

LOSING SLEEP:
A PRELIMINARY INVESTIGATION OF THE COGNITIVE EFFECTS THAT ARISE
FROM POLYPHASIC SLEEP CYCLES

BY
TAYLOR STEPHEN SMYTH

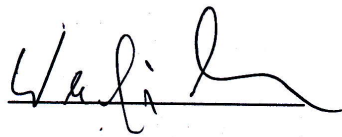
A Thesis Submitted to the Honors College
In Partial Fulfillment of the Bachelors Degree

With Honors in
Biology

THE UNIVERSITY OF ARIZONA

MAY 2013

Approved by:



Dr Wulfila Gronenberg

Department of Neuroscience

**The University of Arizona Electronic Theses and Dissertations
Reproduction and Distribution Rights Form**

The UA Campus Repository supports the dissemination and preservation of scholarship produced by University of Arizona faculty, researchers, and students. The University Library, in collaboration with the Honors College, has established a collection in the UA Campus Repository to share, archive, and preserve undergraduate Honors theses.

Theses that are submitted to the UA Campus Repository are available for public view. Submission of your thesis to the Repository provides an opportunity for you to showcase your work to graduate schools and future employers. It also allows for your work to be accessed by others in your discipline, enabling you to contribute to the knowledge base in your field. Your signature on this consent form will determine whether your thesis is included in the repository.

Name (Last, First, Middle) Smyth, Taylor, Stephen	
Degree title (eg BA, BS, BSE, BSB, BFA): BS	
Honors area (eg Molecular and Cellular Biology, English, Studio Art): Biology	
Date thesis submitted to Honors College: 4-18-2013	
Title of Honors thesis: Losing Sleep: A Preliminary Investigation of the Cognitive Effects ^{that Arise From} Polyphasic Sleep _{Cycles}	
The University of Arizona Library Release Agreement <p>I hereby grant to the University of Arizona Library the nonexclusive worldwide right to reproduce and distribute my dissertation or thesis and abstract (herein, the "licensed materials"), in whole or in part, in any and all media of distribution and in any format in existence now or developed in the future. I represent and warrant to the University of Arizona that the licensed materials are my original work, that I am the sole owner of all rights in and to the licensed materials, and that none of the licensed materials infringe or violate the rights of others. I further represent that I have obtained all necessary rights to permit the University of Arizona Library to reproduce and distribute any nonpublic third party software necessary to access, display, run or print my dissertation or thesis. I acknowledge that University of Arizona Library may elect not to distribute my dissertation or thesis in digital format if, in its reasonable judgment, it believes all such rights have not been secured.</p>	
<input checked="" type="checkbox"/> Yes, make my thesis available in the UA Campus Repository! Student signature: <u>Taylor Smyth</u> Date: <u>4/18</u> Thesis advisor signature: <u>[Signature]</u> Date: <u>4/18/2013</u>	
<input type="checkbox"/> No, do not release my thesis to the UA Campus Repository. Student signature: _____ Date: _____	

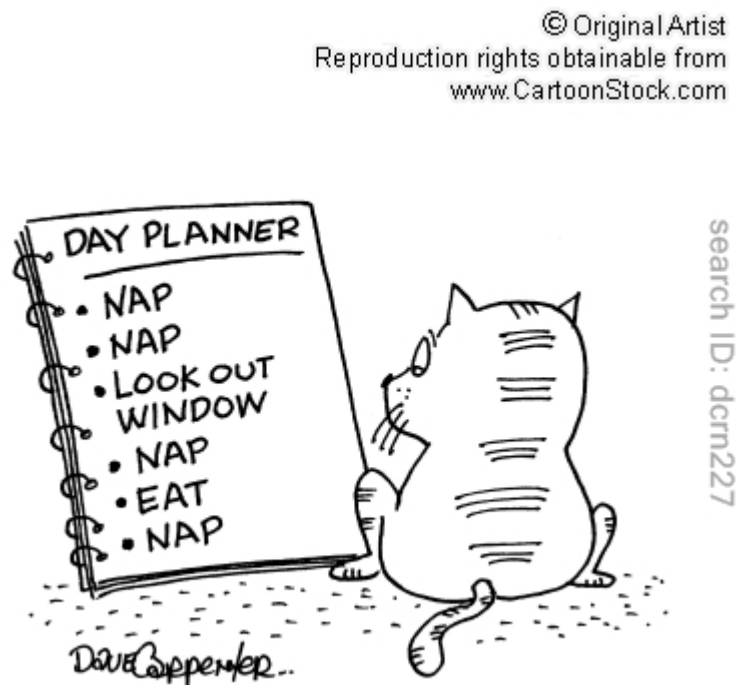
Abstract

A four week investigation of the cognitive and physiological effects that polyphasic sleep had on a human subject. The subject was put onto Uberman's sleep schedule and took cognitive tests for four weeks measuring memory, concentration and problem solving skills. Additionally weight, food intake, and dreams were recorded. After two weeks exercise one hour of anaerobic exercise was introduced. From the data recorded there was no significant variance in cognitive ability due to change of sleep pattern yet there was a noticeable weight change.

Losing Sleep

A Preliminary Investigation of the Cognitive Effects that Arise from Polyphasic Sleep Cycles

Smyth, Taylor. HNRS 498H, University of Arizona, and 3/12/2013



Summary: A four week investigation of the cognitive and physiological effects that polyphasic sleep had on a human subject. The subject was put onto Uberman's sleep schedule and took cognitive tests for four weeks measuring memory, concentration and problem solving skills. Additionally weight, food intake, and dreams were recorded. After two weeks exercise one hour of anaerobic exercise was introduced. From the data recorded there was no significant variance in cognitive ability due to change of sleep pattern yet there was a noticeable weight change.

Introduction:

Being a college student stressed with school, part time jobs, and the future, one of the hardest things to budget for is time. Naturally I've always been interested in manipulations of standard sleep cycles that could give me more of that such coveted time. Therefore I found it quite interesting to hear about sleep cycles in which subjects still slept but only in short burst "naps" throughout the day. One such study was done in by Claudio Stampi (6, 7) in long distant racing sailors. In this setting, two sailors were on a boat and alternated sleeping in the theory that the less amount of time they spent sleeping the higher likelihood that they would win the race (7).

Another similar advantage is in long distance cycling. Similarly to how the sailors want to decrease their time sleeping, long distant bikers want to maximize the amount of time they are on their bike in an attempt to traverse the most distance over long durations of time with minimal sleep activity.

In another study done by Claudio Stampi (6), he experimentally measured what cognitive affects happened to a subject that underwent this polyphasic sleep adaption. In his book chronicled "Why We Nap" he explains how he set up this experiment. For over 6 months he recorded the activity of this subject and recorded MRI scans and cognitive tests that this subject did (6). This experiment in particular was what I modeled my investigation after.

After reading Stampi's experiments, I was intrigued with his findings and wanted to experiment with this process myself. I watched as many youtube videos on polyphasic sleep that I could. One such video entitled Polyphasic sleep briefly yet thoroughly goes through Stampi's study in "Why We Nap" (5). Another video that I watched was chronicled by a woman named Aeia. Although not in a clinical setting, she showed herself being on a polyphasic sleep cycle but

quit because she kept gaining weight (2). As a result I was intrigued and wanted to investigate this in my portion of the experiment.

After reading all the material that I could obtain, I decided that I wanted to mimic Stampi's study but only for a short duration of a month. The intention behind this experiment was to mimic his study but add different tests and a new element of exercise to better understand this phenomenon by perhaps recording weight and diet as well. However, because I could not convince my twin brother to do the experiment I remained the guinea pig in this trial. I had hoped I would obtain someone else to do this experiment for me however, not due to lack of trying on my part, I had to play Frankenstein and Frankenstein's monster for this experiment.

Methods:

For this experiment I subjected myself to the classic Uberman sleep schedule over the duration of four weeks. According to the sleep schedule, I took 30 minute naps at 3, 7, and 11 AM and PM leaving me three hours and thirty minutes to stay awake in between each nap. Each time I woke up from a nap I took three assessments on the Lumosity website (<http://www.lumosity.com>) assessing my attention, problem solving and memory (3). I also subjectively rated my tiredness level on a scale of 1-10 with a 10 being extremely alert and 1 being a sleep deprived zombie. Food intake, dreams, and weight were also initially recorded however only weight was continually measured throughout the duration of the experiment. In an attempt to limit some of my error, I coerced my twin brother to take the same tests that I did every time he woke up from his normal sleep to serve as a control for the tests. He did not subjectively rate himself, record dreams, or record his weight.

Due to the nature of this experiment and partially due to my own concern with my ability to drive a motorized vehicle while possibly sleep deprived, I stayed at my parent's house for the entire duration of this experiment with both my parents and my brother. Due to my father's strange habit of waking up at five o'clock in the morning coupled with my brother's tendency to stay awake until 11 o'clock at night, I had two great mediators to help me wake up as well as reminding me to go to sleep. With their help, I was only unsupervised for my 3 AM nap which understandably was the nap that I overslept the most.

In addition to my family, I kept two alarms with me whenever I dozed off for a nap. Both were set for thirty minutes after my scheduled sleep. One was a normal high pitched table clock while the other (my phone) was a deep rumbling evacuation alarm that one might hear at a nuclear reactor. Usually it was the latter alarm that woke me from my slumber.

In the last two weeks of the experiment, I actively exercised for one hour in every twenty-four hour period. This was a stark contrast from the prior two months in which little to no exercise was completed on a weekly basis. This hour of exercise took place from 8 to 9 AM immediately after my 7 AM nap. Although it may have been more reasonable to break up this exercise component into several ten to twenty minute bouts, I did not come to that realization until after I had already began and I did not wish to change that which I had already started.

Because I intended to stay up for long periods of time, I did not drink caffeine for the entire duration of the experiment. No energy drink stimulant, depressant, or drug was ingested knowingly. Alcohol, however, was consumed on two occasions: my birthday and on New Year's both in moderation and within reason. No specific diet was observed for this experiment.

Results and Data:

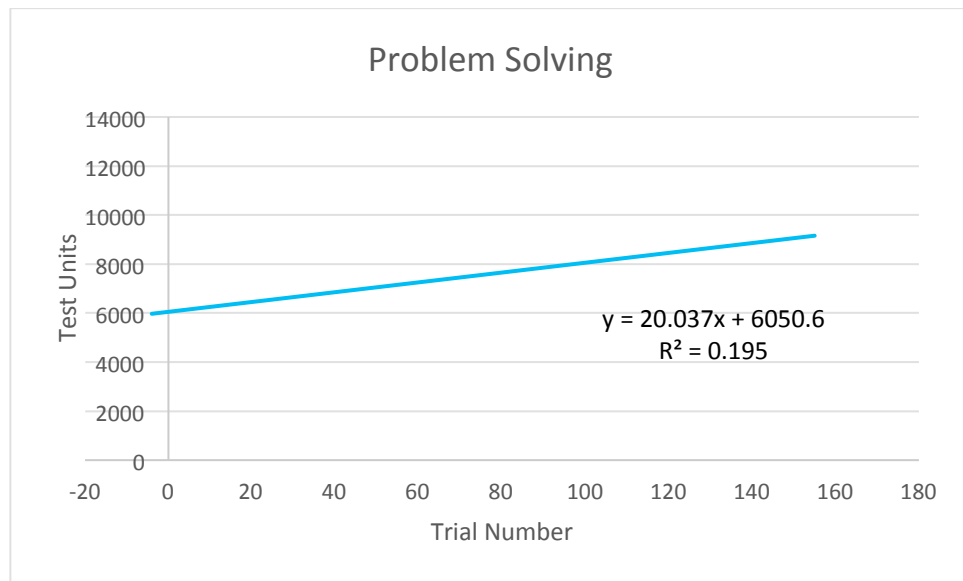


Figure 1: A Trend line of the results of the Lumosity Problem Solving test over the duration of 28 days. The test units are arbitrarily given by Lumosity and the trial number corresponds to the 1-160 times that this test was taken.

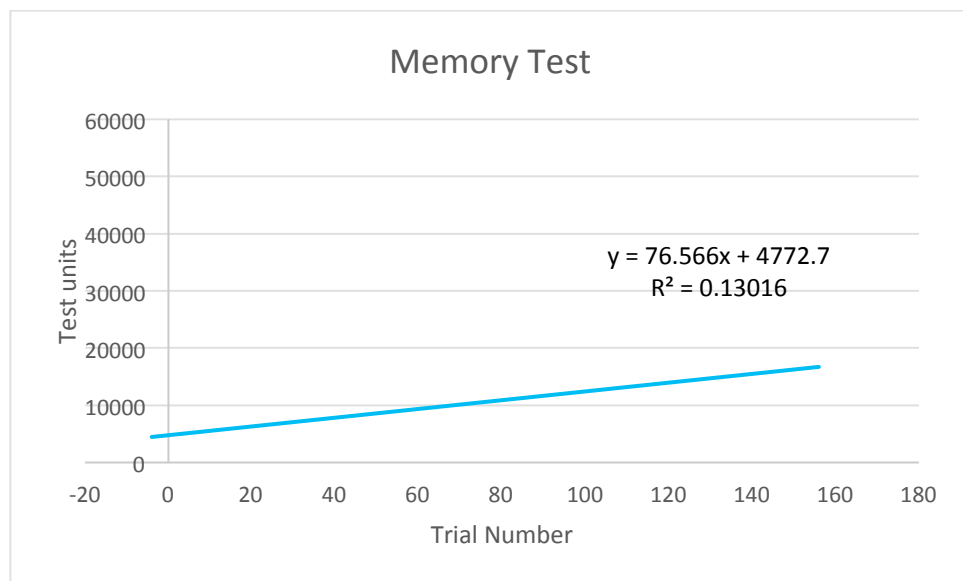


Figure 2: A Trend line of the results of the Lumosity Memory test over the duration of 28 days. The test units are arbitrarily given by Lumosity and the trial number corresponds to the 1-160 times that this test was taken.

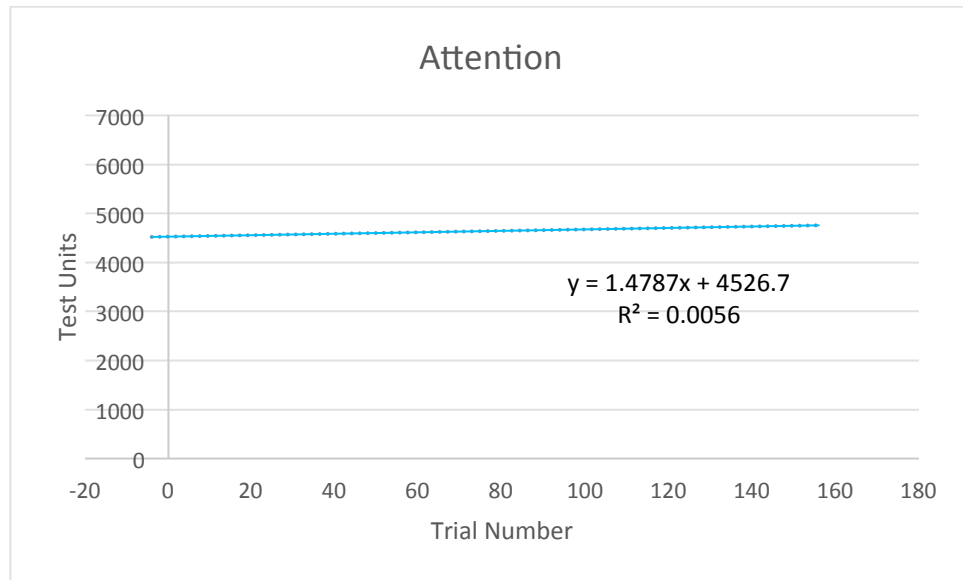


Figure 3: A Trend line of the results of the Lumosity Attention test over the duration of 28 days. The test units are arbitrarily given by Lumosity and the trial number corresponds to the 1-160 times that this test was taken.

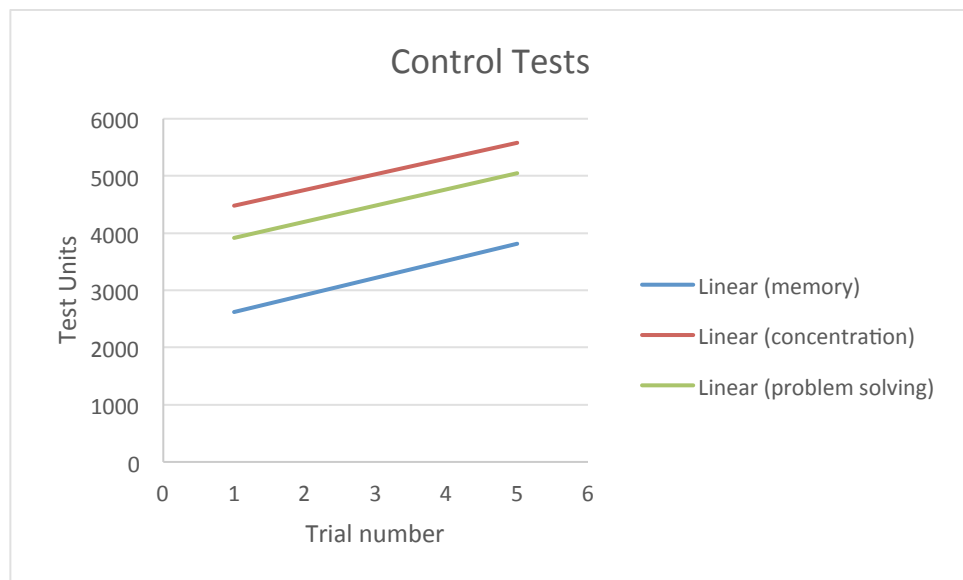


Figure 4: A Trend line of the results of the Lumosity Problem Solving, Attention, and Memory tests over the duration of 28 days for the control subject. The test units are arbitrarily given by Lumosity and the trial number corresponds to the 1-6 times that this test was taken.

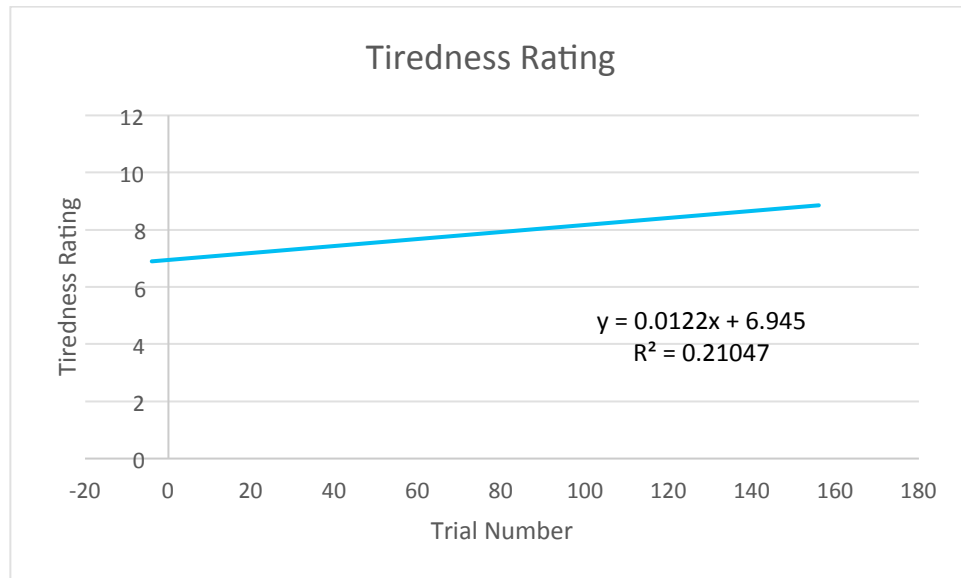


Figure 5: A Trend line of the results of the subjective Tiredness Rating over the duration of 28 days. The tiredness rating was subjectively rated on a scale of 1-10 and the trial number corresponds to the 1-160 times that this rating was given.

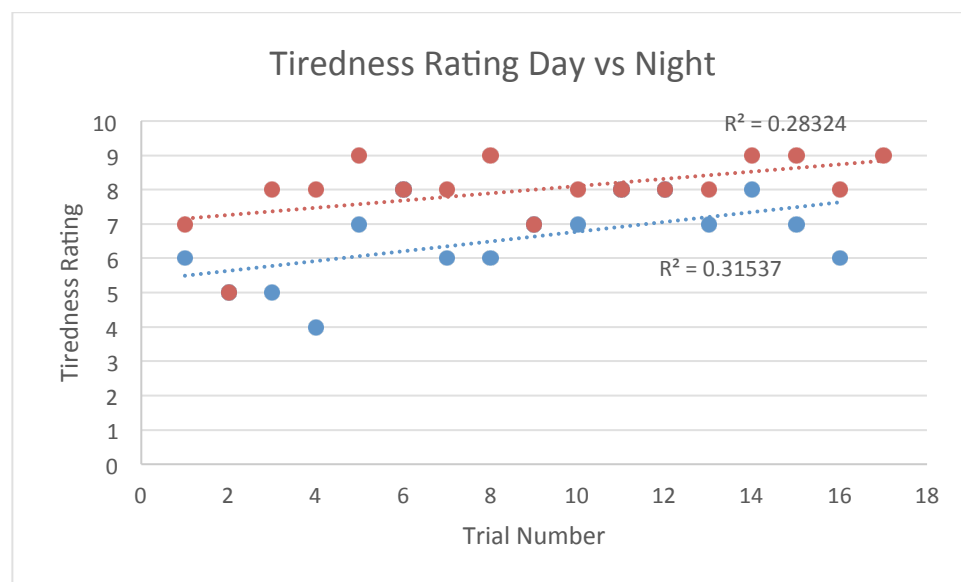


Figure 6: Trend lines of the results of the subjective Tiredness Rating according to time of day. The blue trend line represents the rating at night and the red trend line represents the rating during the day. The tiredness rating was subjectively rated on a scale of 1-10 and the trial number corresponds to the number of times this rating was given.

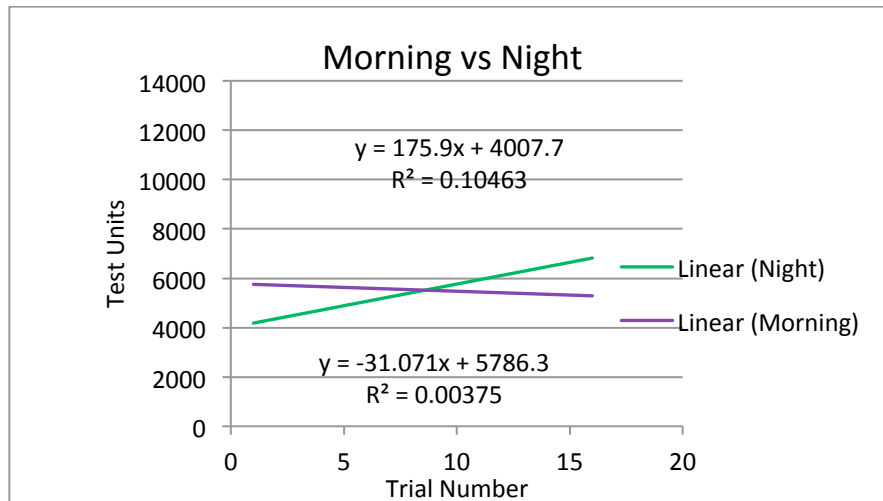


Figure 7: A Trend line of the results of the Lumosity Problem Solving test over the duration of 28 days. The purple trend line represents tests taken at during 7pm 11pm and 3am while the green trend line represents tests taken at 7am, 11am, and 3pm. The test units are arbitrarily given by Lumosity and the trial number corresponds to the 1-160 times that this test was taken.

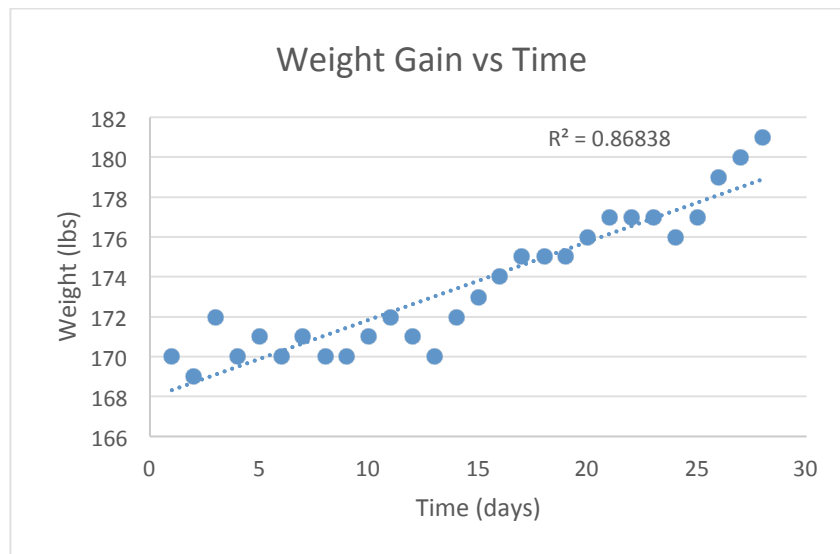


Figure 8: A Trend line of the results of the weight change over the duration of 28 days. The weight was measured on a bathroom scale in pounds and the time was in days.

Discussion:

From the data recorded in Figures 1-3 there was no significant increase or decrease in the test scores over the duration of this experiment. All of the figures r squared values were remarkably low therefore suggesting that the linear expression shown did not well fit the plot displayed. As a result, this suggests that there was no significant disadvantage or advantage of polyphasic sleep cycles in comparison to monophasic sleep at least in terms of the three tests of memory, attention, and problem solving.

In comparison to my brother's tests, (control) my tests portrayed a similar upward trend that his did (Figure 4). Although both my set of tests and his set of tests are not significant, because both tests illustrated the same upward trend, I would argue that they represent the fact that we both got better at the tests as the experiment progressed. This may be attributed to the sheer number of times that we took the test.

Additionally it was interesting to note that my tiredness rating also correlated with the upward trends of the tests. Because the majority of the lower tiredness scores are at the beginning of the experiment, I could contribute this to me being very tired during the beginning of the experiment and then later on adjusting to the rather difficult sleep schedule. In Figure 6, the tiredness rating also appears to correspond to the time of day although the r squared values are relatively small. During the night my tiredness ratings were overall lower than my daytime ratings which I suppose I could attribute to being more tired during the night.

Perhaps one of the most interesting findings of this experiment is illustrated best in the final figure. Over the course of this entire experiment I gained close to ten pounds changing from 170lbs at the start to 178lbs over four weeks. This can be seen well from the Figure 8 above. However because this weight gain took place over the winter holidays I could not definitively

know whether the weight gain alone could be attributed to my different sleep pattern or whether it was due to the holiday eating. In hindsight it would have been nice if my brother (control) had recorded his weight to better illuminate this issue. In related studies I found mixed evidence of weight gain in previous experiments. For instance according to Grant Stoddard, a New York writer, he claims of losing close to ten pounds throughout his four week period which is in stark contrast to my close to ten pounds gained (4). He cites evidence from sleep specialists that suggest that this may be caused by the bodies increased metabolism and in turn catabolism that could lead to rapid weight loss. In another experience, the subject claims she quit the cycle because of her weight gain over the course of several months (2). Sadly Stampi's paper, the only scientific paper mentioned in this study does not mention weight gain although he may have recorded it. Clearly this issue would be interesting to investigate in the future.

Although I was able to complete this experiment, many things could have been handled better in hindsight. Without a doubt the most difficult component of this experiment was waking up. My body, despite my best interests, would resist me and try to get as much sleep as it could. Twice I was awakened by my sister and brother telling me that my alarms had gone off for about thirty minutes and I still did not wake up. On two other occasions I was woken up by my mother hours after I was supposed to have woken up. Certainly if this experiment was done in a clinical setting similarly to Stampi's investigation, the oversleeping issue could have been avoided. Similarly it would have been more convenient if the exercise element to this procedure had been more structured and monitored as well which easily could have been done if this experiment was done in a clinical setting.

In terms of my own well-being similarly to another experimenter I had a very difficult time separating days from one another (1). As a result it was confusing sometimes whether or not

I had already taken a shower or brushed my teeth or even eaten yet. Perhaps that confusion of eating could explain my weight gain. I do wish I had recorded how much food I had eaten and I recommend that as a source for further investigation.

Because this experiment was done on myself, I feel that I had a lot more pressure to take the tests and to record the data than if I had observed another person doing it. Therefore I would argue that it would have been much better to observe and watch someone rather than to be the experimenter and the experiment. Certainly towards the end of the experiment, in the last few days, I was getting quite sick of the tests and recording data that I was starting to lose it. Perhaps I shouldn't have been taking a winter session class as well.

Because I was the only subject in this sleep study, it was difficult to make any definitive conclusions from this study, however, as a pilot study the preliminary results provide insightful directionality and suggest that many more investigations need to be done to better understand what happens in these sleep cycles. Since this investigation only dealt with measureable written tests, perhaps hormone fluctuation could be monitored as well as how a subject performs on the tests at different times of the day. Additionally because I gained weight over this study perhaps food intake could be measured and this experiment could be done over the summer to determine if there is some rationale for the weight gain while recording food intake as well. Either study would be interesting perhaps for both different patterns would be observed.

Works Cited

- 1) "The DaVinci Sleep Schedule." *The DaVinci Sleep Schedule*. N.p., n.d. Web. 27 Mar. 2013.
<<http://rebirthofreason.com/Spirit/Blogs/101.shtml>>.

- 2) "Giving up Polyphasic Sleep." *YouTube*. YouTube, 04 July 2010. Web. 27 Mar. 2013.
<<http://www.youtube.com/watch?v=0RG44dnwyM0>>.
- 3) "Harness Your Brain's Neuroplasticity and Train Your Way to a Brighter Life." *Lumosity*.
N.p., n.d. Web. 02 Apr. 2013. <<http://www.lumosity.com/>>.
- 4) "Is Sleep Really Necessary?" *Do You Need 8 Hours? : Sleep Health : Men's Health Spotlight : MensHealth.com*. N.p., n.d. Web. 27 Mar. 2013.
<<http://www.menshealth.com/spotlight/sleep/8-hours.php>>.
- 5) "Polyphasic Sleep Study." *YouTube*. YouTube, 13 June 2008. Web. 27 Mar. 2013.
<<http://www.youtube.com/watch?v=myi2sRph69A>>.
- 6) Stampi, Claudio. *Why We Nap: Evolution, Chronobiology, and Functions of Polyphasic and Ultrashort Sleep*. Boston: Birkhäuser, 1992. Print.
- 7) Stampi, Claudio(1989): Polyphasic sleep strategies improve prolonged sustained performance:
A field study on 99 sailors, *Work & Stress: An International Journal of Work, Health & Organizations*, 3:1, 41-55

Thesis Sleep Journal

Sat Dec 15,

Today is the first day of my thesis and I am quite excited and ready to start it. I feel that if/when I am able to master this program, I feel that I will be most successful for studying for many of my classes that I intend to take in the fall. Notably today I was not able to sleep in any of my naps. I suppose my brain is really confused about all the napping.

Sunday Dec 16,

I was not able to get much sleep last night perhaps only 10 minutes total between six different naps. I still feel relatively awake however, it's more in an emergency all-nighter kind of way and I'm not sure how long that it will last.

Monday Dec 17,

It was my mother's birthday today and I was luckily the first person to wish her that due to the fact that I was perhaps the only one up at midnight to wish her that. I've realized that my alarm which sounds like an Emergency missile silo is not conducive to my sister's beauty sleep. Pretty sure she might kill me by the end of this project.

Tuesday Dec 18,

Good News: I finally got my first sizable sleep chunk. Bad News: It was an hour sleep from midnight until one. I feel pretty refreshed although slightly disappointed by my lack of discipline. Clearly Toy Story 3 was not engaging enough to me.

Wednesday, Dec 19,

I went to my first social event today... MY BIRTHDAY... in which I left my parent's house for this project. I had a lot of fun at the party but I sadly had to tell everyone that I needed to leave at 10:45. Everyone really enjoyed my thesis idea but I suppose as of right now it's really bad on my social life. Didn't get a lot of sleep all day...

Thursday, Dec 20

My dad finally assigned me homework for him to do over the night shift. I spent the majority of my night time logging in patient data and boy was THAT fun. I have to say it made me focused and I did stay awake all night long.

Friday, Dec 21

Realized that today is the day that the world is going to end and am pleasantly surprised that I will be up for the most part of it. Haven't seen any signs that it is coming to an end but boy will I be ready. Definitely feel alert and awake today.

Saturday Dec 22

World did not end. Slightly disappointed nothing happened but it is probably for the better. Couldn't fall asleep at my 3:00pm nap and feeling slightly grumpy. Otherwise Netflix is going to be great tonight.

Sunday Dec 23

Slept through my alarm today and was woken by my very concerned mother. She made me feel guilty and made me breakfast. That means it will be difficult to sleep for my next nap.

Monday Dec 24

My parents and my brother are going to the Christmas Eve service at church however they decided to leave me behind for a certain reason. I suppose they don't want me sleeping through half of the sermon. My mother then made me put all the presents under the Christmas tree. Felt strange.

Tuesday Dec 25

Christmas was great and it was good to see all of my family there. My grandpa was really interested in my study and kept asking me scientific questions and wanting to see my tests. He was an engineer and I suppose that's what is keeping his mind going at 90.

Wednesday Dec 26

I played NBA Live, a video game, all night long. It certainly kept me busy and awake but my head hurts from looking at the screen and I definitely want to go to bed right now but I've got two hours to kill...

Thursday Dec 27

I've noticed that it is getting hard for me to differentiate days. For instance my sister told me I smelled and I suppose it had been three days since my last shower... I also have a hard time telling what day it is although I had a hard time doing that before this experiment...

Friday Dec 28

I went to volunteer at the hospital for the first time since being on this schedule. I could not stay very long but no one seemed to notice anything unusual about me and John, the paramedic, was really interested in my study once I told him about it.

Saturday Dec 29

I started my exercise component of this cycle today. It felt good to actually exercise because I haven't been doing anything in two weeks and hopefully it will help me sleep better.

Sunday Dec 30

I had one of my tests in my class today and I watched Treasure Island on Netflix. Still feel alright although I'm sort of getting tired of taking all these tests.

Monday Dec 31

I went over to Ian's house with my brother and had a good time staying up on New Year's. I had to sleep twice over there in his brother's room on the floor with a blanket. Probably only got a total of ten minutes sleep between the two naps, but it was worth it. All of my friends helped me wake up by jumping on me. So not cool...

Tuesday Jan 1

I definitely overslept a little bit today. Mom had to wake me up from the nap along with that yapping dog echo. I really really want to sleep right now.

Wednesday Jan 2

I decided to practice juggling and origami to keep me awake at night. That lasted for about thirty minutes and then I went back to Netflix. I'll do it later...

Thursday Jan 3

I watched Beauty and the Beast with my Mom. It was definitely really fun and I just tried to relate it to Pride and the Prejudice. I'm definitely feeling awake right now and looking forward to life without this schedule.

Friday Jan 4

Went to volunteer again and only stayed for about an hour and half. I'm a horrible volunteer but hey at least I showed up...

Saturday Jan 5

I got packed for school this week. I am definitely looking forward to it. Why you might ask? Because I will be sleeping=) and studying...

Sunday Jan 6

I went out to dinner with my family tonight. Of course it was at 7:00. I had to sleep in the car. Not the most productive method of sleeping.

Monday Jan 7

School started today. Luckily I only had one class to go to. I think that I will have to register for another one at 11 but hopefully I'll be off this schedule by then.

Tuesday Jan 8

No school today. Only had micro and first day is syllabus anyways right. Right?