Placebo Sleep and Student Cognition: Examining the Power of Perception

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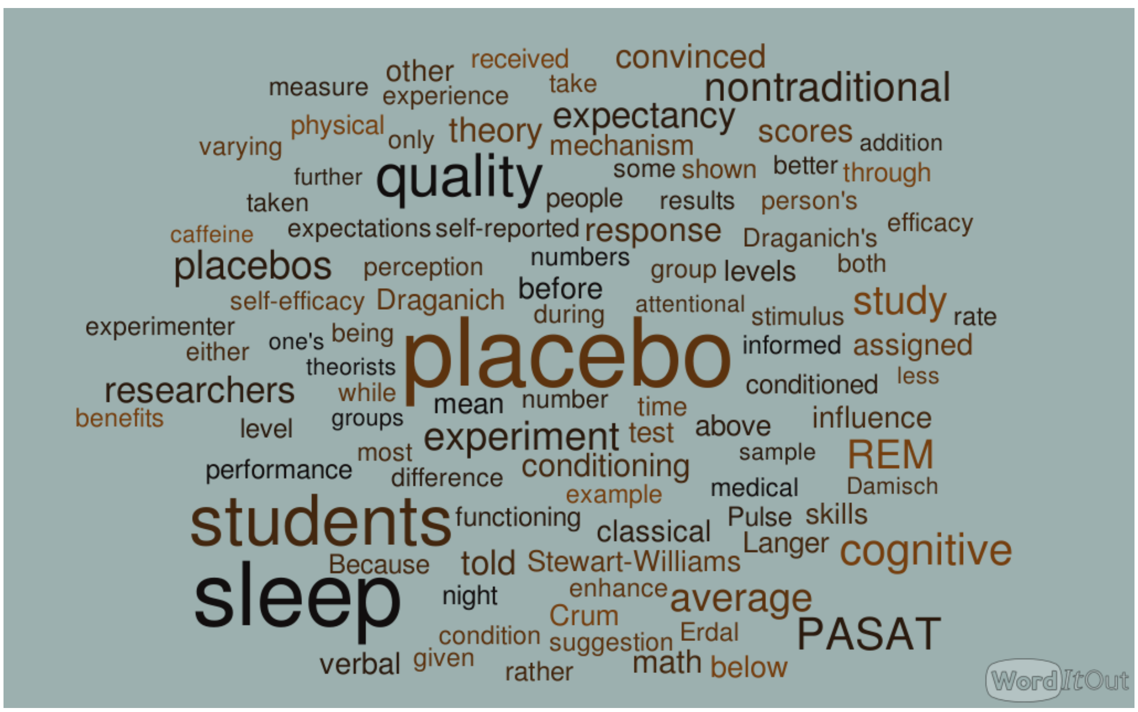

I. INTRODUCTION

The *placebo effect* refers to any event by which a person's *belief* in a treatment actually causes the treatment to function. In the medical setting, traditional placebos take the form of inert pills, syringes, and food/drink, and are often used to cure patients' illnesses based solely on the power of "mind-over-matter." Beyond their conventional setting, placebos have been known to take nontraditional forms more common in everyday life, such as verbal suggestion, in order to activate this "mind-over-matter," or mindset manipulation, phenomenon (Langer et al, 2010). In many studies, nontraditional placebos have served to influence a person's cognitive, physical, and even physiological potential. For example, by convincing people of luck-associated superstition, researchers have shown that "activating a good-luck superstition leads to improved performance by boosting people's belief in their ability to master a task" (Damisch et al, 2010). The idea that placebos lead to "improved performance" by boosting confidence refers to the concept of self-efficacy, which explains the ways in which people can control their behaviors/performances through the power of perception. Christina Draganich and Kristi Erdal of Colorado College revealed the significance of self-efficacy among undergraduate students, showing that students who *perceive* their sleep quality as "above average" cognitively outperform students who perceive their sleep quality as "below average" (Draganich and Erdal, 2014). Both Damisch and Draganich showed the causal influence of a nontraditional placebo on *adults*; never before, however, have nontraditional placebos been applied to *adolescents.* Knowing the benefits that nontraditional placebos can have on cognitive performance, the researcher of this paper has put into question: Can the presence of a nontraditional placebo of sleep quality influence a high school student's cognitive functioning?

II. LITERATURE REVIEW

Theories of Placebo Mechanism

Although there are several considerable modern theories that attempt to explain the placebo effect, the two most popular theories fall under the branch of behavioral psychology: classical conditioning and the expectancy theory.

Classical Conditioning

Originally proposed by Ivan Pavlov (1849-1936), classical conditioning occurs when an organism pairs an unconditioned stimulus (US) with a previously neutral stimulus. The final response to the neutral stimulus (now the conditioned stimulus, CS) is called a conditioned response (CR). This process occurs when the organism is repeatedly exposed to the US and CS together. For example, in Pavlov's studies, a dog was exposed to food (US) and a bell (CS) together. Every time food was presented, the bell was rung. In response to the food, the dog salivated (unconditioned response, UR). Eventually, through repeated exposure, the dog salivated in response to the bell alone (CR) (Pavlov, 1927). Typically, traditional behavioral psychologists have understood classical conditioning of an organism to be an automatic, nonconscious process (Watson, 1924). In terms of placebo mechanism, the placebo serves as the conditioned stimulus, while the placebo effect serves as the conditioned response. Under this theory, when a person responds to a placebo, he/she is doing so automatically.

Classical conditioning theories in placebo mechanism have traditionally been reported in non-human subjects, including dogs, rats, and mice. However, considering the elasticity of the placebo effect, there are several explanations for *human* responses to placebos that fall under classical conditioning (Bendetti and Amanzio, 2011). The most prime example is that in a therapeutic or medical setting. During therapy, the real medicine/treatment is paired with a variety of stimuli, such as pill casings, syringes, and even the therapeutic environment itself. As people are constantly exposed to these pairings, classical conditioning theorists would claim that, were the treatment to be replaced by a placebo, people would respond accordingly in a conditioned response (Stewart-Williams, 2004). In modern explanations of this phenomenon, people have learned that such stimuli often precede the experience of treatment, and therefore people experience a conditioned placebo response (Stewart-Williams, 2004). All in all, most theorists of classical conditioning would contend that a lifetime of medical visits serve as conditioning trials that pair the medical context (CS) with the treatment (CR) (Draganich and Erdal, 2014). The primary flaw of classical conditioning theory is that it often fails to explain placebo effects that take place beyond these medical settings, such as nontraditional placebos of verbal suggestion and superstition. Nonetheless, the classical conditioning theory does support the idea that a stronger conditioned stimulus (e.g. a syringe vs. a pill) leads to a stronger conditioned response (e.g. stronger placebo effect for syringe) (Stewart-Williams, 2004).

Expectancy Theory

The expectancy theory embodies a common understanding of the placebo effect: a person's expectation in the outcomes of the placebo (i.e healing, burning, etc) produces the effects themselves. In other words, "the placebo produces an effect because the recipient expects it to," (Stewart-Williams, 2004). This theory falls in line with social phenomenon such as faith and hope – those who believe in the placebo (are convinced of its effects) are more receptive to its effects. Expectations can be influenced by verbal suggestions (positive or negative language), previous experience, a person's graded likelihood of an event, and/or emotional assessment of a situation (Colloca and Miller, 2011). Because expectancy can only be measured by the recipient's admittance (he or she must admit that they expected the effects), the expectancy theory has been exclusively applied to humans, rather than animals (Stewart-Williams and Podd, 2004). In addition, this theory differs from others in that it does not always entail automatic behavioral responses: although some expectations of placebo mechanism are processed on nonconscious levels (Colagiuri et al, 2011), most expectancy theorists claim that participants must be completely and precisely aware of their expectations in order for the placebo to function (Michael and Garry, 2012). Although the theorists of this division do not claim that the expectancy theory accounts for the complete mechanism of placebos, they do believe that it is the primary explanation for placebo response.

Researchers Stewart-Williams and Podd of Massey University have analyzed some of the most profound implications of this theory. For example, expectancy theory explains how drug advertisement leads to greater placebo effect in buyers (Stewart-Williams and Podd, 2004). Emphasizing the healing effects of a drug may make recipients more inclined to expect to be cured, and thus explains why they experience better "efficacy" of the drug. Similarly, however, listing the side-effects of taking a drug may have a negative effect, leading recipients to experience more of the side effects. Thus, the expectancy theory affirms both the placebo (produces desirable outcomes) and the nocebo (produces undesirable outcomes) (Hahn, 1997). Another implication of this theory claims that changes in expectancy induced by placebos in turn change behavior, which influence a placebo effect. This explains why a patient in pain taking placebo medication to reduce discomfort experiences a reduction in pain: expecting to have her condition improved, the patient may be distracted or put in a better mood. Thus, the expectancy changes the person's behavior, which in turn activates the placebo effect (Stewart-Williams and Dobbs, 2004).

Beyond the medical field, expectancy in a placebo effect may also affect a person's perception of his or her daily activity. For example, placebo expectations during physical exercise may influence perceived exertion during such exercise. Henrik Mothes, professor of the Department of Sports Science at the University of Freiburg in Germany, demonstrated that “participants with more positive expectations [activated through suggestion of a product’s benefits] experienced reduced perceived exertion during the exercise,” (Mothes et al, 2017). In this sense, expectations of a placebo may enhance perceived efficacy in a product/treatment.

A minor shortcoming of the expectancy theory is that the correlation between self-reported expectancy and placebo effect are not always found (Stewart Williams, 2004). There have been instances where cognitive functions other than expectancy have been correlated higher with successful placebo effects. For example, in extensive experiments, Andrew L. Geers of the Department of Psychology at the University of Toledo showed that motivation and goal activation proved to be better predictors of placebo reaction (Geers et al, 2005).

The Nontraditional Placebo Effect

Most placebos in traditional research are contextualized in a medical setting, taking the form of medicine (pills), food, or drink, and often having a therapeutic effect on patients. However, placebos that influence a recipient’s efficacy that take a non tangible form (e.g. verbal suggestion) and/or enhance one’s efficacy (rather than simply healing) are called *nontraditional placebos.* More recently discovered, nontraditional placebos are more commonly mechanized during daily activity, rather than in instances of medicine/therapy.

Christopher J. Beedie and his colleagues were among some of the first researchers to experiment with a nontraditional placebo effect on physical performance. In their 2004 study, six male cyclists biked three experimental 10 km timed trials. After being informed on the benefits of caffeine consumption on cycling efficiency, subjects (not a part of the control group) were told they would be randomly assigned to receive a placebo of some sort -- capsules of 4.5 mg.kg caffeine, and 9.0 mg.kg caffeine. In actuality, all subjects received placebos. When subjects were given a placebo capsule they were told was caffeine, they produced greater power than those a part of the control group, on average (Beedie et al, 2004). In addition, as supported by the classical conditioning theory, subjects who were convinced of consuming larger doses of caffeine produced more power than at baseline (Beedie et al, 2004). In this case, the placebo effect served as an enhancer (rather than the traditional healer) to the recipients' efficacy.

Expanding upon this field of study -- the nontraditional placebo on physical efficacy -- researchers Alia Cum and Ellen Langer determined the extent to which a non tangible placebo (neither pill nor food/drink) influences a person's physical fitness. In their study involving the relationship between one's mindset and his or her health, hotel maids were either told that their work (routine room assistance/cleaning) was beneficial to their health (experimental placebo) or told nothing at all (control group). At the end of a 4-week intervention, Crum and Langer found that hotel maids who were informed of the benefits of their work (given the nontraditional placebo) lost more mean weight and had diminished weight-hip ratios (Crum and Langer, 2007). Considering that all of the hotel maids hardly changed their behavior (if at all) within their work, it can be assumed that their own conceptual belief in the placebo served as the mediator for their physical health. Crum and Langer introduced the importance of "mind-over-matter" and self-efficacy, revealing a possibility that simply providing a nontraditional placebo to sedentary people can help their bodies accommodate greater in their sedentary lifestyles (Crum and Langer, 2007).

Unfortunately, however, the findings of Crum and Langer have yet to be replicated by other researchers. Dixie Stanforth and her colleagues at the University of Texas in Austin followed a similar methodology to the one taken by Crum and Langer: participants were told of the physical benefits of their work and followed over a course of intervention by which they were continually reminded of this nontraditional placebo. Unexpectedly, at the end of both the 4-week and 8-week results, there seemed to be no changes in body weight, BMI, percentage of body fat, and resting heart rate among those who were told of their job's exercise (Stanforth et al, 2011).

Regardless of its lack of replication, the study of Crum and Langer have influenced further research into the physiological effects of nontraditional placebos. In 2011, Crum, this time alongside other colleagues, searched for placebo mechanism in digestive responses to food consumption. In the experiment, participants were given a milkshake and either told that it was a 680-calorie "indulgent" shake or a 140-calorie "sensible" shake; in actuality, all shakes were 380 calories. However, participants given the "indulgent" shake produced significantly less ghrelin, a gut peptide that increases appetite, than participants given the "sensible" shake (Crum, 2011). The results suggest that people can influence their metabolic processes through placebo willingness - the "mind-over-matter" concept once again.

Beyond producing physiological effects, nontraditional placebos have been shown to affect recipients' perception and cognition. Baba Shiv, Ziv Carmon, and Dan Ariely (2005) demonstrated the effects of marketing labels on individuals' perception. In their experiment, participants consumed adrenaline drinks of varying price and were asked to complete puzzle tasks. Consumers that paid a discounted price for the drinks (which claimed to boost mental focus) believed less in the product's benefits and performed worse on the puzzles compared to participants who paid retail price (Shiv et al, 2005). The study implied that expectancy induced by labels and suggestions (aka nontraditional placebos) can have powerful effects on perception and cognition; further, it affirmed previous research in regards to classical conditioning, specifically with claims that a stronger stimuli (pricier placebo) leads to a stronger placebo response

Testing the effects of superstitious expectations, a concept similar to that of the nontraditional placebo effect, researchers Damisch, Stoberock, and Mussweiler found that good-luck phrases (i.e. “break a leg,” keeping one’s fingers crossed) often enhance self-efficacy. Asked to complete golf-putting trials, participants told that the ball they were receiving was lucky (given the nontraditional placebo of verbal suggestion) performed better than those told nothing of luck (Damisch et al, 2009). These results, along with others in more experiments, demonstrated that activating luck through verbal suggestion can enhance one’s physical performance (Damisch et al, 2009).

Undergraduate student Christina Draganich and her professor Kristi Erdal of Colorado College found that the nontraditional placebo in both verbal and nonverbal ways can influence students’ cognitive functioning. In their experiment, 50 undergraduate students were randomly assigned to either be convinced that they got above “average sleep quality” or “below average sleep quality” from the night before. While being explained about the link between REM (rapid eye movement) sleep quality and cognition, students were connected to BIOPAC equipment that (supposedly) would allow the experimenters to calculate the amount of REM sleep students received the night before. Students watched the experimenter calculate either 16.2% REM (for the “below average sleep quality” group) or 28.7% REM (for the “above average sleep quality” group) on a fake spreadsheet. Their findings showed that students convinced that they received below average sleep quality performed worse on tests of memory and attentional skills than students convinced that they received above average sleep quality (Draganich and Erdal, 2014). The researchers implied that cognitive performance is not only affected by sleep quality, but *perceived* sleep quality as well (Draganich and Erdal, 2014).

All of the previously mentioned studies contributed to the ultimate goal of this study: to examine the effect of placebo sleep quality on cognitive self-efficacy. Practically speaking, this study implemented Draganich’s methodology in order to examine how *high school students*, rather than adults, can undergo cognitive self-efficacy in response to a nontraditional sleep placebo. From the results of Draganich's study, the researcher of this paper hypothesized that students convinced that they received "above average sleep quality" would, on average, cognitively outperform students convinced they received "below average sleep quality."

III. METHODS

This study's procedure closely aligns with that of Draganich and Erdal in *Placebo Sleep Affects Cognitive Functioning* (2014), with few exceptions that will be addressed in footnotes.

Participants. Participants from this study came from an ethnically diverse, co-ed, 9th-12th grade suburban high school (SHS) of 4,480 students. 30 students[1] of this SHS between the ages 14 and 18 participated in this study. The students in the sample represented 9th - 12th grade levels, and therefore were representing varying levels of academic courses taken (in terms of course difficulty and honors levels). Among the participants, 21 were girls and 9 were boys[2].

In order to collect the representative sample, students from varying classes on campus were shown presentations and asked to take part in an experiment that studied the effects of sleep quality on cognitive functioning. Students interested in participating gave their consent and were told the estimated dates of their experiment. In some cases, participants were given incentive in the form of $5; in other cases, their incentive was class participation points.

Procedure. Participants reported to the school's health office (particularly the nurse's office, a controlled setting) for the experiment. Before the experiment began, students were reminded of their rights as participants in order to give informed consent; specifically, students were told that there were no perceived risks involved in the experiment, but that if they felt uncomfortable, they should say so and the experiment would stop immediately. At the end of their complete participation, they were rewarded with their incentive.

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[1] The words "participants" and "students" will be used interchangeably throughout the rest of this paper

[2] Draganich's study consisted of 50 total participants, with 19 men and 31 women of undergraduate college

Students started by responding to a single question that asked, “How deeply do you believe you slept last night?” on a scale of 1 to 10, with 10 being very deeply. They were clarified that their response should not indicate the number of hours they slept, but simply how deep and refreshed they felt their sleep was. They were then randomly assigned to either the “above average” sleep quality condition or “below average” sleep quality condition; the participants were, of course, *unaware* that they were assigned to these placebo groups.

All participants watched a short Ted Ed video lesson (5:44 long) that discussed the cognitive benefits of sleep, which included a discussion of REM sleep and its relationship with memory consolidation. Following the video, they were reminded of the key parts of the lesson regarding REM sleep, and further explained what REM sleep entailed (rapid eye movement, brain wave frequency, blood pressure fluctuations, etc). Participants were informed that healthy adults spend around 20% to 25% of their sleep time in REM stage at night; further they were told that those who spend less than 20% in REM sleep tend to perform worse on tests of learning and memory, whereas individuals who spend more than 25% in REM sleep tend to perform better. All information told to the participants up until this point was disguised as background information that would prime them for the placebo to follow.

Participants were then informed of a new technique that had been discovered in recent, credible studies that allowed researchers to estimate one’s percentage of REM sleep from the night before by measuring the lingering physiological measurements of heart rate and oxygen saturation[3] the following day. They were further told that the REM sleep reading based on these two measurements was not influenced by extraneous factors, such as coffee consumption. Students were shown both the complicated algorithm and spreadsheet used for calculating REM sleep percentage to increase the construed legitimacy of the experiment.

[3] Draganich and Erdal convinced their participants that lingering pulse, heart rate, and brainwave frequency could measure REM sleep in the “new technique”

Participants had their pulse and oxygen saturation measured with a Finger Pulse Oximeter (Figure 1), which they were told would give them a reading of their lingering pulse rate and oxygen levels from the night before. The Pulse Oximeter[4] displayed two numbers, as shown in Figure 1, that represented oxygen saturation and heart rate.

Source: www. fingerpulseox.com

Figure 1: The uppermost number on the left image represents the reading of oxygen saturation (in this sample, 97% SpO_2), while the lower number represents the pulse rate (in this sample, 72 beats per minute). These readings are taken by having the student place their index finger in the clamp, as shown in the right image.

After the experimenter collected these readings, participants were told that these two numbers were going to be submitted through a database with the preprogrammed algorithm. Participants then watched the experimenter calculate either 16.2% REM sleep (only for students in the “below average sleep quality” group) or 28.6% REM sleep (only for students in the “above average sleep quality” group) on a spreadsheet containing extensive charts of numbers. The experimenter then compared the participant’s self-reported sleep quality with their “measured” REM percentage, explaining that measured sleep quality has proven to be far more accurate than reported sleep quality in past research. This was done to reduce any skepticism that participants may have had in the Pulse Oximeter measurement.

[4] Instead of a Pulse Oximeter, Draganich and Erdal implemented an EEG machine with BIOPAC equipment

Students were then administered the Paced Auditory Serial Addition Test (PASAT), which assesses auditory attention and speed of processing by examining short-term memory skills, attentional skills, and alertness (Gronwall, 1977). Sleep deprivation has been known to impair attentional skills (Ratcliff and Van Dongen, 2009) as well as speed of response (Lim and Dinges, 2008), so the PASAT is sensitive to the cognitive changes participants may experience in face of the sleep placebo. Students listened to a tape that presented single digit numbers at the rate of one about every 1.8 seconds. Students listened to the first two digits presented and gave a verbal answer of the sum. When the next number on the tape was presented, they then were supposed to add it to the number they had heard directly before, rather than to the number they had just stated aloud. Participants completed 10 practice numbers before being administered the official test, which included a total of 51 digits presented. The experimenter recorded the number of correct “sum responses” out of 50.

After they completed the PASAT, students were informed of the study’s true intent through debriefing.

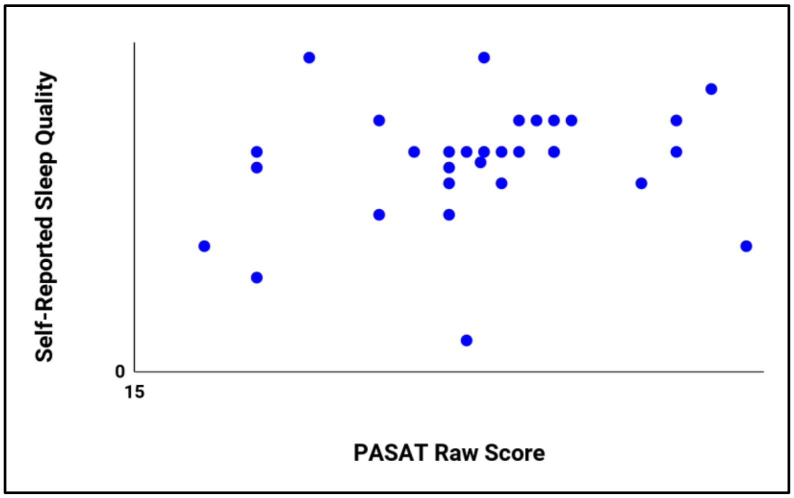
IV. RESULTS

There were three predictors analyzed that, hypothetically, could predict students’ cognitive functioning: self-reported sleep quality, assigned sleep quality, and math level.

Self-reported Sleep Quality (SSQ)

The students self-reported their sleep quality from the night before by responding to the question, “On a scale of 1-10, how deeply do you believe you slept last night?” (with 10 being very deeply and 1 being very poorly). Because this measurement was collected prior to the placebo, it was examined by a correlative value, *r*. Figure 2 shows the correlation between SSQ (1 to 10) and raw PASAT scores (out of 50), with $r = .206$, *ns*.

Figure 2



The mean of all students' SSQ = 6.67, while the mean of all students' PASAT score = 34.8.

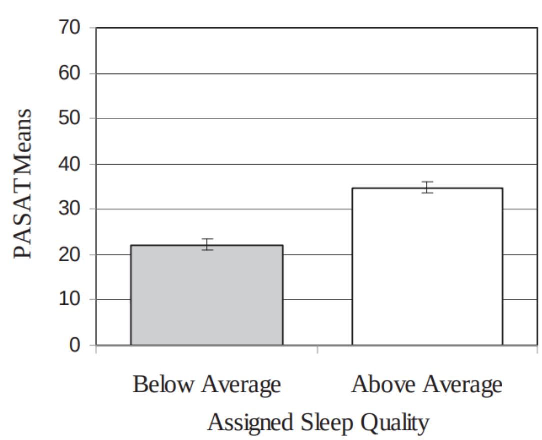
<u>Assigned Sleep Quality</u>

In Draganich's study, the difference in mean PASAT scores between the two assigned sleep quality groups was by 12.68 (see Figure 3); Table 1 below shows their means and standard deviations. The adult mean PASAT score is 36 with standard deviation 13.

Table 1: Draganich's means & standard deviations

Assigned sleep quality	Experiment 1	
	M	*SD*
Below average	22.13	6.35
Above average	34.81	5.92

Figure 3: Draganich's group mean scores

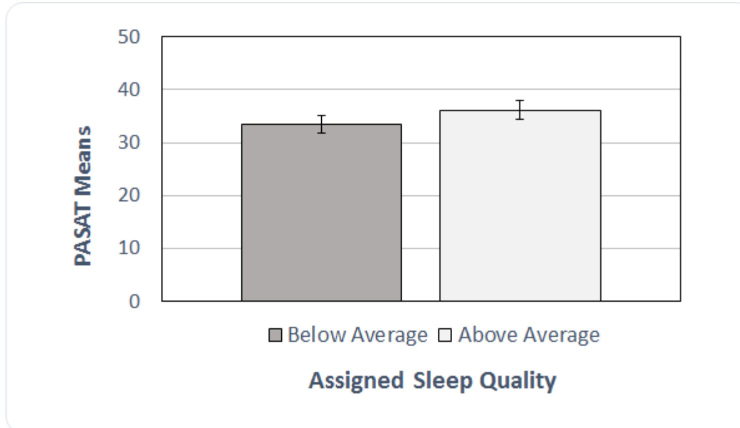


In this study, the difference in mean PASAT scores between the two assigned sleep quality groups was by 2.66 (see Figure 4); Table 2 shows their means and standard deviations.

Table 2: This study's means & standard deviations

Assigned Sleep Quality	M	SD
Below Average	33.47	7.62
Above Average	36.13	8.06

Figure 4: This study's group mean scores



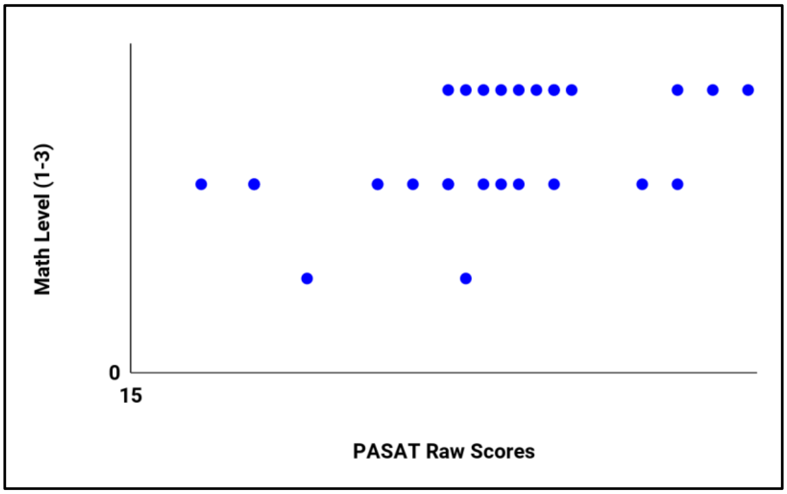
Math Level

Because the PASAT assesses cognitive acuity, the researcher of this study supposed that the current math level taken by students might influence their competence on the test. Among the participants, the current math classes taken included Algebra 1, Geometry, Algebra 2, Precalculus, Business Statistics, Calculus AB, Calculus BC, and Statistics. To find a correlative value between the current math level taken and the PASAT scores of students, the researcher categorized these classes into 3 math levels, as shown below:

Math Level	Classes Included
1	Algebra 1, Geometry, Algebra 2
2	Pre-calc, business statistics
3	Calc AB, Calc BC, Statistics

The researchers categorized these classes in the above way to represent the normal distribution of the high school population. Figure 5 below shows the correlation between math level (1 to 3) and raw PASAT scores (out of 50), with $r = .49$ and $p < .05$.

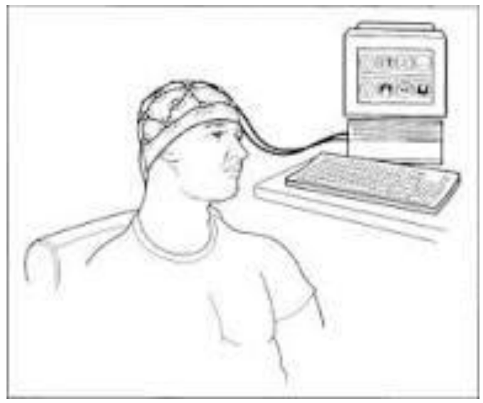
Figure 5



V. DISCUSSION

Like Draganich's study, self-reported sleep quality did not sufficiently predict student cognitive functioning; in other words, students did well on the PASAT regardless of how they personally reported their sleep quality from the night before. Rather, as predicted by the hypothesis, students convinced that they received above average sleep quality tended to cognitively outperform students convinced that they received below average sleep quality. However, it should be duly noted that the placebo improvement in PASAT performance between the two groups is *not* statistically significant (p = .18 at $\alpha - level\ .05$). In other words, it is likely that the difference between these two group mean scores was due to chance, rather than by the mechanisms of the placebo. In fact, while the difference in mean scores for Draganich's study was 12.68, the difference in mean scores for this study was only by 2.66. Comparable to Draganich's participants, the participants in this study were much less responsive to the sleep placebo. The difference in placebo response between these two studies likely occurred because the placebos themselves in each experiment were technically different: Draganich employed an

EEG monitor (Figure 6), while the researcher of this experiment employed a Finger Pulse Oximeter. While both experiments had participants told similar verbal instruction as well as shown similar spreadsheet displays, the technology participants interacted with were vastly different.



Source: www.ece.cornell.edu

Figure 6: An example of an EEG monitor

Because the BIOPAC EEG monitor in Draganich's study appeared more impressive and complicated, participants may have reacted rather strongly; on the other hand, because the Finger Pulse Oximeter in this study seemed more simple, students may have reacted less intensely. After all, as emphasized by classical conditioning theorists of placebo mechanism, stronger stimuli often lead to stronger placebo effects (Stewart-Williams, 2004).

<u>Cognitive Predispositions - Math Levels</u>

Instead of cognitive performance being mediated by the active placebo, other confounding variables may have had greater influence over students' suggestibility as well as their PASAT performances. Although the list of confounding variables is practically endless -- as it could include factors such as the age of the participants or even the time in which the participants were experimented on -- the confounding variable most sensitive to the design of the PASAT is arithmetic predisposition.

Despite the PASAT's design in assessing various cognitive attentional skills (Gronwall, 1977), researchers who have reviewed its reliability have noted that the PASAT is negatively affected by low math level (Tombaugh, 2006). After all, the test measures attentional skills based on the participants' ability to do rudimentary addition in short bursts of time; students more comfortable with these addition skills are predisposed to greater success on the test. Because students who participated in this experiment had varying predispositions to arithmetics -- varying from basic algebra to college-level calculus courses -- the instructions of the PASAT proved to be more difficult for some than others. Figure 5 mentioned earlier displays this tendency, as students who were currently learning at high math levels tended to outperform students who were currently learning at lower math levels. Although the correlative value is only moderately positive, it reinforces the contemporary review of the PASAT's shortcomings, especially with its inability to control and standardize various arithmetic predispositions.

The moderate relationship between math level and PASAT score reveals a significant limitation of placebo sleep, at least within this experiment: an inability to overcome varying cognitive predispositions. The goal of using placebo sleep as an independent measure implies that, when activated, it can change (enhance or impair) students' cognitive functioning. However, this change in cognition is only relative to the predisposed cognitive skills of the students. In other words, the PASAT should have been a measure of how the student's attentional skills *changed* in the face of the placebo sleep. With that in mind, a better design of this experiment's methods is to have the students come in and take the PASAT twice: once to measure their predisposed skills, and again to measure if those skills changed in response to the placebo. However, even with this new methodology, there are some considerable limitations: researchers have noted that the PASAT is extremely sensitive to practice effects (Tombaugh, 2006), that test-retest scores show that a second time taking the test will improve scores anyway.

Thus, for future explorations of this study, researchers should consider using multiple cognitive tests as dependent measures of cognitive functioning, such as those used in Draganich's second experiment (COWAT, SDMT, Digit Span Task, etc).

Students Skepticism

Up until this point, all measures of placebo mechanism within this experiment have assumed that every participant was completely convinced, or manipulated, by the sleep placebo. In fact, while all participants were convinced that the Finger Pulse Oximeter procedure was legitimate -- in that the "new, credible technique" mentioned was real -- not all participants were convinced that their personal measure of REM sleep could predict their PASAT test scores. The experimenter rated participants' convincement by noting their verbal and nonverbal reactions throughout the experiment and during the debriefing. Six participants (three from each assigned sleep quality group) admitted slight skepticism to the experiment's methods, specifically when the experimenter claimed that their personal REM sleep measurement may influence their cognitive abilities. Through debriefing, these six students were still surprised to find that the algorithm and spreadsheet used to measure their REM sleep were fake; therefore, the researchers of this experiment concluded that all students were, to an extent, convinced of the legitimacy of the "credible technique."

VI. CONCLUSION

This study sought to understand if cognitive self-efficacy techniques of placebo sleep could be applied by students at a suburban high school. The goal was, ultimately, to see if students who changed their perception of their sleep quality could accordingly change their cognition. As evidenced by the statistically insignificant differences between the two assigned sleep quality groups, no noteworthy self-efficacy effect was at hand. Despite the hypothesis appearing to be fulfilled, students' scores on the cognitive test were likely mediated by confounding variables, such as arithmetic predispositions. Of course, with a larger sample size -- one in which there are at least 30 individuals in each experimental group to fulfill the Central Limit Theorem -- it is possible that slightly different statistical results may have been yielded. As there are limitations needed to be addressed in both the mechanism of the placebo and design of the cognitive test implemented, further conducted experiments are necessary to determine if adolescents can undergo self-efficacy phenomena as commonly as adults have in past placebo research.

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