by the 2020 Census was 1,528. This represented 3.09% of the total population of Kiblawan. The household population of Kisulan in the 2015 Census was 1,596 broken down into 431 households or an average of 3.70 members per household.

Furthermore, the municipality of Kiblawan situated in the province of Davao del Sur is one of those 1,488 municipalities around the country and belongs to Region XI among the 17 administrative regions in the Philippines, according to the Philippine Statistics Authority (PSA census as of 2021.)

Population and Sample

This study which mainly focused on the effect of caffeine consumption to short-term memory recall were intended to young adults' participants from the age of eighteen (18) to twenty-four (24) years of age. According to the Federal Interagency Forum on Child and Family (2020) an individual from age 18 to twenty-four years old is considered a young adult. The total number of participants included in the experiment will be thirty (30) experimental units composed of fifteen (20) males and fifteen (20) females.

In order to obtain the number of participants for the study, this study employed a convenience sampling technique. Convenience sampling is also known as availability sampling, it is a specific type of a non-probability sampling method that relies on data collection from population members who are conveniently available to participate in the study [32]. The participants took the pre-test and were scored using the statistical analysis rubric of the Rey Auditory Verbal Learning Test (RAVLT) with a total of 75 points. To determine who would qualify as final participants, participants were classified based on their scores. The participants who gained a score of 72-75 were categorized as Very Superior scorers. The participants who got a score of 66-72 belonged to the category of Superior scorers. While the participants who garnered a score of 61-65 were categorized as High Average scorers. The participants who got a score of 56-60 or at expected performance level belonged under the category of Average scorers. Finally, participants who garnered a score of 46-55 which was described as Low Average Level of Performance, and scores of 40-45 which belong under the category of Borderline and those who got a score of 39 and below which fell under the category of extremely low level of performance were taken as the final respondents of the study. Afterwards, they were grouped into control and experimental group respectively.

In the interpretation of the total scores of the participants based on the statistical analysis rubric of the Rey Auditory Verbal Learning Test (RAVLT), the following was utilized:

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Table 2. Table for Interpretation of Pre-test and Post-test Scores

Score Range	Descriptive Level	Interpretation
72-75	Very Superior	This indicates that the participant's memory recall capacity is extremely satisfactory than expected performance level.
66-71	Superior	This indicates that the participant's memory recall capacity is satisfactory than expected performance level.
61-65	High Average	This indicates that the participant's memory recall capacity is above the expected performance level
56-60	Average	This indicates that the participant's memory recall capacity is at expected performance level.
46-55	Low Average	This indicates that the participant's memory recall capacity is below than expected performance level.
40-45	Borderline	This indicates that the participant's memory recall capacity is poor than expected performance level.
39 and below	Extremely Low	This indicates that the participant's memory recall capacity is extremely poor than expected performance level.

Source: (Rey, 1964; Khosravi et al.2016).

Research Instrument

In this study, the researcher adapted the Parenting Style Questionnaire of Baumrind, 1971 to measure the independent variable The research instrument that was utilized in this study is the Rey Auditory Verbal Learning Test (RAVLT). Also called Auditory Verbal Learning Test (AVLT), the Rey Auditory Verbal Learning Test (RAVLT) was originally developed in 1941 by André Rey, a Swiss psychologist, Rey's Auditory Verbal Learning Test (RAVLT) is a powerful neuropsychological tool that is used for assessing episodic memory by providing scores for evaluating different aspects of memory [24]. Briefly, the RAVLT consists of presenting a list of 15 words across five consecutive trials. The list was read aloud to the participant with a 1-s pause between each word and then the participant was immediately asked to recall as many words as he/she remembers. The participants were given 90 seconds to freely recall as many words as possible from the list, in any order. Correct responses, intrusions, and repetitions were recorded, but only correct responses on the immediate recall trial were used for the present study. There were two sets of 15 words that were utilized in this study. Set A was used in the pre-test assessment of the participants and Set B was utilized in the post-test assessment of this experiment.

Statistical Treatment of Data

Mean. During the pre-test and post-test, it was utilized to measure the average scores of the subjects in the control and experimental groups

T-test for Independent Samples. To address objective 3, an independent sample t-test was used by the researcher. A sample t-test is an inferential statistic that is used to determine if there is a significant difference in the means of two groups that are related in some features [36]. As a result, the researcher utilized this tool to identify if there are any significant differences in pre-test and post-test scores between the control and experimental groups.

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Paired Sample T-test. It was utilized to answer objectives number 4 and 5. The dependent samples t-test, also known as the paired samples t-test, is utilized to assess if the difference in means between two paired observations is statistically significant. The same subjects are assessed at two different times or observed using two different methods in this test [26]. Thus, the researcher employed the tool to determine if there exist significant difference between pre-test and post-test scores in the control and experimental group.
ANCOVA. This was employed to address objective number 6. In experimental and quasi-experimental studies, analysis of covariance (ANCOVA) is a commonly used statistical method [23]. ANCOVA is a type of ANOVA that uses regression analysis to control the linear effect of a covariate variable. This is used to examine not only the changes in variance of the dependent variable (ANOVA), as well as the correlation between the dependent variable and covariate at different levels of a particular variable (Regression) [19]. Thus, it was used by the researcher to assess the significant difference between the post-test scores of controls and experimental groups while controlling the pre-test scores.

Exposition of main material of research with complete substantiation of obtained scientific results. Discussion

This chapter presents the results and discussions of the data acquired using the most appropriate statistical tools in this study. The results are presented first by addressing the control and experimental groups' pre-test mean scores, followed by their post-test mean scores. Next is the discussion of the significant difference between pre-test mean scores of the participants in control and experimental groups. The significant difference between the pre-test and post-test mean scores of participants in the control and experimental groups is then presented. The final discussion is the significant difference in the post-test mean scores between control and experimental groups with pre-test mean scores as covariates.

The Pre-Test Mean Scores of Control and Experimental Groups

The pre-test means scores of the control and experimental groups on the Rey Auditory Verbal Learning Test (RAVLT), which consisted of a list of 15 words repeated across five consecutive trials, are shown in Table 3.

Table 3. The pre-test mean scores of young adults' in Control and Experimental Group

Group of Respondents	N	Mean	Std. Deviation	Level of Performance
Control Group	20	46.95	7.14	Low Average
Experimental Group	**20**	**43.50**	**5.76**	**Borderline**

Source: Responses from 40 research respondents.

The pre-test mean scores of the participants in the control group, as illustrated in Table 3, is 46.95 with a standard deviation of 7.14 which indicates that the level of performance of participants in control group is low average or participants' memory recall performance

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is below than expected performance level as described in the interpretation table of the researcher. Meanwhile, the participants in the experimental group attained a mean score of 43.50 with a standard deviation of 5.76. This denotes that the participants in the experimental group are said to be at the borderline level and their memory recall performance is poorer than expected performance level.
In examining the pre-test mean scores of both groups, it can be said that the two groups differ in their level of performance in short-term memory recall. The participants in the experimental group belonged to the borderline category obtaining a lower mean score of memory recall performance compared to the participants in the control group which belonged to the category of low average scorers in terms of short-term memory recall performance.

The Post-Test Mean Scores of Control and Experimental Groups

The post-test mean scores of the control and experimental groups on the Rey Auditory Verbal Learning Test (RAVLT), which consisted of a list of 15 words repeated across five consecutive trials, are illustrated in Table 4.

Table 4. The post-test mean scores of young adults' in Control and Experimental Group

Group of Respondents	N	Mean	Std. Deviation	Level of Performance
Control Group	20	51.95	10.3	Low Average
Experimental	**20**	**52.45**	**9.25**	**Low Average**

Source: Responses from 40 research respondents.

The participants belonging to the control group gained an overall mean score of 51.95 with a standard deviation of 10.3, as shown in Table 4. This denotes that the memory recall performance of participants in the control group is still at the low average level or the participants performed below than expected performance level. On the other hand, looking at the post-test mean scores of the participants in the experimental group, the group obtained a mean score of 52.45 with a standard deviation of 9.25. This indicates that subjects who belonged to the experimental group also performed below than expected performance level with regards to short-term memory recall.
Furthermore, Table 4 shows that the post-test mean scores obtained by both experimental group and control group do not differ in short-term memory recall performance. The post-test mean scores of the participants in the control group and experimental group fall under the category of low average level which reveals that participants in both groups performed below average short-term memory recall performance level and they have a hard time recalling the words they are tasked to recall.

Significant Difference between the Pre-test Mean Scores of Control and Experimental Groups

In this study, the researcher aimed to determine if there is a significant difference between the pre-test mean scores of students in the control group and experimental group. The T-test for Independent Sample was used to address the research problem.

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Table 5. Significant Difference between the Pre-test mean scores of Control Group and Experimental Group

	Mean		T-value	Sig. (2-tailed)	Remarks
	CG	EG			
Pre-test Scores	46.95	43.50	1.681	.101	Not Significant

LEGEND: CG=Control Group; EG=Experimental Group
Source: own work.

As observed in Table 5, the t-value of pre-test mean scores of control and experimental groups is 1.681 with a "sig." (2-tailed) value of .101 which is above the 0.05 level of significance set for this study. These values indicate that the difference between the pre-test scores of control and experimental group on word-list recall to measure the short-term memory performance of the participants is not significant. Moreover, since the result shows a significance value of .101 which is higher than the level of significance set for this study, this signifies that the study failed to reject the null hypothesis. Thus, the difference between the mean scores of the two groups during the pre-test was found to be nearly the same.

Significant Difference between the Pre-test and Post—test mean scores of the respondents in Control Group

This study also aimed to determine whether not consuming caffeine has an effect towards young adults' short-term memory recall. Before and after administering the intervention, coffee intake, the level of mean scores of short-term memory recall performance was measured. Mean scores were calculated and Paired-sample t-test was utilized in order to determine whether there is a significant difference in the short-term memory recall capacity of young adults before and after the intervention was employed.

Table 6. Significant Difference between the Pre-test and Post—test mean scores of the respondents in Control Group

	N	Mean		T-value	Sig. (2-tailed)	Remarks
		Before	After			
Control Group Pre-test Scores & Control Group Post-test Scores	20	46.95	51.95	-3.343	.003	Significant

Source: Responses from 40 research respondents.

As presented in Table 6, short-term memory capacity of participants belonging to the control group who were not given any amount of caffeine are said to have increased. The

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mean scores of the participants in the control group increased from 46.95 to 51.95. However, young adults in the control group fall under the category of low average level or performed below than the average short-term memory recall performance level in the post-test as described in the interpretation table of the researcher.

In addition, results in Table 6 indicate that the performance of participants in post-test word-list memory recall have significantly increased as manifested by sig. (2-tailed) value of 0.003 which is below the 0.05 level of significance set in this study. In addition, with the t-value of -3.343 the results also indicate that there is a significant improvement in the performance of young adults in the control group for short-term memory recall. Therefore, the null hypothesis will be rejected.

According to the findings presented above, young adults' short-term memory recall improves without consuming caffeine. This finding is comparable to what Terry and Phifer (1986) discovered in their research involving a small amount of caffeine to determine if it significantly affects the performance of participants on an auditory and verbal learning test (AVLT). The AVLT is a verbal memory test that assesses memory span, trial-by-trial learning, interference, and delayed recall. The participants received either 0mg or 100mg of caffeine (an average dose). The subjects were given trials with different word lists forty minutes after ingesting caffeine to assess their verbal memory. Finally, they discovered that the control group outperformed the caffeinated group on several facets of verbal recall [36].

Significant Difference between the Pre-test and Post—test mean scores of the respondents in Experimental Group

Another objective of this study was to determine if caffeine consumption has an effect on young adults' short-term memory recall. The level of mean short-term memory recall scores was measured before and after the intervention, which is the distribution of a moderate dose of caffeine to the participants. To establish if there was a significant difference in the short-term memory recall of the subjects in the group before and after a moderate amount of caffeine was given, mean scores were calculated and a Paired sample t-test was utilized.

Table 7. Significant Difference between the Pre-test and Post—test mean scores of the respondents in Experimental Group

	N	Mean		T-value	Sig. (2-tailed)	Remarks
		Before	After			
Experimental Group Pre-test Scores & Experimental Group Post-test Scores	**20**	43.50	52.45	-5.749	.000	**Significant**

Source: Responses from 40 research respondents.

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As shown in Table. 7, the short-term memory recall performance of the participants had increased after being given an energy drink that contains a moderate amount of caffeine. The mean scores of the participants in the experimental group increased from 43.50 to 52.45 or from borderline to low average performance level. Moreover, results in Table 7 signifies that the performance of participants in post-test word-list memory recall have significantly increased as manifested by sig. (2-tailed) value of 0.000 which is below the 0.05 level of significance set for this study. In addition, with the T-value of -5.749 the results also indicate that there is a significant improvement in the performance of young adults in the experimental group for short-term memory recall. Therefore, the null hypothesis will be rejected.

The findings above implies that caffeine consumption demonstrates a positive outcome towards young adults' short-term memory recall. This finding supports findings of Koppelstätter and colleagues' (2005), when they used functional magnetic resonance imaging (fMRI) to examine the influences of caffeine on brain activation in a network of modules that serve short-term memory in 15 healthy adult volunteers during a working memory task. The participants were shown a series of simple images (the letters A, B, C, or D) and asked if one of the images was the same as the one displayed two images previously. The test was completed following a 12-hour caffeine-free period and a four-hour nicotine-free period. Caffeine had a good effect on the participants' short-term memory and reaction times [20]. Similarly, Walker et al. (2002) showed that caffeine increased performance on a paired word associates (PWA) test at UNC-Wilmington. The subject's ability to retain and retrieve words from their verbal short-term memory is tested in this test. Caffeine considerably increased performance on the paired word associates' task, according to the findings [41].

Significant difference in the Post-test Mean Scores between the Control and Experimental Groups with Pre-test Mean scores as Covariates

This study aimed as well to determine if there is a significant difference between post-test scores of young adults in the control group and young adults in the experimental group while controlling the pre-test scores. The analysis of covariance (ANCOVA) was utilized in order to answer the research problem.

Table 8. Significant Difference in the Post-test Mean Scores between the Control and Experimental Groups with Pre-test Mean Scores as Covariates

Source Remarks	Post-Test Mean Scores		F-Value	P-Value	Remarks
	Control	Experimental			
Group Pre-test	51.95	52.45	.142 36.51	.708 .000	Not Significant

Source: Responses from 40 research respondents.

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Table 8 illustrates the analysis of covariance (ANCOVA) of post-test results between treatments. The pre-test with F-value of 36.51 was used as covariate to statistically equate dissimilar prognostic variables that may have an effect on the analysis. In addition, the results specify that when looking for the significant difference between the post-test mean scores between the groups with the pre-test mean scores as covariates, the F-value between groups is .142 with a probability value of .708 ($p>0.05$) indicating no significant difference, thus failed to reject the null hypothesis. This implies that the experimental group with the mean scores of 52.45 perform better than the control group with the mean score of 51.95. However, the results show that there is no significant difference between the young adults' short-term memory recall who were exposed to caffeine and young adults' short-term memory recall who were not exposed to caffeine because post-test mean scores garnered of the two groups were found to be nearly the same.

This phenomenon was revealed in a study conducted by Heinzel et al. (2017), which found that a moderate amount of caffeine (100mg) had no significant effect on a short-term memory task, similar to the study conducted by Repantis et al, (2021), which argued that caffeine (300mg) had no significant effect on reaction times and memory performance when compared to performance of the no-caffeine group. Additionally, Foreman, Barraclough, Moore, Metha, and Madon (1989) involved 32 males in a free recall "supraspan" word list, which is a verbal memory task, and administered 0mg caffeine, 125mg caffeine, and 250mg caffeine. It was discovered that caffeine had no significant influence on the supraspan task in subjects who received varying amounts of caffeine [14]. Furthermore, Mitchell and Redman (1992) claimed that there is no significant difference in short-term memory recall performance between caffeine-exposed and non-caffeine-exposed individuals in a verbal memory test.

Conclusions

Based on the findings of the study, the following conclusions are drawn:

1. Those young adults perform poorly in short-term memory recall. Both the participants' pre-test mean scores were found to be below the expected short-term memory performance of young adults. As an outcome, the young adults' short-term memory recall was found to be below average before they were exposed to various conditions.
2. That giving the participants a bottle of 240 mL water resulted in a considerable improvement in their performance, notwithstanding the fact that it did not improve the general performance level of the control group. Thus, the effectiveness of such conditions had been recognized.
3. There was a considerable improvement in the performance of the young people when they were given a caffeinated drink. In particular, student performance has improved from borderline to below average.
4. That those young adults who had been exposed to caffeine performed better than those young adults who were given a bottle of water. Therefore, caffeine consumption has little effect on young people' short-term memory recall performance.

Recommendations

The researchers recommend the following for future researchers based on the analyzed findings:

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1. Before proceeding to the experiment, the subjects should first be asked about their preferred time to participate in the study. Hence, the more effective it is for the participants to recall the list of words that are asked for them to recall when they participate in this type of study during their preferred time of day or the wakefulness of the body in which they consume the caffeinated drink, also the more beneficial it is to the main objective of this study.
2. Second, this study used a small number of participants, which has an impact on external validity, and all individuals in the experimental group were given only moderate amount of caffeine. As a response, future studies will need to include a larger number of participants and different caffeine dosages for people of various ages. Future research should consider the effects of different ages and coffee doses on memory recall in different age groups.
3. Finally, this research should be conducted in a more controlled setting. Caffeine may have a bigger impact on participants' memory recall ability if they are in a quieter and more undisturbed environment. Furthermore, this study should be conducted in different areas in the Philippines to compare the difference in results, as there may be external factors that influence the participants' memory recall across geographical boundaries.

References

1. Adam, EJ, Nguyen AT, Cowan Theories of working memory: Differences in definition, A degree of modularity, role of attention, and purpose. Lang Speech Hear Serv Sch. 2018;49(3):340- 355. doi:10.1044/2018_LSHSS-17-0114
2. Adam, L. C., Repantis, D., Konrad, B. N., Dresler, M., Kühn, S. (2021). *Memory enhancement with stimulants: Differential neural effects of methylphenidate, modafinil, and caffeine.* A pilot study. Brain and Cognition, 154, 105802.
3. Addicott, M. A., Yang, L. L., Peiffer, A. M., Burnett, L. R., Burdette, J. H., Chen, M. Y., Laurienti, P. J. (2009). The effect of daily caffeine use on cerebral blood flow: How much caffeine can we tolerate?. Human brain mapping, 30(10), 3102-3114.
4. Amin, H. U., Saad, M. N., Malik, A. S. (2017). *The influences of emotion on learning and memory*. Frontiers in psychology, 8, 1454
5. Akomolafe, S. F. (2017). *The effects of caffeine, caffeic acid, and their combination on acetylcholinesterase, adenosine deaminase and arginase activities linked with brain function.* Journal of Food Biochemistry, 41(5), e12401.
6. Alzoubi, K. H., Mhaidat, N. M., Obaid, E. A., Khabour, O. F. (2018). *Caffeine prevents memory impairment induced by hyperhomocysteinemia.* Journal of molecular neuroscience, 66(2), 222-228.
7. Arieputri, V., Hanny, V., Kenji, N., & Permana, D. (2018, July). The Effect of Caffeine Consumption on Attention: An Experiment Conducted on Psychology Students in Indonesia. In Universitas Indonesia International Psychology Symposium for Undergraduate Research (UIPSUR 2017) (pp. 15-20). Atlantis Press.

ISSN 2450-2146 / E-ISSN 2451-1064

8. Baddeley, A. (2006). Working memory: An overview. Working memory and education, 1-31.
9. Balderston, N. L., Vytal, K. E., O'Connell, K., Torrisi, S., Letkiewicz, A., Ernst, M. (2017). *Anxiety patients show reduced working memory related dlPFC activation during safety and threat. Depress.* Anxiety 34, 25–36. doi: 10.1002/da.22518
10. Borella, E., Carretti, B., Sciore, R., Capotosto, E., Taconnat, L., & Cornoldi, C. (2017*). Training working memory in older adults: is there an advantage of using strategies?* Psychol. \ Aging 32, 178–191. doi: 10.1037/pag0000155
11. Chai WJ, Abd Hamid AI, Abdullah JM. Working memory from the psychological and neurosciences perspectives: A review. Front Psychol. 2018;9:401. doi:10.3389/fpsyg.2018.00401
12. Clark I, Landolt H.P. Coffee, caffeine, and sleep: A systematic review of epidemiological studies and randomized controlled trials. Sleep medicine reviews. 2017 Feb 1; 31:708. *Disclosure: some of HPL's research has been supported by Novartis Foundation for Medical-Biological Research.
13. Distelberg, B. J., Staack, A., Elsen, K. D. D., & Sabaté, J. (2017). The effect of coffee and caffeine on mood, sleep, and health-related quality of life. Journal of Caffeine Research, 7(2), 59-70.
14. Gavett, B. E., Gurnani, A. S., Saurman, J. L., Chapman, K. R., Steinberg, E. G., Martin, B., Stern, R. A. (2016). Practice effects on story memory and list learning tests in the neuropsychological assessment of older adults. PloS one, 11(10), e0164492.
15. Gabrish, D. L. (2017). Caffeine Use, Hours of Sleep, and Academic Performance of Undergraduate College Students (Doctoral dissertation, Kent State University).
16. Heck, D. H., Kozma, R., Kay, L. M. (2019). The rhythm of memory: how breathing shapes memory function. Journal of neurophysiology, 122(2), 563-571.
17. Haller, S., Montandon, M.-L., Rodriguez, C., Moser, D., Toma, S., & Hofmeister, J. (2017). Caffeine impact on working memory-related network activation patterns in early stages of cognitive decline. Neuroradiology 59, 387–395. doi: 10.1007/s00234-017-1803-5
18. Heinzel, S., Rimpel, J., Stelzel, C., Rapp, M. A. (2017). Transfer effects to a multimodal dual task after working memory training and associated neural correlates in older adults – a pilot study. Front. Hum. Neurosci. 11:85. doi: 10.3389/fnhum.2017.00085
19. Khosravizadeh, P., Gerami, S. (2010). Word List Recall in Youngsters and Older Adults. BRAIN. Broad Research in Artificial Intelligence and Neuroscience, 2(1), 5-10.
20. Kłopotek, N., Dmowski, P. (2022). Economic and Quality Determinants of Yerba Mate, Tea and Coffee Consumption. *Scientific Journal of Gdynia Maritime University*, (121), 53.
21. Lapac, J. N. T., Regalado, G. M., Dela Cruz, J. P. A., Valbuena, M. J. D. Effects of Amount of Caffeine Levels on the Test Score.
22. Lieberman, H. R. (2003). Nutrition, brain function and cognitive performance☆. Appetite, 40(3), 245-254.
23. Mayer, K., Haimes, E., Calhoun, J. (2018). The relationship between caffeine and short-term memory.
24. Mahoney, C. R., Giles, G. E., Marriott, B. P., Judelson, D. A., Glickman, E. L., Geiselman, P. J., Lieberman, H. R. (2019). Intake of caffeine from all sources and reasons for use by college students. Clinical nutrition, 38(2), 668-675.
25. McLellan, T. M., Caldwell, J. A., Lieberman, H. R. (2016). A review of caffeine's effects on cognitive, physical and occupational performance. Neuroscience & Biobehavioral Reviews, 71, 294-312.

ISSN 2450-2146 / E-ISSN 2451-1064

DOI 10.5281/zenodo.7182609

26. Mishra, P., Singh, U., Pandey, C. M., Mishra, P., Pandey, G. (2019). Application of student's t-test, analysis of variance, and covariance. Annals of cardiac anaesthesia, 22(4), 407.
27. Nehlig, A. (2016). Effects of coffee/caffeine on brain health and disease: What should I tell my patients?. Practical neurology, 16(2), 89-95.
28. Nissim, N. R., O'Shea, A. M., Bryant, V., Porges, E. C., Cohen, R., Woods, A. J. (2017). Frontal structural neural correlates of working memory performance in older adults. Front. Aging Neurosis. 8:328. doi: 10.3389/fnagi.2016.00328
29. Oren, N., Ash, E. L., Tarrasch, R., Hendler, T., Giladi, N., Shapira-Lichter, I. (2017). Neural patterns underlying the effect of negative distractors on working memory in older adults. Neurobiol. Aging 53, 93–102. doi: 10.1016/j.neurobiolaging.2017.01.020
30. Ran, L. S., Liu, W. H., Fang, Y. Y., Xu, S. B., Li, J., Luo, X., Wang, W. (2021). Alcohol, coffee and tea intake and the risk of cognitive deficits: a dose–response meta-analysis. Epidemiology and psychiatric sciences, 30.
31. Repantis, D., Bovy, L., Ohla, K., Kühn, S., & Dresler, M. (2021). Cognitive enhancement effects of stimulants: a randomized controlled trial testing methylphenidate, modafinil, and caffeine. Psychopharmacology, 238(2), 441-451.
32. Rieck, J. R., Rodrigue, K. M., Boylan, M. A., Kennedy, K. M. (2017). Age-related reduction of BOLD modulation to cognitive difficulty predicts poorer task accuracy and poorer fluid reasoning ability. Neuroimage 147, 262–271. doi: 10.1016/j.neuroimage.2016.12.022
33. Schouten, M. A., Tappi, S., Romani, S. (2020). Acrylamide in coffee: formation and possible mitigation strategies–a review. *Critical reviews in food science and nutrition*, 60(22), 3807-3821.
34. Sherman, S. M., Buckley, T. P., Baena, E., Ryan, L. (2016). Caffeine enhances memory performance in young adults during their non-optimal time of day. *Frontiers in psychology*, 7, 1764.
35. Smith, B.D., Gupta, U., and Gupta, B.S. (2007). *Caffeine and activation theory.*
36. Terry, W. S., Phifer, B. (1986). Caffeine and memory performance on the AVLT. *Journal of clinical psychology*, 42(6), 860-863.
37. Thomas, G. (2021). How to do your case study. How to Do Your Case Study, 1-320.
38. Trautmann, C., Burek, D., Hübner, C. A., Girault, J. A., Engmann, O. (2020). A regulatory pathway linking caffeine action, mood and the diurnal clock. *Neuropharmacology*, 172, 108133.
39. Van Duinen, H., Lorist, M. M., Zijdewind, I. (2005). The effect of caffeine on cognitive task performance and motor fatigue. Psychopharmacology, 180(3), 539-547.
40. Wadsworth, W. (2020). Ebbinghaus' Forgetting Curve Explained: The Importance of Spaced Learning for Memory.
41. Walker, J. (2022). Coffee in Recovery Lessons in policymaking and collaboration from Puerto Rico's coffee sector post-Hurricane Maria. Blog IICA.
42. Wu, L., Sun, D., He, Y. (2017). Coffee intake and the incident risk of cognitive disorders: A dose– response meta-analysis of nine prospective cohort studies. *Clinical nutrition*, 36(3), 730- 736.
43. Yeomans, M. R. (2010). Short term effects of alcohol on appetite in humans. Effects of context and restrained eating. Appetite, 55(3), 565-573.
44. Yoo, H., Goncharenko, I., Gu, Y. (2020). Does Caffeine Cause Effect on Short-term Memory? In IICST (pp. 1-6).
45. Zhang, R.C., Madan, C. R. (2021). How does caffeine influence memory? Drug, experimental, and demographic factors. *Neuroscience & Biobehavioral Reviews*, 131, 525-538.

ISSN 2450-2146 / E-ISSN 2451-1064

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International Journal of New Economics and Social Sciences 1 (15) 2022: 267 - 288
DOI 10.5281/zenodo.7182609

46. Zelano, C (2016) Nasal Respiration Entrails Human Limbic Oscillations and Modulates Cognitive Function. Retrieved from -https://jneurosci.org/content/36/49/12448- November 28, 2021
47. Zelano, C., Jiang, H., Zhou, G., Arora, N., Schuele, S., Rosenow, J., Gottfried, J. A. (2016). *Nasal respiration entrains human limbic oscillations and modulates cognitive function.* Journal of Neuroscience, 36(49), 12448-12467.
48. Zlotnik G., Vansintjan A (2019) *Memory: An Extended Definition.* Front. Psychol.10:2523.doi: 10.3389/fpsyg.2019.02523

ISSN 2450-2146 / E-ISSN 2451-1064

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