A Clinical Study on the Island to Find the Effects of Physical Activity on Short-Term Memory Recall

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Abstract

Naps are extremely popular among people looking to prolong their alertness throughout their day, as many believe that such naps can boost their short-term capabilities. However, an increasing reliance on naps as a cognitive function enhancer raises questions regarding the optimal duration for napping. We want to know if there is such a thing as "too long" of a nap, and whether performing physical activities other than napping can potentially benefit short-term memory. Thus, our study aims to determine which physical activity is the most effective in boosting short-term memory. The experimental design we chose is a two-way ANOVA with a blocking factor of age. We selected 162 participants based on multistage random sampling and randomly assigned them to 9 different treatment groups based on the physical activities. The participants were divided into a young age group (18-30), a middle age group (31-45), and an old age group (46+). To collect our data, we asked participants to perform the assigned physical activity for a certain amount of time, then we conducted a memory game and recorded how well their memory recall was.

Introduction

According to the CDC, more than a third of U.S. adults are getting below the required amount of sleep on an extended basis. People who consistently do not get a sufficient amount of sleep are more likely to experience disease and negative health outcomes, such as obesity, diabetes, heart disease, and mental distress. Furthermore, chronic lack of sleep often leaves people feeling foggy. A large reason for this phenomenon has to do with a slowing of the brain's thought process and a severely diminished memory.

Naps are an extremely common way people attempt to remedy their sleep deprived state and increase alertness. With the large student population in the U.S., napping is an essential part of the day to be able to perform at one's best. In fact, studies have shown

that more than three quarters of adults in the United States have taken a nap within the last three months.

Therefore, our experimental study aims to answer the question: Is napping effective to increase memory recall in adults over the age of 18? This paper explores the possibility that other activities, such as taking a calming walk outside or simply lounging around and watching TV may have an impact on memory. In order to pinpoint the best possible course of action, these activities were studied in three different durations; 0 minutes, 30 minutes, and 60 minutes. Our assertion is a long nap (nearing an hour) will have the greatest impact on the memory recall of individuals.

Methods

Participants

Using the statistical software G-Power, we determined that 162 participants would be included in our experiment. The subjects for this study were pulled from the *Island*, a virtual population of characters that are modeled to represent the behaviors and reactions of actual human beings. Due to logistical challenges stemming from using this source, a multi-stage random sample was employed in order to get an accurate representation of the *Island*'s population. The first stage of our sampling involved choosing 10 of the largest cities to be randomly selected from. In the next stage, a home is randomly selected from the chosen city. Then, in the final stage, an individual in the chosen home meeting our minimum age (18+) is randomly selected.

Design

The design of our study is a Two-Way Factorial design. The treatment groups are combinations of activity (relaxing walk outdoors, napping, watching television) and duration of activity (0, 30, 60).

Factor	Treatment Groups		
type of activity	napping	relaxing walk outdoors	watch television
time period	0 mins	30 mins	60 mins
blocking (age in years)	18-30	31-45	46+

Figure 1. Treatment group diagram

The following is the factor diagram:

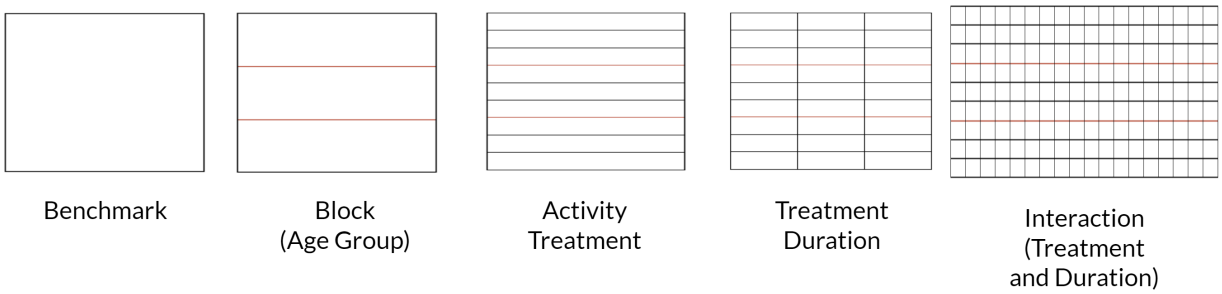


Figure 2. Factor Diagram for two-way factorial design with blocking

$df_{benchmark} = 1$

$df_{block} = 2$

$df_{activity} = 2$

$df_{duration} = 2$

$df_{interaction} = 4$

We decided to block based on age due to the considerable variation in memory recall attributed to age. The different activities assigned to the participants aim to determine the best course of action to improve cognition in a mid-day setting. Since these activities could have different effects based on their duration (such as a short period of grogginess after a

long nap Lovato and Lack (2010)), we have different duration groups as well.

Instruments

Cognitive function in the Islanders will be measured with a "Memory Game" in which they are timed in their ability to remember flashcards. We chose to perform the test at varying times after the treatment was administered (immediately after watching TV and taking a walk outdoors and ~30 minutes after waking up from the nap). This is based on when the literature says the potential positive effects take effect, Lambourne and Tomporowski (2010) and Lovato and Lack (2010). Choosing the durations of 30 and 60 minutes allowed us to keep consistency between the different activities.

Procedure

Step 1: Perform multistage "random" sampling of the Islanders:

1.) Randomly select a city out of the 10 most populated cities on the Island

2.) Randomly select a home in the chosen city

3.) Randomly select an individual in the chosen home, given they meet the minimum age requirement

4.) Add the subject to the experimental study if they consent

Step 2: For each Islander chosen to take part in the experiment, randomly assign treatments and durations such that the design is balanced.

Step 3: Administer the treatment for each islander.

Step 4: After the predetermined amount of time after the Islander completes the activity (immediately for TV and relaxing walk outside groups and ~30 minutes later for the napping group), have the Islanders perform the memory game.

Step 5: Record the times for each Islanders once they complete the game.

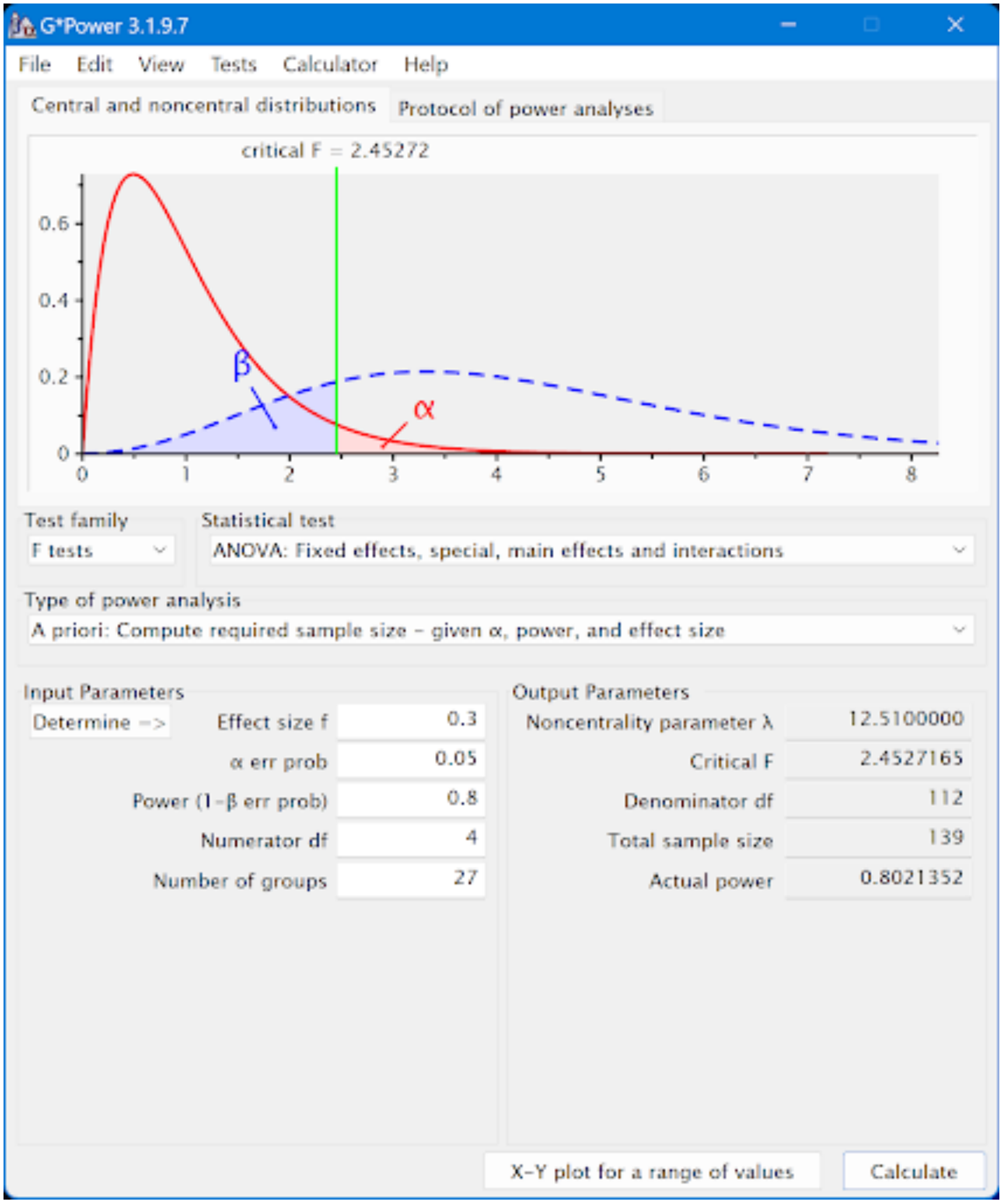
Data Analysis

Method of Data Analysis

Using the statistical programming language R, we will perform an ANOVA on the memory game times received from the Islanders. We plan to test whether or not the treatment, duration, the interaction between treatments and duration, or age are significant factors in producing different memory game scores in the *Island* environment.

Sample Size Determination

Our design uses a power of 0.8, meaning if there truly is a relationship between the factors and the response with the memory game, we have a high probability of detecting it. Our significance level of 0.05 also ensures that there is a low risk of falsely determining that there is a relationship between the factors and the response. Our effect size of 0.3 is positioned in between a 'medium' and 'high' value, meaning that the factors will have a substantial strength. With G-Power, we determined that 139 subjects had to be included in this study. In order to ensure a balanced design with an equal number of subjects in each of the 9 treatment groups and the 3 blocking groups, we rounded up to a total of 162 participants.



130

131 *Figure 3. Sample size determination using G-Power for two-way factorial design with*

132 *blocking*

Results

Interaction Plot

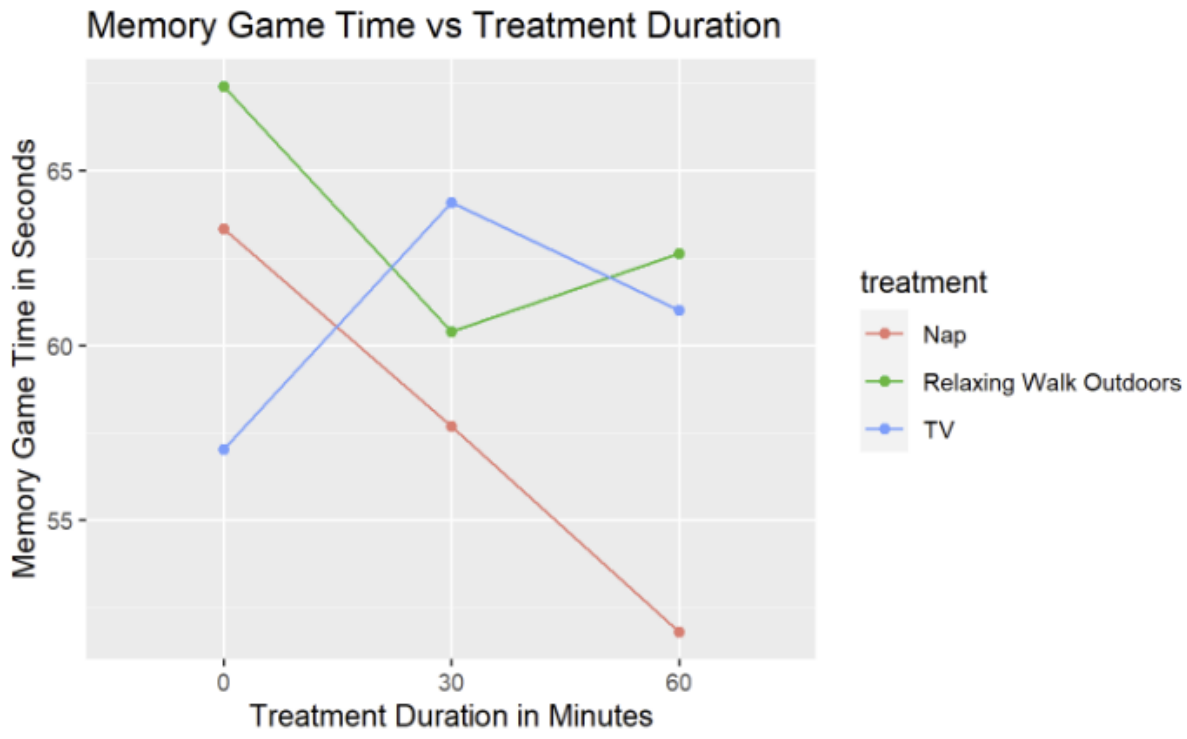


Figure 4. The interaction plot above appears to suggest there is a relationship between treatment and memory game scores. Other than the control groups, the napping treatment consistently had the lowest times, indicating the best memory recall. Additionally, along with the watching TV group, a longer duration appears to improve the Islanders' performance at the memory game. However, it is important to note that any potential pattern that appears to exist may likely be exaggerated by the relatively small range of times on the y-axis.

Box Plots

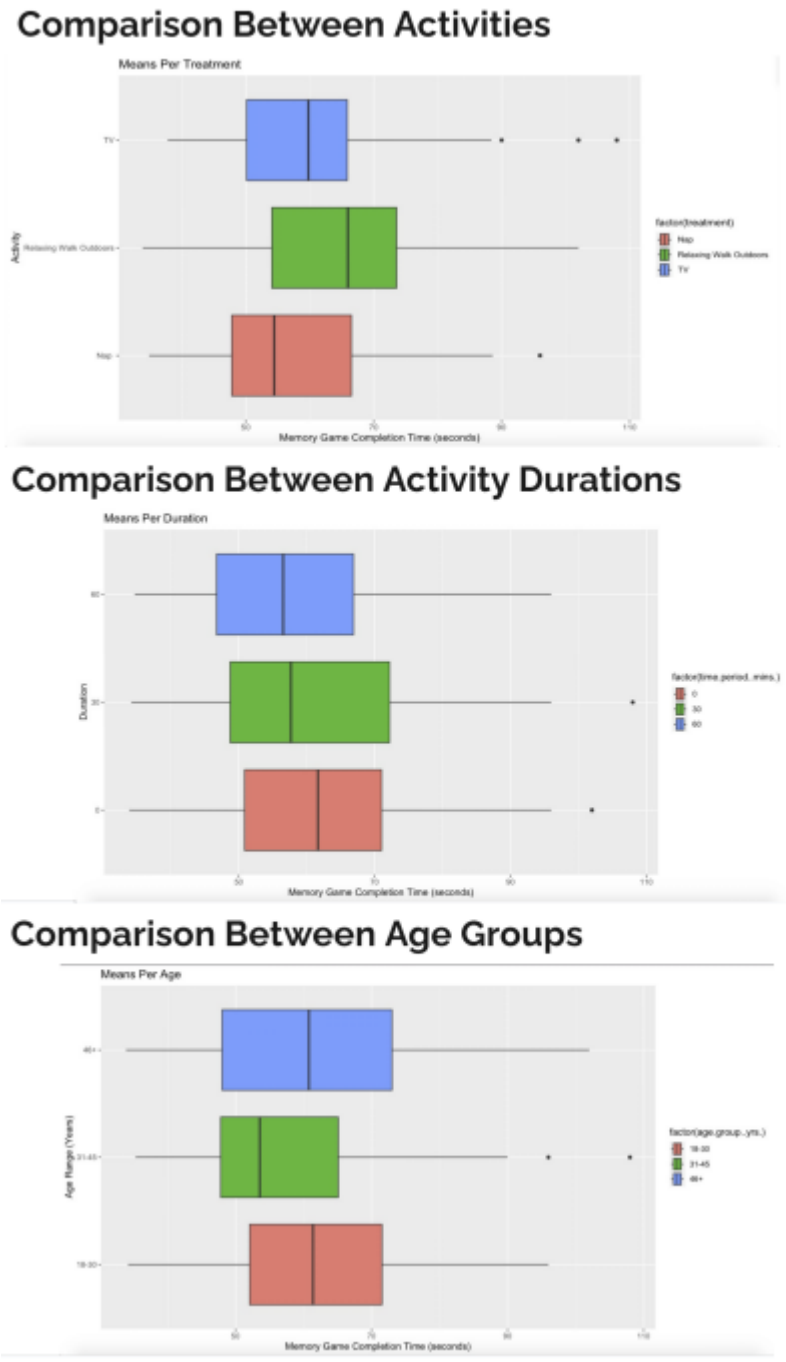


Figure 5. Box plots comparing activities, durations, and age groups respectively. The visualization of the data into box plots shows that there is not much of a noticeable variation in group medians or IQR. This calls into question whether or not there is a significant effect on memory recall by any of the factors. Napping appears to have the

lowest times as a group, however it is much too close to the other groups to say for certain whether or not there is any significant difference.

ANOVA Table

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Activity	2	927	463.7	2.029	0.135
Duration	2	456	228.2	0.998	0.371
Age Group	2	759	379.3	1.660	0.194
Activity:Duration	4	1627	406.7	1.780	0.136
Residuals	151	34505	228.5		

Table 1. Two way factorial design with blocking for age. None of the above p-values for each factor is significant. However, most of the p-values are below the 0.20 mark. Ultimately, we have no evidence to suggest there is a relationship between age, activity, duration, or their interaction and memory recall in the Islanders.

Model Diagnostics

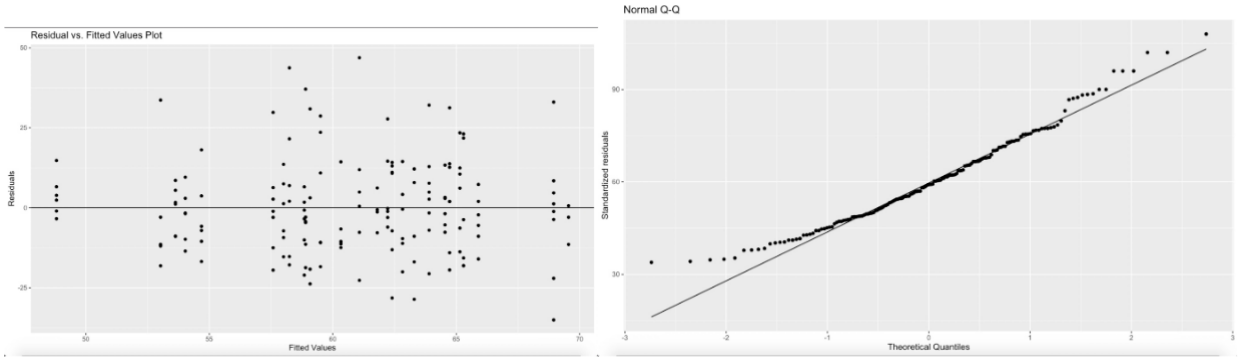


Figure 6. The residual plot shows a constant variance along the fitted values. There also appears to be a lack of any distinguishable pattern, supporting the assumption that this model is valid. The Normal Q-Q plot also appears to roughly follow a straight line,

indicating that the error term is normally distributed. However, there may be a slight skew present.

Reduced Models

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
factor(treatment)	2	927	463.7	1.981	0.141
factor(age.group..yrs.)	2	698	348.8	1.490	0.229
factor(treatment):factor(age.group..yrs.)	4	835	208.7	0.892	0.470
Residuals	153	35814	234.1		

Table 2. This reduced ANOVA model with the duration factor does not result in a better model. Each factor increases in p-value in this new alternate model.

Discussion

Our study attempted to determine whether or not certain physical activities, such as napping and walking outside in a relaxing environment had an effect on memory recall of people in the *Island*. The study attempted to push back on the idea that simply relaxing is the most optimal way of increasing one's alertness during the day.

In order to produce a study with a power of 0.8 and a significance level of 0.05 with an effect size of 0.3, we determined that we would have to sample 139 Islanders at minimum. However, in order to maintain a balanced design between the 9 treatment groups and the three blocking groups, we decided to sample 162. Initially, there were some promising trends found in the interaction plot, with the napping group having the lowest memory game times (especially with the 60 minute duration group). However, interaction plots may be misleading depending on the scale of the y-axis. Ultimately, an ANOVA of the data showed that there were no significant factors relating to the memory game times.

Furthermore, when inspecting the box plots of the data, there appears to be very little variation in the different treatment groups. The napping group had the lower median time, but the close proximity of the distributions prevents leaves us with no evidence of a

conclusive difference.

Additionally, a proposed reduced model that removed the duration factor resulted in a lesser model with lower p-values for each remaining factor. Despite the lack of a significant relationship between the factors and the memory scores, it is important to acknowledge the shortcomings of this study. First and foremost, this study used raw memory game times as a response variable instead of taking the difference of a before and after time. This approach may have been beneficial in offsetting variations from person to person. Additionally, sampling from the *Island* makes it nearly impossible to have a truly random group of subjects. The *Island* also limits the ability for researchers to compare certain treatments, as many possible treatments can only be done with one or two durations that may not line up with each other. Another aspect of this study to look at is our sampling demographics. We attempted to study both males and females, adults of all ages above 18, and Islanders from multiple regions. In retrospect, this may have been too much of an undertaking, and our study may have been better off studying a smaller subsection of the population.

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