A Clinical Study on the Effects of Vodka, Caffeine Tablets, and Reefers to Memory on Working-Age Islander Males

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1 Abstract

The impact and influence of psychoactive substances to human cognition, particularly memory, has been of interest to scientific inquiry. With numerous substances impacting the lifestyles of virtually all working individuals around the world, experiments and studies help us understand cognitive influences further. In our study, we experiment with three substances: 100 mg caffeine tablets, 30 mL vodka shots, and reefers among 36 randomly selected working-age males in the city of Hofn. Our repeated measures design experiment where each male is subject to one substance through multiple treatments allow us to identify how these particular substances affect the memory over a span of one hour. With the results of the data of our experiment, we are able to identify the quantitative impact to memory cognition these substances cause, providing valuable insights to the ongoing discourse on psychoactive substances.

2 Introduction

Around the world, it is a common societal observation that humans are reliant on psychoactive stimulants and are growing to incorporate these more and more to their everyday lives. Based on the provided research topics provided for Island Environment Study, we were particularly interested by Topic #30, concerning the effects of coffee, alcohol, and reefer on short-term memory.

Caffeinated coffees, alcohol, cannabis, and amphetamines are just a few that humans resort to for variety of purposes including energy boost, increased mood, stress and pain relief, and focus. As the prevalence of these substances increase and dependency grows, people begin to question and wonder about the impacts to one's health, including both physiological and psychological elements. Particularly pertaining to the cognitive elements, the retention of memory is of particular interest in determining the effects of these stimulants.

Majority of people rely on caffeine in their everyday lives. It is the most widely used psychoactive substance in the world, with greater than 80% resorting to it in some way in the Western society. Research has determined that in terms of cognitive function, caffeine has the same impact as that of cocaine, in relation to mechanisms of action, increasing the circulation of cortisol and adrenaline in the body, to increase activity in the brain and nervous system. One of the many phenomenons that instill curiosity in researchers is the effect on how caffeine impacts memory and the retention of information collected short-term versus long-term. There aren't the most conclusive results from such questions, and we hope that our particular research into the males affected by caffeine in Hofn will provide us more of a clarified understanding of such effects.

In addition to caffeine being a psychoactive drug, there are other kinds of drugs that people resort to for a variety of reasons. Studies have shown that reefer (marijuana) and alcohol are the most common substances in the rising generations in adolescence that are used for pain relief, comfort, and leisure. Reefers and alcohol are considered depressant drugs, meaning that they suppress and prevent the brain's ability to function normally. Their long term effects include those that impact the macro-structural integrity of the brain, including volume and cortical thickness. Similar to how researchers are interested in the correlation between caffeine and memory retention, the same applies to these depressants. Studies have alluded that alcohol primarily disrupts the brain to form new long-term memories as well as the ability to keep new information active in short-term memory for at least a few seconds. In addition, the use of marijuana has also provided the same conclusions, as tetrahydrocannabinol (THC) in marijuana alters the hippocampus, which is the area in the brain responsible for memory formation and processing. Our research here then is to determine how alcohol (in this study, one 30ML shot of vodka) and one marijuana cigarette (as mentioned here as "reefer") impacts the memory retention of cards through a repeated measures experimented within a 1 hour experimentation window.

In our study, we apply our current understandings of what is already known about the impact of these psychoactive substances and narrowed our substances to 100 mg caffeine tablets, 30 mL vodka shots, and reefers to pinpoint particular effects of these varieties of drugs (including those classified depressant vs

stimulants) among working-age islander males in order to best aim to identify cognitive functions' impacts on such substances.

3 Methods & Procedures

3.1 Participants

This experiment will solely focus on the islanders residing in the city of Hofn. We divided the total number of houses (in Hofn) into 36 equal groups and randomly selected one house from each group. If the selected house had a willing participant that fit our design criteria, then that participant was chosen. Otherwise, we randomly selected a different house (within that same group) and repeated the process until we had all 36 participants.

3.2 Design

Since each subject will be measured four times, we will be using a repeated measures design. Our design parameters are as follows:

- Response variable: the results of the Memory Game (in seconds)
- Between-block factor: Substance (Caffeine, Alcohol, Reefer)
- Within-block factor: Time (pre-intake, after 20 minutes, after 40 minutes, after 1 hour)
- Blocking: Islanders (due to their variability)
- Interaction: Substance & Time
- Held-constant factors: Age Group (18-45), Gender (Male), Place of Residence (Hofn)

Below is our detailed factor diagram:

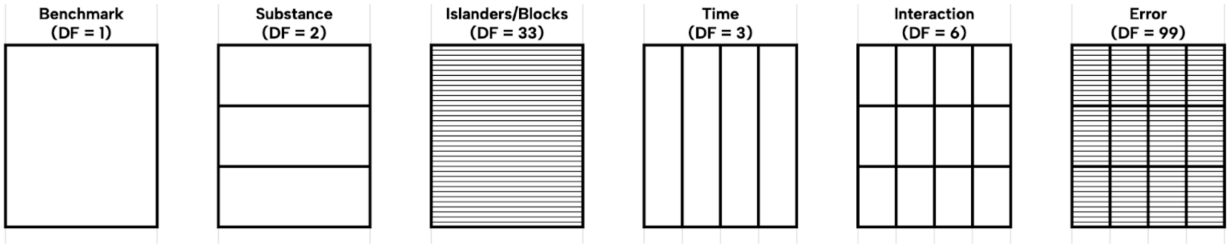

Figure 1: Factor Diagram for Experiment

3.3 Measurements

Each participant is asked to complete the "memory game" four times. For every instance of a "memory game", the participant is shown 30 cards (randomly placed in a grid) with each card containing one image. There will be 15 pairs of images in total. Then, the cards are flipped so that the participant can no longer see the images. At this point, we begin the timer, and ask the participant to flip over two cards at a time to see if they are a matching pair. If it is a matching pair, those cards will stay flipped over; if not, the participant must flip them back and continue with their search. The timer stops once the participant has located all 15 pairs.

3.4 Procedure

Step 1: Find 36 willing participants from the city of Hofn. (For sampling details, refer to *Section 3.1: Participants*).

Step 2: Randomly divide these participants into 3 groups. Each group will be assigned to one of the following three substances:

1. Caffeine Tablet 100mg
2. 30 mL Vodka
3. Reefer

Step 3: For each participant, have them complete a memory game before taking any substances.

Step 4: For each participant, provide them with the substance that they were assigned to.

Step 5: After 20 minutes, have each participant complete a memory game again.

Step 6: Repeat **Step 5** but after 40 minutes and after an hour from the initial substance intake.

4 Data Analysis

4.1 Type of Statistical Analysis

We will fit an "effects model" to our data since we want to compare the effects of each factor level. After doing so, we will conduct a statistical analysis using the ANOVA (Analysis of Variance) summary table to see which factors are found to be significant. As part of a repeated measures design, we will consider the participants to be our "Error" term within the model. In addition, we will perform post-hoc tests, conducting ANOVA on each substance to further evaluate their significance.

4.2 Sample Size Determination

Typically, the benchmark value for statistical power is 0.8; however, for our experiment, we decided to use a power of 0.9, hoping for a more robust result. Our alpha level was set to be 0.05 and our effect size was set to 0.5. Since we are considering the between-block factors, the number of groups was set to 3 (indicating the three types of substances). The number of measurements was set to 4, and lastly, the correlation among repeated measures was simply set to the default value of 0.5. Using G*Power, we obtained a total sample size of 36, and this led us to have a balanced design where 12 islanders are assigned to each substance (See **Figure 2** on next page for the G*Power output).

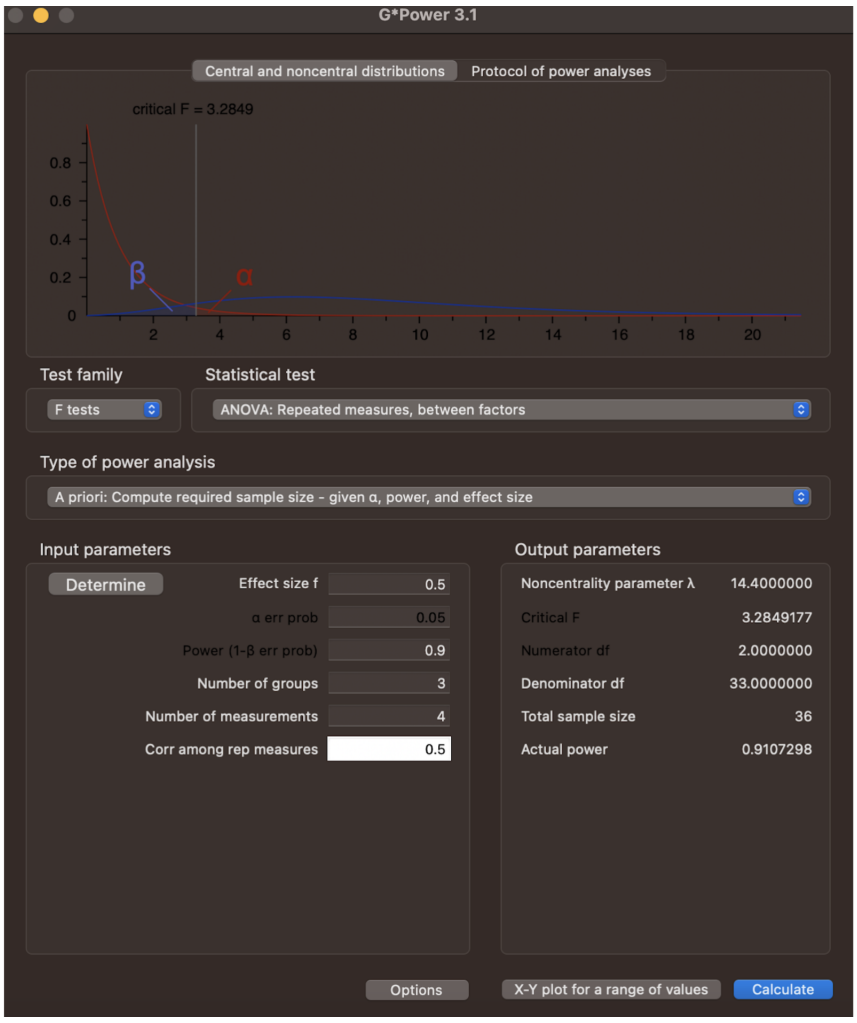

Figure 2: G*Power Output to Determine Sample Size

5 Results

5.1 ANOVA Analysis for Repeated Measures

	Df	Sum Sq	Mean Sq	F value	Pr(>5)
Error: factor(Subject)					
Substance	2	1479	739.5	0.527	0.595
Residuals	33	46318	1403.6		
Error: Within					
Time	3	38.5	12.84	0.701	0.554
Substance:Time	6	81.7	13.61	0.743	0.616
Residuals	99	1813.9	18.32		

Table 1: Repeated Measures Between Factor ANOVA Analysis

For the between-factor ANOVA Analysis depicted in **Table 1**, Substance shows a p-value of 0.595, suggesting that there is no statistically significant effect between different substances on changes in short-term memory. For the within-factor ANOVA Analysis shows that Time had a p-value of 0.554, suggesting that there was no significant difference in mean score between times (0 minutes, 20 minutes, 40 minutes, and 60 minutes). Additionally, the p-value for the interaction between Substance and Time was 0.616, suggesting that changes in score for each time were not affected differently based on the substance consumed. Overall,

our analysis suggests that caffeine, alcohol, and reefers do not significantly affect short-term memory from the time of consumption of the substance to the time it is metabolized.

5.2 Post-Hoc ANOVA Analysis for Each Substance

	Df	Sum Sq	Mean Sq	F value	Pr(>5)
Error: factor(Subject)					
Residuals	11	18085	1644		
Error: Within					
Time	3	37.9	12.63	0.689	0.565
Residuals	33	604.7	18.32		

Table 2: Post-Hoc ANOVA Analysis for Alcohol

	Df	Sum Sq	Mean Sq	F value	Pr(>5)
Error: factor(Subject)					
Residuals	11	16005	1455		
Error: Within					
Time	3	29.0	9.676	0.419	0.74
Residuals	33	761.8	23.084		

Table 3: Post-Hoc ANOVA Analysis for Caffeine

	Df	Sum Sq	Mean Sq	F value	Pr(>5)
Error: factor(Subject)					
Residuals	11	12228	1112		
Error: Within					
Time	3	53.3	17.76	1.31	0.288
Residuals	33	447.4	13.56		

Table 4: Post-Hoc ANOVA Analysis for Reefer

Using three Repeated Measures ANOVA analyses, as seen in **Table 2**, **Table 3**, and **Table 4**, each consisting of one substance, result in a Within Factors p-value of 0.565 for alcohol, 0.74 for caffeine, and 0.288 for Reefers. None of the substances showed any statistically significant change across times of measurement with a significance level of $\alpha = 0.05$.

5.3 Residual Diagnostics

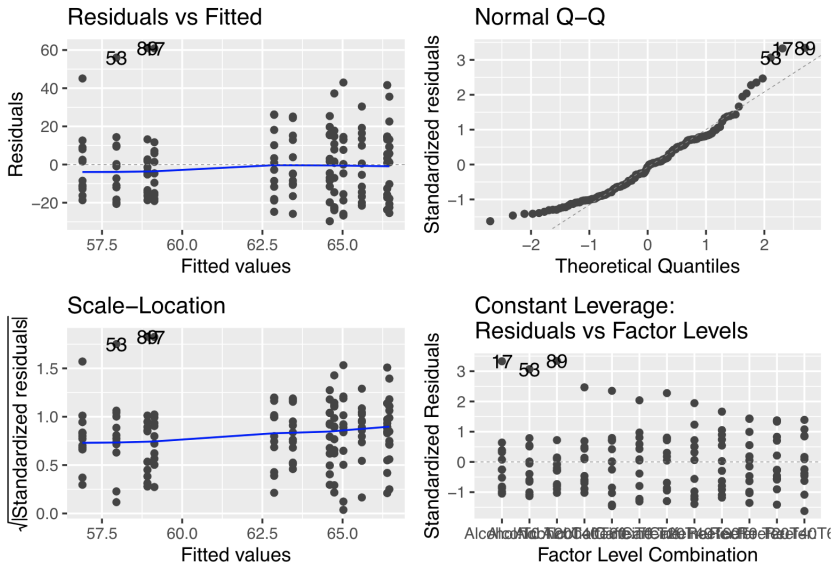

Figure 3: Summary Diagnostic Plots of Residuals for ANOVA Results (Fitted)

The residual plot shows random and normally distributed residual points, fulfilling the normality of errors and the constant variance assumptions. The Q-Q plot shows a slight right skew, suggesting that there are a few high outliers. The leverage plot also confirms that there are several outliers.

5.4 Interaction Plots

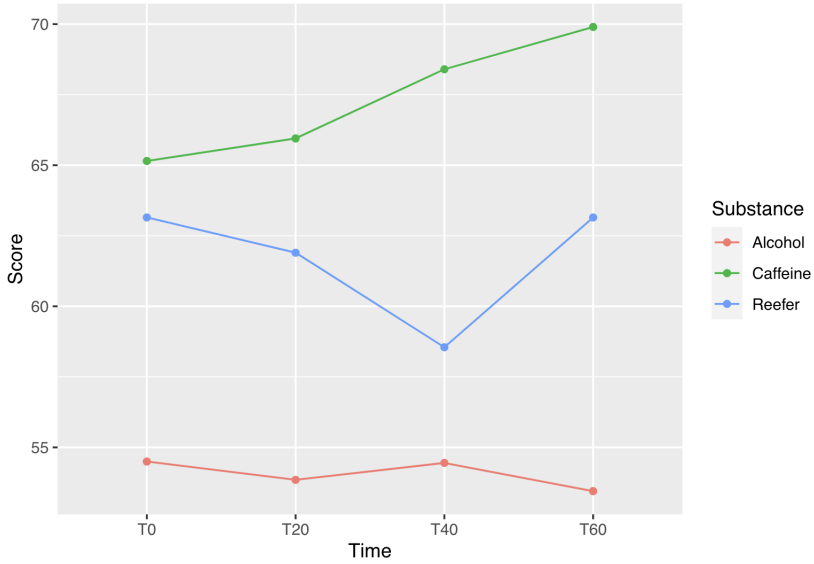

Figure 4: Interaction Plot of Substances and Time

The lines of the interaction plot are not parallel, so there is some interaction between substances and time. However, within the time frame that we recorded measurements, there are no points of intersection, which could be due to the difference in mean scores of the first measurement (the control). It could be due to a weak interaction effect, which is especially apparent between alcohol and reefers.

5.5 Box Plots

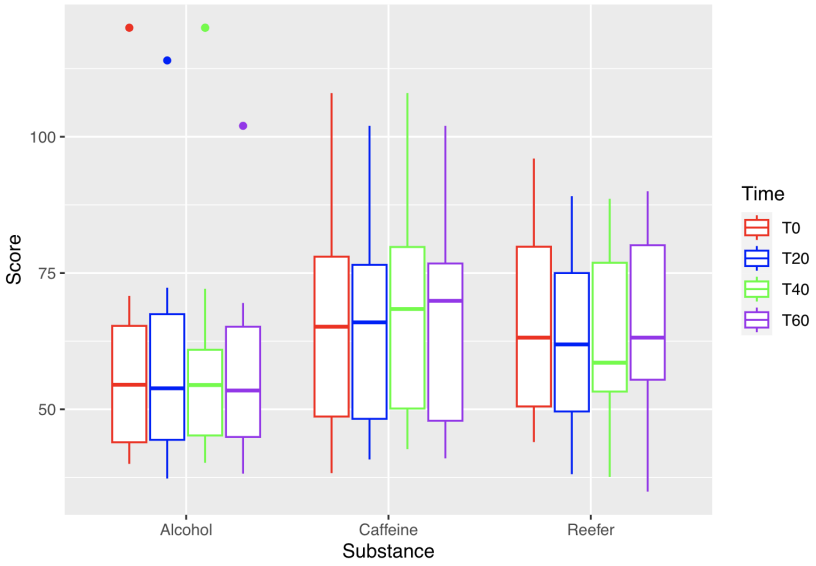

Figure 5: Boxplot of Time Against Substance

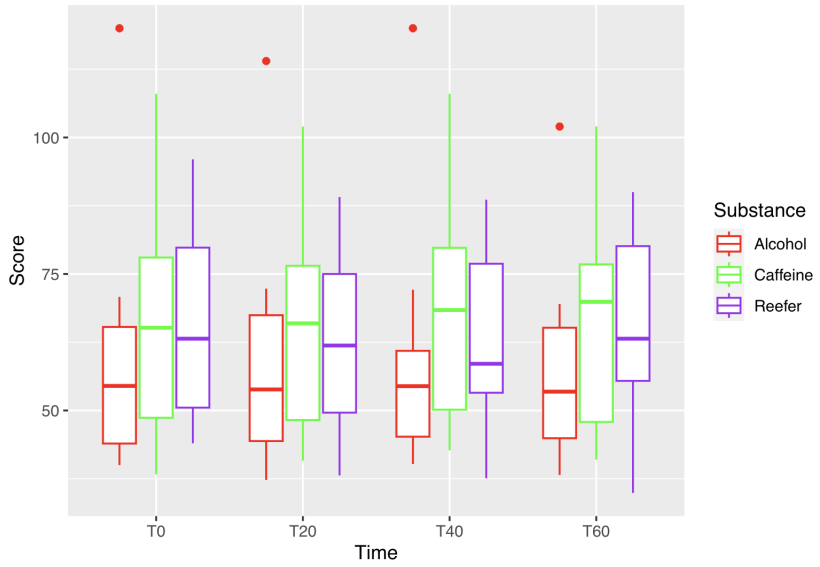

Figure 6: Boxplot of Substance Against Time

Figure 5 groups the data by substance and compares the box plots of different times. Clearly, the box plots look similar to each other, displaying similar medians and interquartile ranges across all the substances. Alcohol displayed similar median scores for each of the four measurements. Caffeine displayed a rising median score for each measurement. Reefers generally had a similar median, except for the third measurement, which is much lower than the other measurements.

Figure 6 groups the data by time and compares the box plots of different substances. It shows how different the data of each substance was from each other. Alcohol's median scores are consistently below the medians for caffeine and reefers while Caffeine's median scores are consistently above the median of both.

6 Discussion

The purpose of our study was to determine the effects of various psychoactive substances (caffeine, alcohol, and reefer) on our short-term memory. We used a repeated measures experimental design in order to determine whether or not the aforementioned substances or time after consumption would affect short-term memory.

After collecting the data, our ANOVA analysis showed that neither time, substance, nor their interaction were statistically significant. This result is consistent with our post-hoc analysis, which grouped the data by substance. This surprised us as we had expected some statistically significant effect from either time or substance. Regarding potential future studies, a control group should be established in addition to the three groups tested.

From the interaction plot, we see that none of the lines are parallel, indicating partial interaction between the type of substance and time. However, there are also no intersections, most likely meaning that there is a very weak interaction effect or the median scores in the beginning were too far apart. More data and a higher frequency of measurements are likely needed to confirm an interaction.

Looking at **Figure 5**, it is evident that time does appear to not be a significant factor since boxplots are all similar for any given substance. This is less evident when looking at the substances, as there appears to be more variability between them. While caffeine and reefer have similar median scores for all of their times, alcohol shows a lower mean score for any given time. Alcohol is also the least variable, though it has the most outliers out of the three substances. Overall, our boxplots support our conclusion that time and

type of substance are not significant factors in short-term memory.

Our experimental design had some limitations that can be improved upon. Firstly, we had no control group to determine whether psychoactive substances had any effect on short-term memory. We had chosen to not record the scores for the memory game right after they consumed the substance since the substances required time to be metabolized by the body. Our analysis shows that the type of substance that was ingested had no effect on the results of the memory game. However, since there was considerable variation between the control groups of different substances, it was not particularly helpful in determining whether or not the three psychoactive substances have any effect at all on short-term memory. The doses that were given (100mg of caffeine, 30mL of vodka, and reefers without a set measurement) were likely too low to make a considerable difference in the scores, since the body had metabolized a large portion of the substance after one hour. Because of this, the effects of the substances were mild at best in the subjects. Additionally, people were of different weights, which meant that heavier people would feel the effects less than lighter people. People also metabolize alcohol at different rates, so it may be helpful to test for blood alcohol content. In future experiments, we likely would increase the dosage and consumption of each substance to future see if substance and time were consistent. We would also test for the amount of the substance in the body.

In addition to this, the time of day was not controlled, though it is unlikely that this is a potential factor as all the participants were tested midday. The previous fact also somewhat mitigates another potential confounding variable of the participants' hunger level. Due to the time of day at which the participants were tested, it is unlikely that they had either too much or too little food in their stomachs at the time of the experiment. Moving forward, the time of day should be another factor in addition to gender that should be controlled in order to truly determine if they are non-factors.

7 Resources

1. Daly, J W et al. "Ar koffein beroendeframkallande? Världens mest nyttjade psykoaktiva substans påverkar samma delar av hjärnan som kokain" [Is caffeine addictive? The most widely used psychoactive substance in the world affects same parts of the brain as cocaine]. *Lakartidningen* vol. 95,51-52 (1998): 5878-83.

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