

# Displacements

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# Chemical Induction of PHB Depolymerases in Bacteria

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## Abstract

Petroleum-based plastics have a negative environmental impact based on their accumulation and inability to be broken down. The use of bioplastics is a possible solution to having the convenience of plastics without the environmental harm. Poly-hydroxybutyrate (PHB) is a bioplastic that is synthesized by certain bacteria to store carbon and energy. In order to use PHB as an effective energy source, some bacteria synthesize PHB depolymerases – enzymes that degrade PHB. These enzymes allow PHB to degrade more quickly than petroleum-based plastics. To find a quicker way to degrade PHB, chemical induction of PHB depolymerase activity in *Acidovorax wautersii* strain H8 was observed through turbidimetric assay. These assays were used to measure the cloudiness of solutions, which could be correlated to enzyme activity. PHB itself and its monomer, 3-hydroxybutyrate (3HB), both induced depolymerase activity. Based on PHB assays, 3HB is the more effective chemical inducer for this particular strain of bacteria.

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## Introduction

Petroleum-based plastics have become increasingly popular and with them have come the concern of their negative environmental impact. As a result of their convenience, plastics are produced at a rate exceeding 300 million tons annually (1) with a projected increase to 810 million tons per year by 2050 (2). Petroleum-based plastics can persist in the environment for thousands of years beyond their intended use, causing problems which include the accumulation of plastics in natural habitats, the potential ingestion and entanglement of plastic by animals, and the leeching of petroleum-based chemicals into environments (1). A potential alternative to using conventional petroleum-based plastics is using bioplastics. Bioplastics are derived from living sources, and some have the potential to be more biodegradable than conventional plastics. Poly-3-hydroxybutyrate (PHB) is one such bioplastic.

Discovered in 1925 by Lemoigne (3), PHB is synthesized by certain bacteria as a form of energy storage similar to fat storage in animals (4). PHB accumulates in storage granules of PHB-producing bacteria, and when these bacteria die, they leave PHB in the environment. PHB-degrading bacteria can then use their extracellular depolymerases to break down and utilize this PHB (3). These depolymerases used by PHB-degraders help to break down PHB into its constituent components, which are non-toxic and naturally found in animals (2). This decrease in environmental harm means that PHB and similar bioplastics can help to alleviate some of the problems caused by conventional plastics.

PHB is in a class of biodegradable polymers known as polyhydroxyalkanoates (PHAs), and is itself considered a short chain length PHA (5). PHAs are promising alternatives to conventional plastics because they can have a wide variety of side chains in the polymer, and so can have similar properties to polyethylene, polypropylene, and other petroleum-based plastics (6). PHB itself has potential as a food containing bioplastic, since its permeability to oxygen is less than that of polyethylene or polypropylene (6). In terms of commercial applications, PHAs have already been used in the creation of shampoo bottles and in waterproof films on the back of diaper sheets (2). PHB also has potential uses in the medical field due to its lack of toxicity and promotion of regeneration. Thus, PHB may be used to construct orthopedic pins, stents, stitches, and nerve guides (7).

Over twenty PHB-degrading bacteria have been isolated from sewage, compost, and water treatment facilities, and they have been further characterized and identified in the laboratory (8). Selection of PHB-degrading bacteria was done by plating bacteria onto plates where PHB was the sole carbon source. The next step was to test whether PHB-degrading enzyme activity was inducible, specifically in *Acidovorax wautersii* strain H8. Work has been done on the characterization of a PHA depolymerase in another *Acidovorax* strain (9), but this study sought to potentially quicken the degradation of PHB through chemical induction of PHB depolymerase.

In order to make PHB and similar bioplastics an efficient alternative to petroleum-based plastics, the degradation of PHB into harmless components needs to be optimized. Currently, PHB degradation occurs

relatively slowly (9), and PHA shampoo bottles were observed to take 5-10 years to degrade in field experiments (2). The optimization of PHB degradation would cause the bioplastic to be rid of more quickly, decreasing its environmental impact. This study sought to answer the question of what chemicals (inducers) could stimulate or inhibit the activity of enzymes responsible for degrading PHB by *Acidovorax wautersii* strain H8, and if activity of these enzymes could be stimulated, which inducers were best at induction. Knowledge of inducers is important because it can provide a solution to bioplastic degradation before the potential problem of PHB-based plastic accumulation occurs.

## Methods

*Acidovorax wautersii* strain H8 was isolated and identified from CSU Chico compost and was tested for PHB depolymerase activity induction with various chemical agents. The chemical agents that were tested were PHB (Sigma Aldrich 363502), 3-hydroxybutyrate (Sigma 166898), polylactic acid (PLA), lactose, and glucose. The bacteria were grown in tryptic soy broth (TSB) overnight, harvested by centrifugation, and diluted to 1:100 in M9 + nutrient broth. This culture was grown to exponential growth, harvested by centrifugation, and resuspended with ¼ original volume M9 salts. The cell suspension was aliquoted into flasks, and then 2 mL of the test inductant was added. Each induction flask was done in duplicate. Samples were taken from each flask at 4, 8, 12, 16, and 24 hours for the first round of experiments (for the second round, samples were not taken at 24 hours). The control sample with no test inductant had an additional sample taken at 0 hours. The samples were centrifuged and the cell-free supernatant containing the exoenzymes was assayed for activity.

The first assay involved mixing the supernatant with a solution of PHB and measuring the absorbance, using a spectrophotometer at 600nm wavelength, as the PHB was broken down by the depolymerase. The A600 of the samples was read at 0, 5, 10, 20, 30, 45, 60, 75, and 90 minutes. The second assay was an Indoxyl acetate assay, which produced a blue product that was measured by a spectrophotometer at a wavelength of 660 nm. In this assay, 0.5 mL of the supernatant was combined with 0.4 mL of phosphate buffer saline (PBS) 10mM, pH 7.4 buffer in a cuvette and equilibrated at 34°C for 10 minutes, then 0.1 mL of

protein, and designing primers to find the gene that encodes the enzyme. Additionally, more induction studies may be performed on other isolates.

Characterizing exoenzyme activity in isolate strains is important because it may be helpful in creating an efficient means toward bioplastic degradation. In order

indoxyl acetate (10 mg/mL in 100% ethanol) was added to the mixture to start the reaction.

With the assays used, certain outcomes were expected if a chemical was an inducer. In the PHB assay, a decrease in A660 corresponded with a degradation of PHB, so a more substantial decrease indicated induction of enzyme activity. For the Indoxyl acetate assay, an increase in A660 over time indicated induction of enzyme activity because PHB depolymerase oxidizes indoxyl acetate into indigo (10), producing a blue product that increases A660.

## Results

PHB assays showed the greatest decrease in A600 for those cultures that were grown in the presence of 3HB and PHB (Fig. 1). Similar results were observed for the indoxyl acetate assays, with A660 increasing most when 3HB and PHB were presented as inducers (Fig. 2). For the PHB assays, greatest enzyme activities for 3HB and PHB induced cultures were from samples taken at 8 hours in the presence of the inducer (Fig. 1). The rest of the inducers (PLA, lactose, glucose) displayed no large difference from the control in terms of enzyme activity for both the PHB and indoxyl acetate assay. For these inducers, the A600 for the PHB assays remained relatively stable with regards to both induction and assay incubation time, while the A660 for the indoxyl acetate assay showed slight increase over assay incubation time in a manner similar to the control (Fig. 2).

## Discussion

The results suggest that both 3HB and PHB chemically induce the PHB depolymerase activity of *Acidovorax wautersii* strain H8. According to PHB assays, 3HB appears to be a better inducer for PHB depolymerase activity (Fig. 3). 3HB, being the monomer of PHB, may induce enzyme activity based on its similarity in shape to PHB (11). Chemical induction increases PHB depolymerase activity, but further studies will have to be done to understand the mechanism of induction (i.e. as a cofactor for the enzyme, as an inducer of gene expression, or as a signal for extracellular transport).

Future studies will likely model others that have isolated and characterized PHB depolymerases (3,5,12,13). Similarly, cloning of the gene that encodes PHB depolymerase into other bacteria may be performed. This process would involve isolating the depolymerase, sequencing the N-terminus of the

to create environmentally conscious bioplastics, there needs to be a method of degrading them so that their effect on natural habitats and wildlife is reduced. If the degradation of a bioplastics such as PHB can be optimized through the use of inducing chemicals, environmental harm caused by the long-term



persistence and accumulation of petroleum-based plastics may be decreased.

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Figures

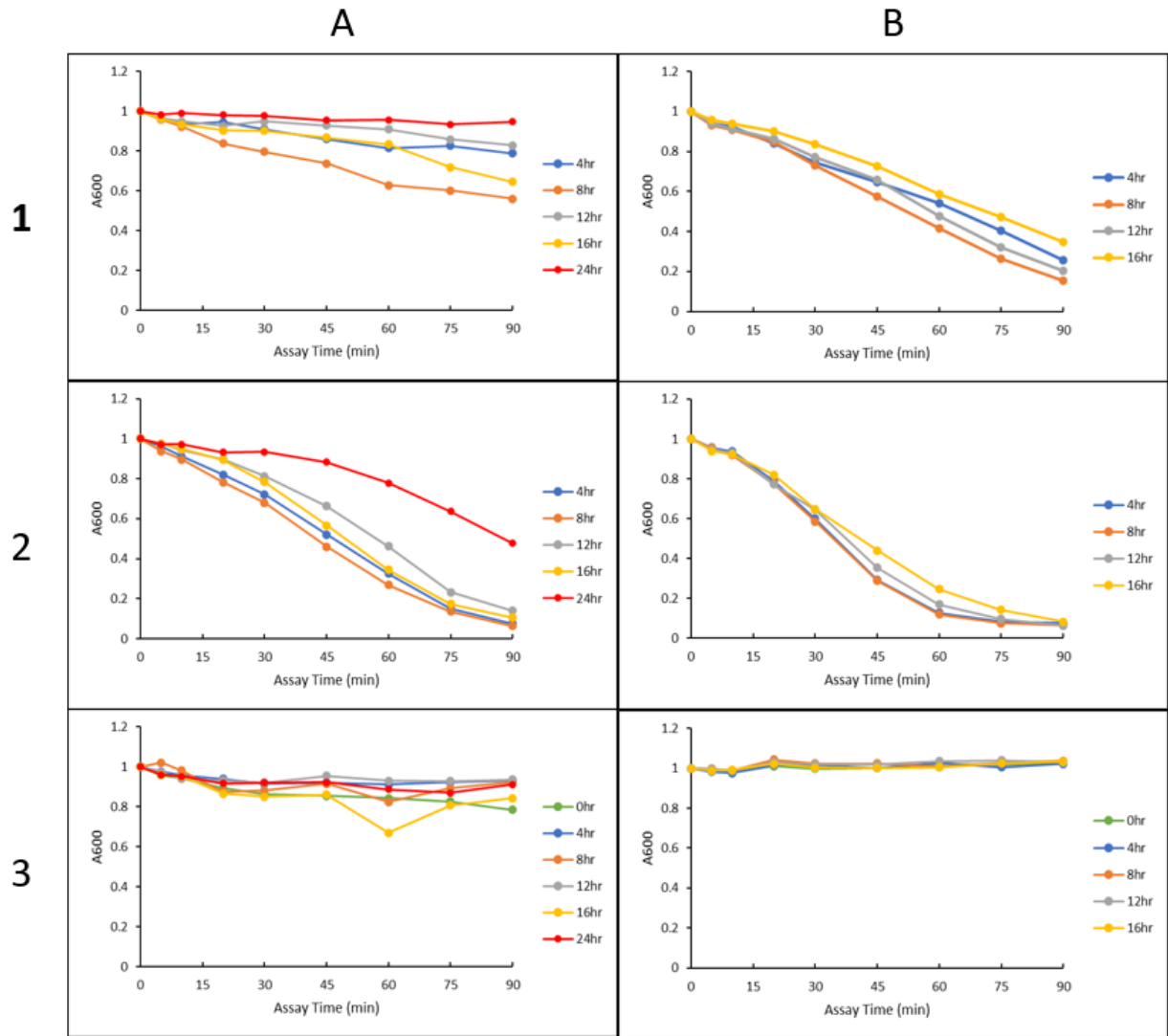


Fig. 1: Normalized absorbances (A600) of PHB assays over time, with results from Spring 2019 (A) and Summer 2020 (B). Each row represents a different inducer tested: PHB (1), 3HB (2), and the control (3).

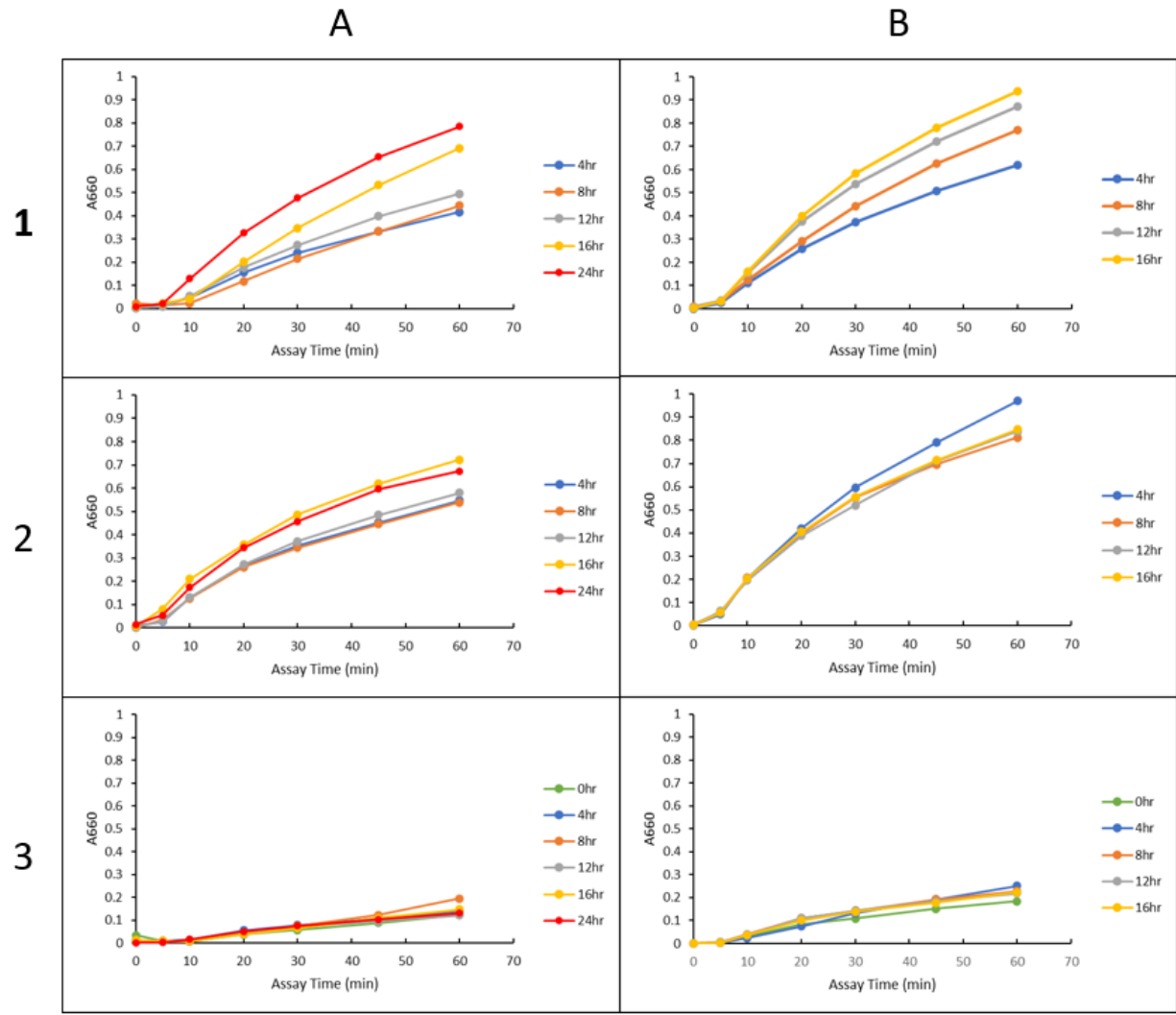


Fig. 2: Absorbances (A660) of indoxyl acetate assays over time, with results from Spring 2019 (A) and Summer 2020 (B). Each row represents a different inducer tested: PHB (1), 3HB (2), and the control (3).

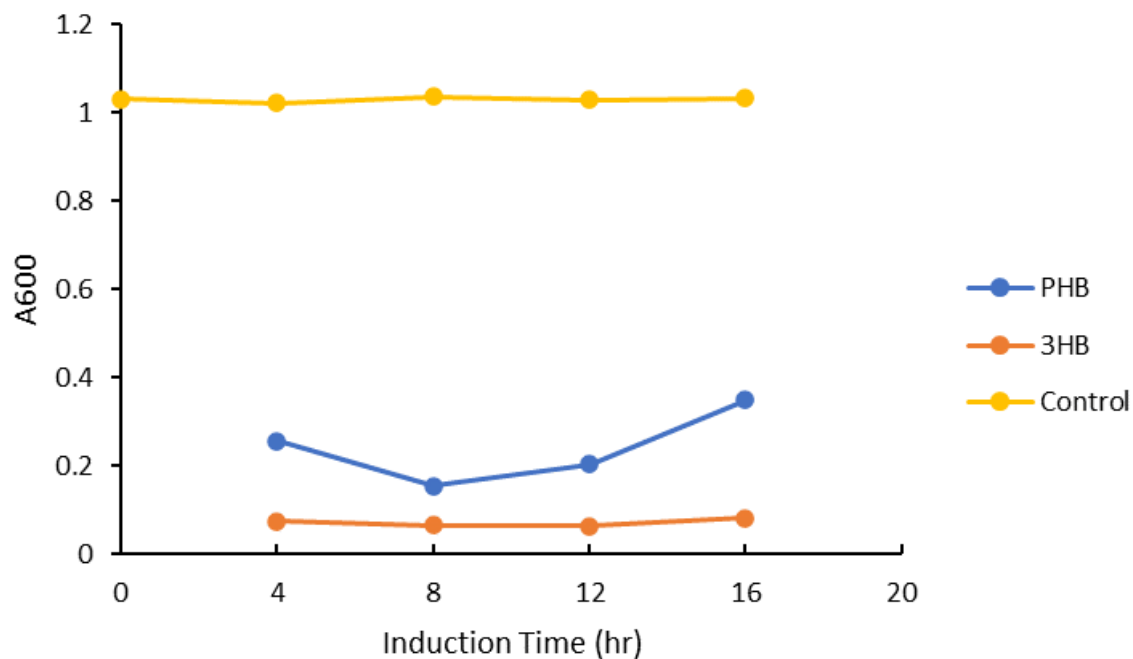


Fig. 3: Normalized absorbance (A600) of Spring 2020 PHB assays at 90min for each induction sampling time.

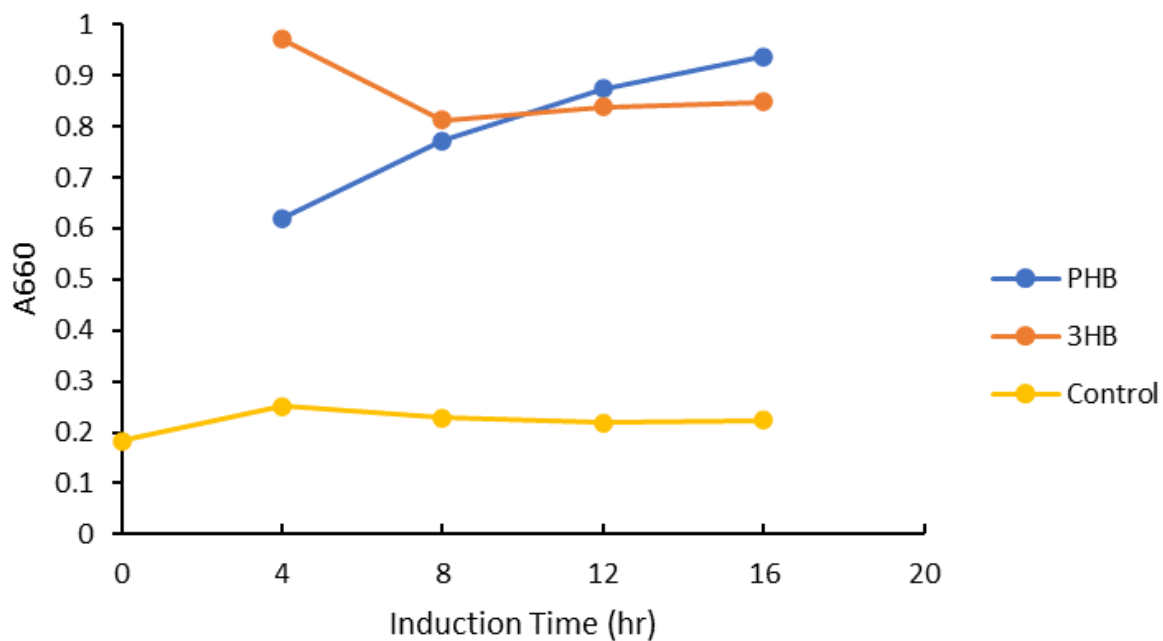


Fig. 4: Absorbance (A660) of Spring 2020 indoxyl acetate assays at 60min for each induction sampling time.

# Gender Differences in Memory Recall Among College Students

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## Abstract

Memory recall impacts cognitive performance in both men and women. The present research examined gender differences in memory recall through a Free Recall Memory Test and a Visual-Spatial Test. It was hypothesized that women will score higher in performance compared to men in Free Recall and that men will score higher in performance compared to women in Visual-Spatial Recall. A sample of 248 students (212 females, 35 males) students were recruited through CSU Stanislaus Department of Psychology online participant pool (SONA). All participants completed the Free Recall Test which consisted of memorizing 10 gender-neutral words and 10 numbers in 60 seconds. After reading a short distractor paragraph, participants were then instructed to select the correct words and numbers from the previous list. Participants then completed the Visual-Spatial Test, which consisted of five short video clips showing a 4x3 grid label with letters. After viewing each video, participants were asked to select the correct sequence shown in the video. To test whether there were differences in memory recall between the two genders, data were analyzed using an independent samples t-test. The research hypothesis was not supported. No significant results were found relative to free memory recall, or visual spatial recall. Although not significant, women scored slightly higher in free memory recall and slightly lower in visual spatial memory recall as compared to men. Results from this study are inconclusive when compared to previous studies. Additionally, scores from both the free recall and visual spatial task suggest there are no differences between male and female students.

*Keywords: Memory, Free Recall, Visual-Spatial Test*

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## Introduction

There has been much debate on whether there are gender differences in memory recall between men and women. It is important to analyze gender differences in memory recall as it can be helpful for different teaching methods to enhance the student learning process. Recent research has examined different factors that increase memory recall such as, masculine stereotype items, feminine stereotype object, and gender-neutral items using a free recall test (Baer et al. 2006). It was determined that women were more likely to score high in performance on a free recall test compared to men. It has also been shown that men have a higher level of visual episodic memory compared to women (Pauls et al. 2013). However, there is no conclusive evidence suggesting gender differences in memory recall among college students.

## Literature Review

In an attempt to examine how gender stereotypes affect memory recall, Baer et al. (2006) hypothesized that participants would recall more stereotypical objects relative to the participant's gender. A sample of 176 undergraduate students, 97 females, 79 male participants were presented with a sheet of paper containing 30 objects presented in random order. Ten of the objects were stereotypically masculine, 10 were stereotypically feminine, with the remaining 10 being gender neutral. Participants were instructed to view the 30 objects for a period of one minute, at which time they were instructed to turn the page over and write down as many objects as possible from the previous list. They were given two minutes to complete the memory recall test. Results indicated that female students scored higher in performance on both stereotypical feminine objects and gender-neutral objects compared to male students. No significant differences were found relative to

stereotypical masculine objects between male and female students. Pauls et al. (2013) examined the effects of gender differences and age on episodic memory and visual working memory. A sample of 696 participants, 330 men, 366 women between the age of 16-69 were asked to complete the Wechsler Memory Scale (Wechsler, 2009) which was designed to assess auditory episodic, visual episodic and visual memory. Each test was given to the participants with appropriate designs relative to the type of memory being tested. Results indicated that there were gender differences in memory recall between men and women. Overall, women scored higher in performance on the auditory memory task compared to men. It was determined that adolescents and male adults scored higher in performance on both visual memory tasks. The purpose of the present study was to examine gender differences in memory recall among college students. Participants were instructed to complete a memory task relative to free memory free recall, as well as a task relative to visual-spatial memory. It was hypothesized that women will score higher in performance compared to men when given a free recall test. It was also hypothesized that men will score in higher performance on a visual-spatial test compared to women.

## Methods

### *Participants*

A sample of 246 participants (212 females, 34 males) students were recruited through the CSU Stanislaus Department of Psychology online participant pool (SONA). The participant's ages ranged from 18 to 53. The sample was predominantly Hispanic/Latino (56.1%), heterosexual (89%), and upperclassmen (74.9%). All Participants were given 2 SONA credit for participating in the study, which may have counted as experimental credit for a psychology class.

### Design

The research design was a single factor, two-group, between-subjects design to examine gender differences in memory recall among college students. The independent variable was gender, male or female. Participants were asked to identify which gender they identified most with. The dependent variables were memory recall scores on the free recall test and the visual-spatial test.

### Measures and Materials

The measures used in the study were a demographics questionnaire, a free recall memory test and a visual-spatial memory test. The demographics questionnaire consisted of 5 questions designed to assess the participant's personal characteristics, 1 which asked them to indicate which gender they identified with. The free recall memory test consisted of 30 gender neutral words and numbers, 20 of which were part of a previously viewed word and number list. The visual spatial test consisted of 5 multiple choice questions, 1 question for each sequence previously viewed in each video, designed to assess the participant's ability to select the correct sequence viewed. The materials used in the study included the free recall task consisted of a list of 20 random gender neutral words and numbers, a short paragraph used as a distractor exercise, and the visual-spatial task which consisted of five videos, each which contained a grid of 4X3 boxes labeled with letters. Each video also contained a different sequence of letters. The first video consisted of the following sequence B, F, N. The second video sequence consisted of F, J, T, Q. The third video sequence consisted of T, V, D, S, B. The fourth video sequence consisted of C, P, F, J, T, Q. The final video sequence consisted of P, S, B, E, Q, D, N.

### Procedure

Participants were recruited through SONA and various classrooms with professor permission. Those who were interested were able to access further information about the study, the consent form, questionnaires, word lists, video clips, and scales through Qualtrics. Once a participant agreed to participate, he or she was instructed to complete a consent form. After completing the consent form, the participants were instructed to complete a demographics questionnaire, at which time they were asked to identify which gender they most identified with, male or female. Participants were then instructed to complete a free recall task at which time were shown a list of 20 random words and numbers that they were asked to memorize for a period of one minute. They were then asked to read a short paragraph for distraction purposes. After indicating that they are done reading the paragraph, participants were instructed to complete the Free Recall Memory Test at which time they were shown a second list of 30 random words and numbers, 20 of which were part of the original word and number list. Participants were instructed to select all the words and numbers they were able to recall from the original list. After completing the Free Recall Test, participants were directed to the visual spatial task at which time they were asked to watch the first of the five video clips showing a 4X3 grid label with letters. After viewing each video, participants were asked to complete the Visual-Spatial Test at which time they were instructed to select the right sequence shown in the video.

At the end of the study, the participants were directed to the debriefing sheet at which time they were thanked for their participation and the purpose of the study was explained to them. It was clarified to them that the study's purpose was to examine factors pertaining to gender differences in memory recall in college students.

### Results

Data were analyzed using an Independent samples t-test to determine if there are gender differences in memory recall among college students. No significant results were found relative to free memory recall,  $t(246) = -0.56, p = .96, d = .01$ , or visual spatial recall,  $t(246) = 1.18, p = .23, d = .23$ . Although not significant, women scored slightly higher in free memory recall, ( $n = 212, M = 9.96, SD = 4.5$ ), and slightly lower in visual spatial memory ( $n = 212, M = 3.92, SD = 1.61$ ) compared to men ( $n = 34, M = 9.91, SD = 3.99; n = 34, M = 4.26, SD = 1.36$ , respectively) (see Table 1 and Figure 1).

Table 1  
Descriptive Statistics for Memory Recall Tests as a Function of Gender

Gender	Type of Memory Test					
	Free Recall			Visual-Spatial Task		
	n	M	SD	n	M	SD
Male	34	9.91	3.99	34	4.26	1.36
Female	212	9.96	4.5	212	3.92	1.61

Note. N = 246

Figure 1

Mean Score for Memory Recall Test as a Function of Gender



### Discussion

The results of the present study did not support the hypotheses that women will score higher in performance compared to men when given a free recall test and that men will score higher in performance on a visual-spatial test compared to women. Although there was a slight difference between men and women, the results are not consistent with (Pauls et al.2013) study. Results from this study may also suggest that in reality there are no gender differences in memory recall among college students when given a Free Recall Test and a Visual-Spatial Test.

### Future work

In most research studies, there are limitations that affect the overall outcome of the study. In this study, limitations involved a small sample size and the sample being restricted mainly to one college campus. Since this study mainly focused on gender differences, results may

possibly be inaccurate. There was a disproportionality between genders, female students predominantly outnumbered male student participants. In order to receive more accurate results, future studies should focus on recruiting an equal sample size between men and women.

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# Disruption of Mating-type Switching in Industrial Strains of *Saccharomyces cerevisiae* Strains by CRISPR/Cas9

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## Abstract

Yeast, *Saccharomyces cerevisiae*, is an important organism used to make a multitude of products for human consumption including bread, beer, and wine. There are different strains of yeast that exhibit a variety of flavor profiles and ethanol content during alcohol fermentation due to their differing genetics. To exhibit new characteristics and flavor profiles in alcoholic beverages, genetic changes to existing yeast strains must occur. I plan to use cell fusion of two strains to make a novel hybrid strain. For successful cell fusion, both strains must sporulate to produce stable haploids that cannot switch their mating type. I am interested in using English cider for cell fusion; however, it has the ability to switch its mating rendering impossible to use. I plan to solve this problem by using CRISPR/Cas9 technology to introduce a mutation into the gene that allows the mating type switch to occur. Once a mutant is identified, cell fusion experiments of English cider with banana sake yeast will create novel yeast hybrids. These hybrids can be used to make new alcoholic beverages that exhibit good flavor profiles while also having a high ethanol content.

## Introduction

Yeasts are a widely used organism that makes the creation of alcoholic drinks easy and affordable. Companies that brew alcoholic drinks using yeast are always looking for ways to improve their products by creating new flavors with different levels of ethanol content. The dream of any consumer would be a drink with high ethanol content with a pleasant taste. The creation of novel yeast strains will change the future of the alcohol industry. To make new yeast strains, genetic changes must occur. Several technologies currently being used to cause genetic changes include mutation, spheroplast (protoplast) fusion, electrofusion and transformation, and cell fusion (hybridization)<sup>1</sup>. Cell fusion imitates the natural yeast life cycle therefore making it the most natural technique.

Yeast cells can be found in three different cell types:  $\alpha$ -haploid, a-haploid, and  $\alpha/a$  diploid. The  $\alpha/a$  diploid cells cannot mate with each other, however, they can sporulate into four haploid cells through meiosis producing two  $\alpha$ -haploids and two a-haploids. The two opposing haploid mating types can mate through a process called cell fusion in order to become one  $\alpha/a$ -diploid cell<sup>2</sup>. To fuse two different yeast strains, the haploids must be isolated into their respective mating types. Homothallic strains have the ability to switch their mating type while in haploid form, which allows them to mate with the other cells with which they were isolated. This instability of haploids mating type makes homothallic strains

impossible to use for cell fusion with another yeast strain's haploid.

Two requirements must be met if any yeast

Yeast strain	Sporulation	Mating-type switch
English cider	yes	yes
Chardonnay wine	yes	no
Banana sake	yes	no
sake	yes	yes
Sweet mead	yes	no
American wheat	no	N/A
Irish ale	no	N/A
Italian red	no	N/A
Octoberfest	no	N/A
Abbey IV ale	yes	no

Table 1: Testing of sporulation and mating-type switch of yeast strains.

strain can be used for cell fusion: 1. the yeast must sporulate into haploids and 2. those haploids must exhibit mating type stability (that is, no mating-type switch). Several industrial strains have been tested and characterized in our lab for those two requirements (Table 1). Six strains successfully sporulated and only two of those six could switch mating type. The strain that I will be using is the English cider strain, which is able to sporulate stable haploids, but the haploids switch mating types thus cannot be used for fusion with other haploids. This mating type switch is



possible because of a site-specific endonuclease

Position	209	238	279	369	413	417	485	486	492	506	527	565	667	668	789	836	1009	1184	1214	1377	1424	1635	1710	1740	1741	1759
Wild-type <i>HO</i>	G	C	C	G	C	T	T	T	T	T	T	A	G	G	A	A	G	A	T	C	A	C	C	C	G	T
English cider	G	C	C	G	C	T	T	T	T	T	T	A	G	G	A	A	G	A	T	C	A	C	C	C	G	T
Mutant <i>ho</i>	G	T	A	A	C	T	T	T	T	T	T	G	A	G	A	A	A	A	C	T	T	T	T	T	G	T
Banana sake	G	C	A	A	C	T	T	C	T	T	T	G	G	G	G	A	A	A	T	C	T	C	A	T	G	T

Figure 2: DNA sequence positions of wild-type *HO* gene compared to mutant *ho*. English cider strain exhibits *HO* genotype, whereas Banana sake exhibits *ho* genotype.

expressed from the *HO* gene<sup>3</sup>. In one study, others have isolated many *ho*<sup>-</sup> mutants from nature and characterized their mating type switch<sup>4</sup>. There were a few common sites of mutation in the *HO* gene in heterothallic cells found in nature that seem to inactivate the endonuclease and thus mating type switch<sup>4</sup>. The main goal of my project is to use CRISPR/Cas9 technology to precisely mutate A->T at the 1424<sup>th</sup> position of the *HO* gene to create a heterothallic English cider strain.

The strain we have chosen to mutate is English cider because it retains good flavors during fermentation, can sporulate, and is homothallic. The English cider strain has the wild-type *HO* genotype (Figure 2), which is why it's haploids can switch-mating types. Banana sake exhibits high ethanol content and is a possible candidate for cell fusion.

### Methods

The CRISPR/Cas9 protocol used was developed by Cold Springs Harbor Laboratory<sup>7</sup>. I first designed a primer set to create pCAS-gRNA plasmid that would express a guide RNA which locates the exact position in the genome that we want to mutate. I also constructed the repair DNA by designing another primer set and PCR reactions. This repair DNA is needed when the yeast double-strand break repair system introduces the A1424T mutation after the Cas9 enzyme cuts the DNA where the guide RNA binds. The purified pCAS-gRNA and repair DNA were transformed into competent English cider yeast and screened for mutants. The plasmid had an antibacterial resistance gene for kanamycin. We used YPD+ Kanamycin plates to screen for cells that had successfully taken-up and expressed the plasmid. Possible candidates were grown in YPD to increase the cell count, then Quiagen DNA miniprep kit was used to lyse and extract the DNA from the cells. PCR was performed to amplify the *HO* gene and some candidates were sent to Eton Biosciences Inc. for sequencing.

### Results

Previous members of my lab analyzed sequences to find that Banana sake is heterothallic and has the mutant *ho* genotype with the A1424T mutation that we are targeting for English cider (Figure 2). A study that tested the genotypes of several yeast strains found in nature found several common mutations in the *HO* gene in heterothallic strains. One of the most common mutations to the gene found in all but one strain tested was an adenine to thymine at 1424<sup>th</sup> position (CAT → CTT, His → Leu). According to Meiron *et al*<sup>5</sup>, the A1424T mutation causes a loss of function of the *HO* endonuclease that inhibits its binding to DNA. This mutation has also been shown to decrease the mating type switching ability, but did

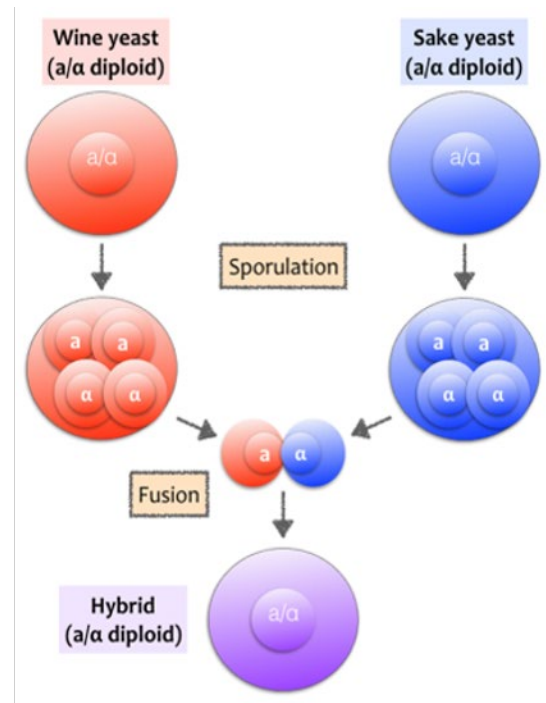
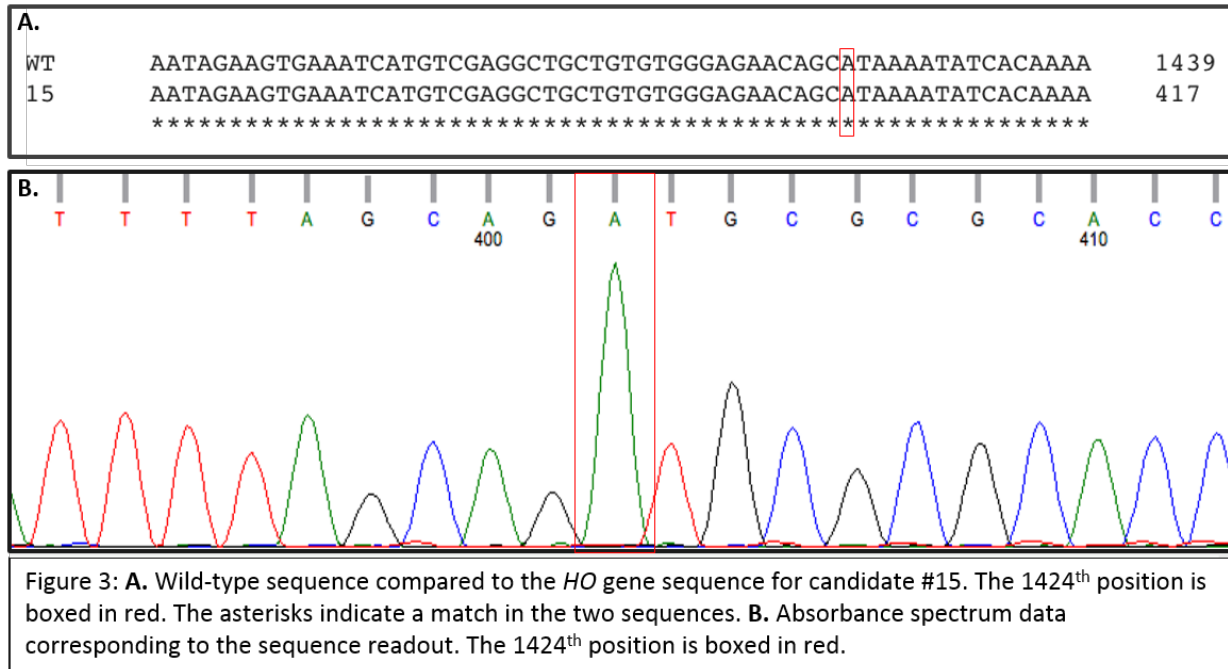


Figure 1: Cell fusion of two yeast strains creating a hybrid diploid.

not eradicate it completely<sup>6</sup>. For these reasons, the A1424T is the target mutation in English cider strain. If this mutation gives a heterothallic phenotype in the English cider yeast, it would add to the overall understanding of the yeast genome. It would also provide an easy solution to creating more natural yeast hybrids from other naturally homothallic strains.

and change possible variables within the protocol that may be producing low yields. CRISPR/Cas9 is a new technology that has not yet been perfected. With repetition and trouble-shooting, I could design a CRISPR protocol that works best with the English cider strain.



A total of 50 candidates were isolated after screening for expression of the pCAS plasmid. I could not predict the mutation success rate, so I wanted a plethora of candidates to analyze to increase the chances of finding a successful mutant. So far, ten candidates (#1-5, #11-15) had their *HO* gene genotyped for the A1424T mutation. All 10 of those candidates came back negative for the mutation and showed the wild type genotype. In figure 3.A, you can see the wild type genotype compared against the sequencing data from Candidate #15. At the 1424 position, there is still an A rather than a T. The figure shows only the section of the *HO* gene that the target mutation was located and not the entire gene sequence. The absorbance data in figure 3.B shows a strong peak for adenine at the 1424 position to confirm it was an accurate read. The remaining candidates still need to be sequenced to see if any mutations were successfully integrated into their genome.

### Discussion

Within the 40 remaining candidates, It is possible that none of the 40 candidates have integrated the mutation. In this case, I would repeat the transformation experiments with the pCAS plasmid

A more desirable outcome would be one of the candidates having a successful mutation. A Successful mutation would give insight to the yeast genome, the functionality of the *HO* gene, and the importance of the sight specific mutation made. If a mutation is found, the original colony of that candidate will be streaked on multiple YPD plates to increase the number of cells to be used for later experiments. They will then be tested for the two requirements for cell fusion, which are sporulation and haploid mating-type stability. If they are positive for both requirements, then that mutant candidate can be used for cell fusion experiments with Banana sake strain to create a new hybrid strain. The hybrid strain could be used to create new products as it may exhibit characteristics of both the English cider and Banana sake strain during fermentation. Though CRISPR products cannot legally be sold yet, this has the potential to transform the way companies and consumers think about alcohol production and the safety associated with introducing a single nucleotide targeted mutation.

### Acknowledgements

I would like to give a huge thank you to my mentor Dr. Choong-Min Kang for guiding me through this project. A special thanks to Nathan Weber and the

rest of the Kang Lab for being there by my side while experimenting. Finally, thank you to the McNair Scholars Program and the Honors Program for supporting me in my endeavors as a scientist.

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# The Detection and Extraction of Microplastics From the Pacific Mole Crab from Del Monte Beach, Monterey, CA

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## Abstract

400 million tons of plastic is produced annually and remains in the environment, breaking down into increasingly smaller pieces. Microplastic pollution is a major emerging threat to global environmental health. These microscopic pieces of plastic can cause physiological, mechanical, and chemical injuries on organisms; moreover, microplastic bioaccumulation could harm organisms higher up the food chain. This study examines the presence of microplastics in the biota, specifically the Pacific Mole Crab, *Emerita analoga*. Samples were collected at Del Monte beach in Monterey Bay, CA. By detecting and quantifying microplastics in the environment, the pervasiveness of microplastic pollution along the California coast can be determined. Detection of microplastics in the crabs was completed by digesting organic material and filtering the digest. Quantification of microplastics was done using Nile red and observation under a fluorescent microscope. My results indicate that microplastics are a widespread contaminant in the marine environment of Monterey Bay, found in two thirds of the crab sample population. A correlation between the size and weight of the crabs and the number of microplastics was also found.

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## Introduction

Millions of tons of plastic is produced around the globe every year. Considering much of this plastic ends up littering our environment, a significant amount of plastics ends up contaminating our planet. Because plastic is basically non-biodegradable, this plastic remains in our environment, accumulating, and because it cannot be degraded, the larger plastic is instead broken down into smaller and smaller pieces by factors like weathering and erosion. This process is similar to how rocks are broken down into sand. Microplastics are tiny particles of plastic, ranging from five millimeters to one micrometer (Sharma and Chatterjee 2017). There are many ways microplastics could cause damage to the environment. Microplastics could contain toxins that could be harmful to the ecosystem and are a major emerging threat to environmental health. This pollution has the potential to harm both the environment and humans. Microplastics can cause physical and mechanical harm in organisms, such as by blockages or internal injuries, as well as chemical damage. This chemical damage is caused by the microplastics acting as a vector, absorbing and accumulating harmful

substances inside an organism (Guzzetti et al. 2018). These harmful substances include heavy metals, DDTs, hydrocarbons, pesticides, etc., which can act as stressors, toxins, mutagens, or carcinogens. The Pacific mole crab, more commonly known as sand crabs, are found all along the North American west coast from Kodiak Island, Alaska, all the way to Baja California. They are incredibly important invertebrates to the coastal food chain and are indicator organisms, reflecting the health of their environment (Horn et al. 2019). Due to global warming, essential organisms in the intermediate part of the food chain are dying out, causing higher organisms to change their regular diet. Larger mammals, such as sea otters and sea lions, are such an affected population. These larger mammals are being forced to eat things that are not regularly in their diet, such as the Pacific mole crab. Sand crabs filter-feed plankton, specifically dinoflagellates. However, sand crabs can also filter feed other things that reside in the water, such as microplastics.

This research on sand crabs also has a broader ecological significance. A sand crab filter feeds by burrowing in the sediment and sticking their antennae in the water above, where they can filter plankton from the water. As a sand crab filter feeds, microplastics can accumulate in their tissue if microplastics are present in their environment. When a predator ingests multiple

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microplastic-contaminated crabs, a more significant number of microplastics is taken in, increasing in its concentration in the predator's tissues. This process is called biomagnification. Biomagnification causes increasingly higher concentrations of the chemical to accumulate in animals farther up the food chain and could cause significant harm to tissues of fish, birds, and marine mammals (Nelms et al. 2018). This study investigated the presence of microplastics in the bodies of sand crabs. When microplastics were detected, they were quantified, and their type and size were analyzed. Due to significant microplastic pollution on the Californian coast, I will find microplastics in the gills and digestive tract in approximately a third of the Pacific mole crab samples.

## Methods

### Crab sample preparation:

The Pacific mole crab samples were collected from a coastal beach at Del Monte beach in California. All the crab samples collected were female. The crab samples were taken to CSU Stanislaus and frozen. To begin an experiment, one to three crab samples were thawed, and the carapace length and the weight of each crab was measured. The crabs were then rinsed to rid the outside of any sand or debris. The egg mass, shell, and legs were then removed. After de-shelling, the crab was crushed using a mortar and pestle until a smooth paste remained. 30% Hydrogen peroxide was added to the crushed crab sample and mixed with the pestle, until it was a fairly homogeneous mixture. After pouring the mixture into a clean glass container, the mortar and pestle was rinsed with hydrogen peroxide until the mortar was clean. Then the crab/hydrogen peroxide mixture was put into the glass container, which was then put into the shaking water bath and incubated it at 40°C for 48 hours.

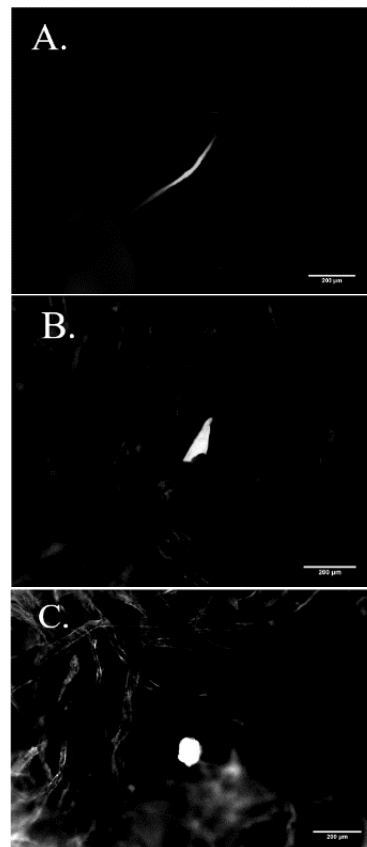
### Filtration and Microscopy

Upon completion of incubation, the digest was filtered using a vacuum filter. After moving the digest to the top portion of the filter, the tissue-solution was filtered through a paper membrane (pore size of 22µm). After filtering, the sample was moved to a clean glass petri dish and a quick optical examination was done. The filtrate was then stained with 3-4 drops of Nile Red fluorescent staining dye. After letting the dye sit for ten minutes, the stained filtrate were covered with aluminum foil and subjected to the fluorescent microscope. The circular piece of filter paper was placed onto a clean glass slide, and examined for microplastics. If microplastics were present, they fluoresced. Only fluorescing pieces ranging between five millimeters to one micrometer were observed as that is the diameter range criteria of microplastics. The

TRITC filter, a 2.5 msec exposure time, and a 100X objective lens were used to view the samples. Microplastics were photographed using computer software, their shape types determined, and size quantified using the computer-generated program software. The number of microplastics that were found per crab was recorded and a size bar and labels were added to each picture of the microplastics.

### Analysis

The microplastics were divided into three different types by shape: microplastic fibers, microplastic beads, and microplastic particles. Fibers (A.) were long thin string-like pieces of microplastic. Particles (B.) were oddly shaped pieces that had jagged edges. Microbeads (C.) were rounded microplastics with a smooth circular outline. I then put all the collected data into an Excel sheet and kept the pictures to analyze later. The data was analyzed using Excel and ImageJ. Water and sediment samples taken from the same location as the crab samples were saved for future analysis

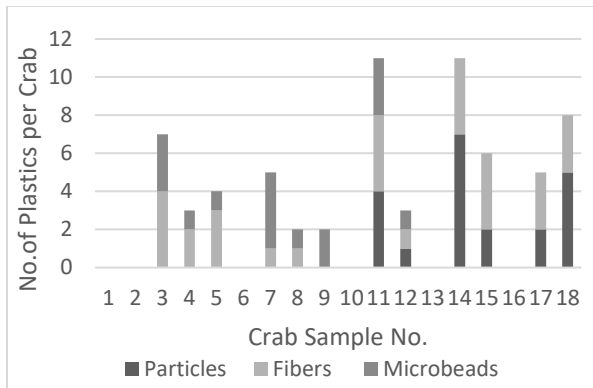


## Results

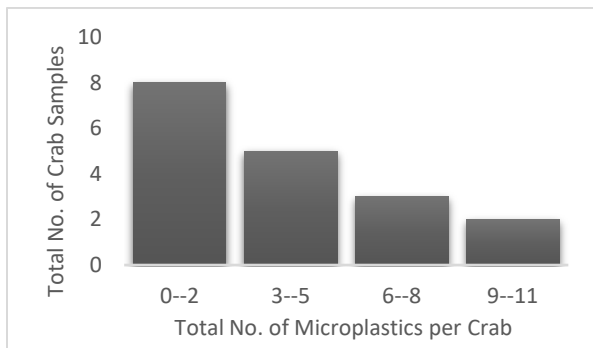
The data from eighteen female crab samples was collected and analyzed between November 2019-

May 2020. Two thirds of the crab samples were found to have microplastics in the internal bodies of the crabs (12/18). The average number of microplastics found in the samples that contained microplastics was approximately five pieces. The most amount of microplastics found in one crab sample was 11 pieces of microplastics and there were six crabs that contained zero microplastics. The most numerous type of microplastic I found in the crabs was microplastic fibers, which accounted for 45% of the total microplastics found. The least common type of microplastic I found was microplastic beads, which made up 24% of the total microplastics found.

The average carapace length of the crab samples was 31.71mm, with a range of 27.99mm - 36.66mm. The average weight of the crab samples was 3.74 g, with a range of 2.165g – 5.746g. There is a correlation between the total number of microplastics and the weight of the crab as well as a correlation between the total number of microplastics and the length of the carapace.

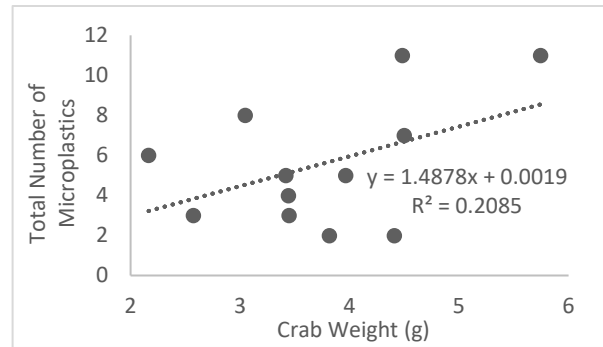


**Figure 1:** The number and type of microplastics found in the total crab samples. A crab sample number corresponding to an absent bar represents a crab that had no microplastics detected.

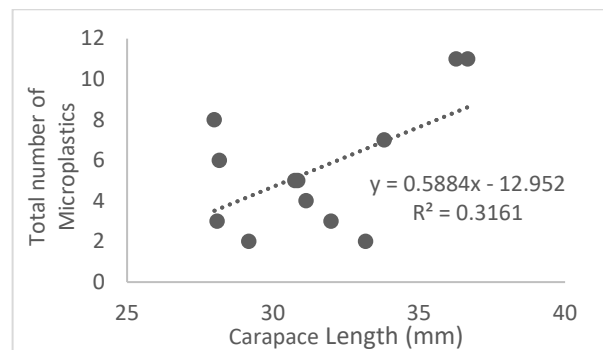


**Figure 2:** The number of crabs with the corresponding number of microplastics. This shows the distribution of

microplastics in the sample population. In general crabs had a few to no microplastics.



**Figure 3:** The number of microplastics found in each crab sample that contained microplastics compared to the weight of each crab sample.



**Figure 4:** The number of microplastics found in each crab sample that contained microplastics compared to the length of the carapace of each crab.

## Discussion

Microplastics were found in the majority of crab samples. This abundance surprised me, as instead of finding microplastics in approximately a third of my samples, I found microplastics in approximately two thirds of my samples (Fig. 1). The data gathered suggests that the number of microplastics found is linked to crab size and weight. The correlation of increasing numbers of microplastics with increasing crab weight (Fig. 3) could indicate that crabs that find more food or eat more food ingest more microplastics which then accumulate in their bodies more quickly. The correlation with increasing numbers of microplastics with increasing carapace length (Fig. 4) then could indicate that older crabs who have been feeding for longer, accumulate more microplastics because they have been filter feeding for a longer amount of time. Preliminary data shows an absence of microplastics in the eggs/egg mass of several female crab sample and a lack of microplastics in the Pacific

mole crab's parasites, *Profilicollis altmani*, in several crab samples. The Pacific sand crab has a common internal parasite, the acanthocephalan, *Profilicollis altmani*.

When analyzing the microplastic shapes, there was a disproportionate abundance of microplastic fibers (Fig. 1). The abundance of fibers could indicate that that particular type of microplastic is easier to filter and accumulate in the bodies of crabs. This could also indicate what types of plastics they were consuming and give us information about the source of the plastic pollution. This could have a broader effect on the ecosystem as certain types of microplastic could have the ability to accumulate in different organisms. Certain shapes of microplastic could also factor into the process of bioaccumulation.

During pilot studies, different digestion reagents, temperatures, and RPM on the shaking water bath were determined to streamline extraction and detection of MPs from our samples. It was found that 30% hydrogen peroxide was a more effective digestion reagent than 10% potassium hydroxide, 75 RMP worked better than 50 RMP for incubating crab digests, and the digest was more effective when the incubation temperature was at 40°C rather than 35°C.

While applying fluorescent microscopy to detect MPs, a green fluorescent filter was used because a previous study found that the green filter caused the MPs to fluoresce better than red and it helped prevent other contaminants from fluorescing (Erni-Cassola et al. 2017). One study found that Nile red is absorbed onto the surface of the microplastics and when irradiated with blue light, become fluorescent (Maes et al. 2017). However, when Nile Red stained MPs were examined using various filters on the fluorescent microscope, the best settings were found to be TRITC filter and 2.5 msec exposure, using a 100X objective lens.

Overall, the research has been successful thus far. Even though there was not a large sample size of crab, sediment, and water samples, methods for a working protocol for the three different specimens were developed. In preliminary studies, microplastics were found in the water and sediment collected from Del Monte beach. By finding microplastics in the

water and sediment, I supported the fact I found microplastics in the sand crabs, as the water and sediment are from the environment where the crabs are feeding from and living in.

### Acknowledgements

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# Predicting Student Success to Ensure Equity for Students

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## Abstract

In this paper we use machine learning algorithms to create predictive models of student success on the Writing Proficiency Screening Test (WPST) at California State University, Stanislaus. The data used included academic history, SES (socioeconomic standing), and demographic for the 3357 students who were tested in 2009-2011 at Stan State. The goal of this research project was to better identify “at risk” scholars before taking the WPST. The WPST is a graduation requirement for all students and to fail this exam may mean another semester in school. Identifying at risk scholars with predictive models may be the key in reducing cost and length of time in school.

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## Introduction

In 2019 college students across California will have to undergo some form of an English proficiency exam before the completion of their undergraduate degree. At California State University (CSU) Stanislaus, this exam is called the Writing Proficiency Screening Test (WPST). According to the CSU Stanislaus WPST website, “The Writing Proficiency Screening Test (WPST) assesses your readiness for Writing Proficiency (WP) courses, which are writing intensive courses designed to teach discipline-specific writing conventions.” (“Writing Proficiency”, n.d.) It is important to note that WP courses are necessary for graduating in a timely manner and failing the WPST can mean waiting another semester before taking these vital classes. Moreover, it is common knowledge that student debt is on the rise and the increased cost of attending school for an extended amount of time is money that could be used for more useful purposes. Hence, it is important for schools to identify “at risk” scholars who could benefit from extra help.

At CSU Stanislaus, 67% of students are first generation students, which means that neither of the students’ parents attended college. (“Stan State Enrollment”, 2018) It is well documented that first-generation students are at higher risk of prolonging school and dropping out. According to National Center for Education Statistics (NCES), it has been found that first-generation students drop out of college at a proportionally higher rate than students whose parents graduated from college. (Bennett, Chen, & Cataldi, 2018) Furthermore, it has been shown that first-generation students generally stay up to 6 years in college, with the NCES reporting that 60% of students that were first-time, full-time undergraduates in fall 2010 graduated 6 years later, or 150% of the standard timeframe. (“The NCES Fast Facts”, 2018)

It is vital for universities to do everything they can for students to stay on the path to success and graduate in a timely manner. With that in mind, many people are looking to technology for solutions. All colleges and universities in the United States are required to collect data on their students, which means there is an abundance of data waiting to be explored. Computers make it faster and more cost-effective than ever to analyze large sets of data. This area of Computer Science has become known as Data Mining.

Data mining uses machine learning algorithms to create predictive models that may explain relationships between demographic and income, or any other attributes associated with a big set of data. Its predictive power could be used to identify “at risk” students, which universities could then extend assistance to.

## Background

Previous studies have already shown that it is possible to create an accurate model to predict student success. One study completed at Iowa State University found a model that could perfectly predict passing students from a training data set (0% error) and successfully forecast a test set (8% error). (Vu, 2016) The study noted that there was not a model that could successfully predict student scores on their English proficiency test. However, there were factors that could accurately predict highest and lowest essay scores. (Vu, 2016) Another study done at University of New Mexico found that they could correctly predict the future progress of a student using first semester grades with a margin of error of 0.16. (Slim, Heileman, Kozlick, & Abdallah, 2014) These studies demonstrate that we can reliably use students’ past performance statistics as a measure for future progress.

Other studies have shown that data mining could be used to target “at-risk” students more precisely. For



example, a study conducted in Singapore concluded that data mining increased the efficiency of selecting potentially weak students for remedial classes, which they claimed reduced the burden on both students and teachers. (Ma, Liu, Wong, Yu, P., & Lee, 2000) Another study found that with machine learning, the problem of student retention could be identified as early as the third week of a semester with 97% accuracy, as well as identifying students less likely to achieve a passing grade as early as the fourth week with an accuracy of 97.2%. (Gray, C. C., & Perkins, D, 2019) This shows that not only is it possible to accurately predict the success of students, but that with machine learning it can be done quickly and efficiently. This could allow for intervention programs to be put into place to help struggling students before it is too late to change their course in a semester.

Lastly, it has been shown that it is possible to identify factors that help predict student success. For instance, a study in Brazil found that grades and absences were the most relevant factors for predicting the end of the year academic outcomes of their students. In addition, demographic factors revealed that neighborhood, school, and age were also potential indicators of either student success or failure. (Fernandes, Holanda, Victorino, Borges, Carvalho, & Erven, 2019) Moreover, another study done with data from approximately 200,000 high school students, located in two separate school districts, found that 8th grade GPA was a highly predictive attribute of on-time high school graduation. (Lakkaraju, et al., 2015) This further demonstrates that machine learning algorithms can identify major factors in predicting student outcomes.

### **Thesis and Rationale**

By using modern machine learning and data mining techniques, institutions of higher education can greatly increase retention rates, especially among first-generation scholars. There are some questions that need to be addressed to more efficiently meet this goal, which include: With academic, financial, and demographic data of students, can we make a model that can accurately predict student outcomes on the WPST? Which attributes hold the most weight in accurately predicting student outcomes on the WPST?

With something as significant as education, it cannot be understated how important it is to find and rectify negative patterns quickly so that a student has the tools they need to succeed. This will help ensure equity for all students and hopefully encourage others to seek higher education that may have previously been out of their reach. I believe that machine learning is the best and most efficient way to accomplish this task. The advent of machine learning techniques allows us to identify patterns, as well as possible outcomes, far more quickly and with greater accuracy than ever before.

### **Method**

I received data from the Computer Science department of California State University, Stanislaus that was already anonymized. It contained information on 3,357 students. The data contained information on students' academic history, SES (socioeconomic standing), demographic and WPST score. All data received was from the years 2009-2011. Upon receiving and before analyzing the data, I preprocessed the data, to address issues such as missing values, outliers, and differences in data granularity. Since we were trying to model the first-time test taking 579 instances were removed where the instances were the second or more time attempting the WPST.

During the preprocessing of the data it was also found that transfer students were missing data associated with the ACT (American College Test) and SAT (Scholastic Aptitude Test). So, to address this issue the data was split into two groups. The Community College transfer group (CC group) and the students who entered Stanislaus State straight from high school (HS group). The CC group contained a total of 1733 instances. While the HS group contained a total of 1044 instances. Of the 1733 CC group instances 314 were failed and 1419 were passed (CC group, 18% fail, 82% pass). Among the HS group of 1044 instances 162 were failed and 992 were passed (HS group, 16% fails, 84% pass).

The data sets were unbalanced, meaning that there were more instances of pass than fail. Imbalanced data sets tend to impact the effectiveness of the algorithms to predict student outcomes. Moreover, the algorithm might be overwhelmed by the majority class and not be able to discern what makes a student fail. (Xu-Ying, Jianxin Wu & Zhi-Hua Zhou, 2009) To combat this we implemented the tactic of under sampling the majority class, which means that we randomly selected pass instances and randomly left some out so that the data set would be even. To illustrate the HS group had 162 fail and 992 pass instances. Therefore, under sampling the majority class would mean that we randomly select 162 instances out of the 992 pass instances. Although we under sampled the majority class for training purposes, we tested the models on the real-world ratio by adding pass instances to the test sets. By randomly adding pass instances, we were able to obtain the CC group ratio of 18% fail/82% pass and the HS group ratio 16% fails/84% pass for the testing sets.

In addition, I explored methods to filter out redundant attributes, such as the Weka built in wrapper function and looking at the correlation of attributes. Redundant attributes were attributes that told the same information. For example, the English as a Second Language (ESL) and language spoken. They basically say the same information and thus don't add information for modeling purposes. I then used Weka to run machine

learning algorithms on the data with the selected attributes.

Weka is an open-source program that contains a collection of machine learning algorithms used for data mining tasks. It also contains tools for data preparation, classification, regression, clustering, association rules mining, and visualization.(Eibe, Mark, & Ian, 2016) After preprocessing the data was run on the Weka algorithms J48, Random Forest, Naive Bayes, and SMO.

Using the 10-fold cross-evaluations a standard machine learning technique to avoid overfitting the data. Overfitting produces a model that corresponds too closely or precisely with a particular data set. Models that are overfitted tend to fail at making predictions about future data.

The general procedure for cross 10 evaluation is as follows:

- 1) Shuffle the dataset randomly.
- 2) Split the dataset into k (in our case k = 10) groups.
- 3) For each unique group:
  - a) Take the group as a hold out or test data set.

- b) Take the remaining groups as a training data set.
- c) Fit a model on the training set and evaluate it on the test set.
- d) Retain the evaluation score and discard the model.

- 4) Summarize the skill of the model using the sample of model evaluation scores (Brownlee, 2018)

Lastly, I compared the different models by looking at the averages of the 10 models that were produced by cross 10-fold evaluation. I also considered their kappa statistics which is a statistic that looks to see if the model correctly classifies both cases of pass or fail.

## Results

The results for the models for Highschool and CC group are summarized below in the tables.

High School Group	Correctly Classified Instances	% Correct	Incorrectly Classified Instances	% Incorrectly	Kappa statistic
J48 Base Case	74.1	<b>74.1</b>	25.9	25.9	0.19175
J48 Attribute 1	59	59	41	41	0.10942
J48 Attribute 2	61.1	61.1	38.9	38.9	0.19203
NaiveBayes Base Case	67.7	67.7	32.3	32.3	<b>0.22189</b>
NaiveBayes Attribute 1	63.9	63.9	36.1	36.1	0.2081
NaiveBayes Attribute 2	61.9	61.9	38.1	38.1	0.21868
RandForest Base Case	64.1	64.1	35.9	35.9	0.19475
RandForest Attribute 1	63.8	63.8	36.2	36.2	0.15797
Random Forest Attribute 2	60	60	40	40	0.14271
SMO Base Case	57	57	43	<b>43</b>	0.09668
SMO Attribute 1	60	60	40	40	0.17211
SMO Attribute 2	57	57	43	<b>43</b>	0.16826

(High School Group Table:

**Base Case Attributes:** 51, SexCode, RaceEthnicity, EthnicCode, CitizenCode, CountryCCCode, HSGradYear, InstOriginCode, InstName, EnrollStatusCode, StudentLevelCode, College, Department, Major, DegObjCode, EmphasisCode, TransferUnitsEarned, TransferGpa, CampusGpa, TotalUnitsEarned, TotalGPa, EptCode, ElmCode, EOPCode, CriticalThinkingCourse, EnglishCompositionCourse, MathQuantReasoningCourse, OralCommunicationCourse, SAT1WritingScore, ACTWritingScore, TotalUnitsAttempted, HSGPA, ACTEnglishScore, ACTMathScore, ACTReadingScore, ACTScienceReasoning, ACTCompositeScore, ELMTTotalScore, EPTEssayScore, EPTReadingScore, EPTCompositionScore, EPTTotalScore, SAT1VerbalScore, SAT1MathScore, SAT1CompositeScore, ESL, DB, LEVEL, LANG, SPEC, EFC, LOW\_INCOME

**Attributes 1 HS Group:** 21, RaceEthnicity, EthnicCode, CitizenCode, CountryCCCode, InstOriginCode, EnrollStatusCode, CampusGpa, TotalGPa, EptCode, EOPCode, HSGPA, ACTEnglishScore, ACTReadingScore, EPTTotalScore, SAT1VerbalScore, SAT1MathScore, SAT1CompositeScore, ESL, LANG, EFC, LOW\_INCOME

**Attribute 2 HS Group J48:** 6, SexCode, EmphasisCode, EptCode, ElmCode, ACTReadingScore, Date of Birth

**Attribute 2 HS Group Naive Bayes:**4, RaceEthnicity, Major, EptCode, SAT1WritingScore

**Attribute 2 HS Group RandomForest:** 3, RaceEthnicity, EthnicCode, SPEC

**Attribute 2 HS Group SMO:** 7, RaceEthnicity, CitizenCode, EnrollStatusCode, Major, EptCode, EOPCode, SAT1MathScore)

\*Bolded numbers are to show the highest number in that category

Community College Group	Correctly Classified Instances	% Correct	Incorrectly Classified Instances	% Incorrect	Kappa statistic
J48 Base Case	79.2	46.04651	92.8	53.95349	0.06758
J48 Attribute 1	74.9	43.5465	97.1	56.4535	0.06776
J48 Attribute 2	77.2	44.88371	94.8	55.11629	0.05861
NaiveBayes Base Case	89.4	51.97676	82.6	48.02324	0.11294
NaiveBayes Attribute 1	88.9	51.68605	83.1	48.31395	0.11652
NaiveBayes Attribute 2	101	58.72094	71	41.27906	0.1905
RandForest Base Case	85.5	49.7093	86.5	50.2907	0.07055
RandForest Attribute 1	75.9	44.12791	96.1	<b>55.87209</b>	0.06464
Random Forest Attribute 2	77.2	44.88371	94.8	55.11629	0.05861
SMO Base Case	83.8	48.72092	88.2	51.27908	0.08267
SMO Attribute 1	85.6	49.76744	86.4	50.23256	0.10916
SMO Attribute 2	101.2	<b>58.83721</b>	70.8	41.16279	<b>0.18774</b>

(Community College Group Table:

**Base Case Attributes:**36, SexCode, RaceEthnicity, EthnicCode, CitizenCode, CountryCCCode, HSGradYear, InstOriginCode, InstName, EnrollStatusCode, StudentLevelCode, College, Department, Major, DegObjCode, EmphasisCode, TransferUnitsEarned, TransferGpa, CampusGpa, TotalUnitsEarned, TotalGPa, EptCode, ElmCode, EOPCode, CriticalThinkingCourse, EnglishCompositionCourse, MathQuantReasoningCourse, OralCommunicationCourse, TotalUnitsAttempted, ESL, DB, LEVEL, LANG, FRESH, SPEC, EFC, LOW\_INCOME

**Attribute 1:** 17, RaceEthnicity, EthnicCode, CitizenCode, CountryCCCode, EnrollStatusCode, StudentLevelCode, CampusGpa, TotalUnitsEarned, TotalGPa, ElmCode, MathQuantReasoningCourse, TotalUnitsAttempted, ESL, LEVEL, LANG, EFC, LOW\_INCOME

**Attribute 2 J48:** 3, RaceEthnicity, EthnicCode, StudentLevelCode

**Attribute 2 Naive Bayes:**6, SexCode, EthnicCode, OralCommunicationCourse, ESL, LEVEL, LOW\_INCOME

**Attribute 2 Random Forest:** 7, SexCode, RaceEthnicity, EthnicCode, StudentLevelCode, ElmCode, ESL, LEVEL

**Attribute 2 SMO:** 5, Department, DegObjCode, ElmCode, ESL, Pass or Fail, LEVEL)

\*Bolded numbers are to show the highest number in that category

## Discussion

To discuss the results of the models we must first understand Cohen's kappa Statistic. Cohen's kappa statistic measures how the test set of data was classified by the model. It considers that the amount of correctly classified instances can be high, but that the model itself may be weak. When looking at the data the following table shows the breakdown of the kappa statistic.

Value of Kappa	Level of Agreement
0-.20	None
.21-.39	Minimal
.40-.59	Weak
.60-.79	Moderate
.80-.90	Strong
Above .90	Almost Perfect

(Kappa Statistic table: McHugh, M. (2012). Interrater reliability: The kappa statistic. *Biochemia Medica*,22(3), 276-282.)

As we can see from the above table the level of agreement with the original test set may be high or low.

If we look at the HS Group Table, we can see that the kappa statistic for the models across the board never goes over 0.25. Although, on average the models classified about 50% of the training set correctly. For the algorithm J48 the highest correctly classified was 74.1% which was the base case. Some might think that this

means the model was doing well. However, the kappa statistic for the J48 base case was 0.19175 which means that the model was not great at classifying fail. It can be explained like this. If our current test set is 80% pass and 20% fail, then even if it classifies every instance as pass the model will still be correctly classifying 80% of the data set. However, this is not a great model and will have a very low kappa statistic. So, to conclude the models overall for the High School group were weak and not able to distinguish pass from fail.

If we look at the Community College Table, we see that the overall kappa statistic for each model did not go over 0.2. Although the highest correctly classified SMO Base Case at 58.83721% but the kappa statistic was 0.18774 which means the model was weak. As we saw in the High School Group, correctly classified doesn't mean a great model and overall, the CC group models were weak.

A reason that the models may have been weak is because the data sets were too small. Having too little data makes it hard for the algorithm to distinguish what makes an instance a pass or fail. Another reason small data sets may make a weak model is because they don't accurately represent the group at large. The sample may be missing key instances that would help the algorithm distinguish between the two classes of pass and fail.

To add, another reason why the models may have been weak is because of the use of redundant attributes when training the model. For instance, the attributes RaceEthnicity, EthnicCode, CitizenCode, and CountryCCCode were used for training HS Group models

for the first round of attribute selection. These attributes are redundant because they don't add new information to the training set, this added information is essentially meaningless and is known as noise. Noise makes it harder for the algorithm to discern what attributes make a student more likely to fail.

Its important to note that since the models were not accurate in predicting student outcomes, there no real evidence for any attribute being key markers for success or failure of the WPST.

For future work it is essential to acquire data that is most recent and to train the models on a larger data set. With more data the computer may be able to distinguish between a student who will fail or pass the WPST. It would also benefit to get more information on the students themselves. For example, individual class grades such as English course work may make the notable difference in creating a reliable model. It is also important that further work in attribute selection is necessary. It is imperative that redundancy and noise are mitigated to ensure a better use of the current machine learning algorithms.

### Acknowledgements

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# Relativistic Effect of Cosmogenic Muons

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## Abstract

Muons are 2<sup>nd</sup> generation leptons which have a mass of 105 MeV, 200 times more massive than an electron, with a negative charge. When cosmic rays hit earth's atmosphere, pions are created and decay into muons within 26 nanoseconds. Muons interact electromagnetically with other particles and therefore can travel a relatively long distance while losing energy in the process. The lifetime of muons is about 2.197 microseconds and sometimes travel at near the speed of light. According to Classical Mechanics, muons travelling at nearly the speed of light,  $2.998 \times 10^8$  m/s, will take approximately 50 microseconds to reach sea level which is 25 times longer than muon lifetimes. Muons can however, be detected at sea level at a rate far greater than classical predictions. This is due to time dilation, a modern physics prediction made by Albert Einstein for objects travelling near the speed of light [2]. When taking a relativistic approach detection becomes possible and the predictions become reliable [1].

*Keywords:* muon, relativity, time dilation

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## Introduction

When cosmic rays collide with the upper atmosphere, an air shower is produced. An air shower is a cascade of ionized particles and electromagnetic radiation. When a particle strikes a nucleus in the air from the primary cosmic rays it produces energetic particles like pions that decay in the air into other particles like muons which then travel toward earth to be detected.

Einstein's Special Relativity is based on two principles. Light in a vacuum is the same speed for all observers and the laws of physics are the same for all observers in uniform motion relative to one another. This has great implications for objects that are moving at near the speed of light. In the case of this research that object is a muon particle. Time dilation is a product of Special Relativity that explains how muons could be detected at elevations where their lifetime would not allow. In terms of muons, time dilation is when a muon that is traveling at the speed of light experiences a slower time rate than that of an observer that is not moving at all. This makes it possible for muons to reach sea-level because to us as observers, we see a longer muon lifetime that is true of the muon.

## Methods

To test the Relativistic Effect of Muons there is a few things needed. A detector, a way of recording data, and a portable way to house all the equipment. The

detector is a cylindrical scintillator that interacts with charged particles as they pass through and produce scintillation light, also known as photons. By measuring the intensity of the scintillation light, we can infer the amount of energy a particle left behind. A photomultiplier tube can produce a pulse output whose height is proportional to the energy that was left in the scintillator by the charged particle. What is measured is a voltage produced by the photomultiplier tube that is converted to digital signal and counted by a counting device. The photomultiplier tube used required a period of normalization. This is mainly due to temperature. Depending on the temperature the high voltage inside the PMT would change. To compliment the PMT an Analog to Digital Binary Counter (ADBC) was built to increase the portability of the experiment. A signal from the PMT was input to the ADBC and stored in binary code on the ADBC without the need of a computer.

The signal produced from the PMT is inverted and somewhat weak. This signal also includes unwanted background that needs to be filtered through. The ADBC serves two purposes. The first is to filter through all the signals and keep the desired signals. This is done by first amplifying the signal then cutting off the undesired signals. The left-over signals are now seen as digital signals recognized by the counter and registered. Once counted the signal is cut off from the PMT and can be seen on the LED display in Binary. The LED displays 8-bit increments of data and can be switched with the switch buttons connected to it. The first button displays the first 8 bits, the second shows the second set of 8 bits

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and so on. The fifth button is used to reset the counter to be used again. This counter can display a total of 32 bits, counting up to 4,294,967,296. The Schematics can be seen In Figure 1 and the actual counter in Figure 2.

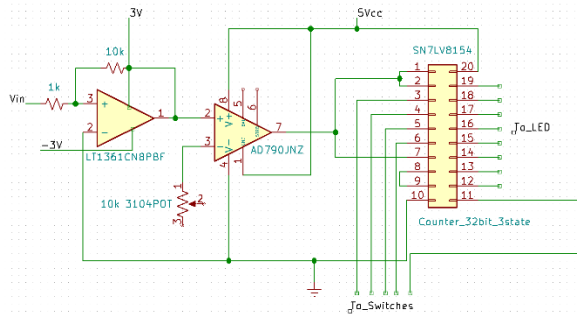


Figure 1: Switches number 1-5 from left to right. Switch number five is the reset switch

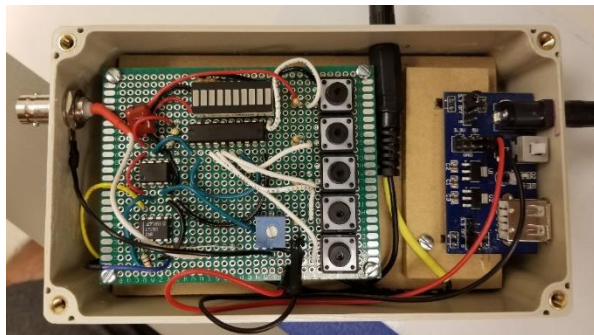


Figure 2: Switches number 1-5 from bottom to top. LED displays on-off as 1 or 0 respectively from left to right. The leftmost bit being the 1s place from the first 8 bits. Device is powered by D-Cell Batteries at different voltages.

Using this equipment, the muon flux was tested for five hours at a time at different elevations. To calibrate the device, it was first tested at around 100 ft. Knowing the rate of muons at this elevation we could calibrate the equipment to read around 3.6 muons per second. Once tested, the muon detector will be transported to different elevations to acquire data. The reason is that the flux of muons needs to be recorded at different elevations to extrapolate the exponential effect it has. The location at sea-level is Stanislaus State University – 100 ft (31 meters). Data acquisitions at different altitudes will be conducted at Yosemite National Park in the following locations. Hodgdon Meadow - 4200 ft (1402 meters), Crane Flat Campground-6200 ft (1890 meters), and Tuolumne Meadows Campground-8600 ft (2621 meters). To see the effect of Relativity we need to find out the length the muon has traveled in its lifetime.

## Expected Results

At 100 ft, we expect to detect 3.6 muon per second. Given this and the life time of the muon of  $2.2 \mu\text{s}$ , we can extrapolate what the expected behavior of the muons will be at different heights.  $2.2 \mu\text{s}$  is the lifetime at the rest frame of the muon and is the non-relativistic lifetime that would not allow the muons to be detected at sea-level. Note that this is the proper lifetime for a muon, and if it was not moving at the speed of light it would hold. The relativistic lifetime is what we as observers see. The relativistic lifetime is expected to be around  $16 \mu\text{s}$  [3]. To relate the non-relativistic and relativistic lifetimes we must find the gamma factor predicted by Einstein. This gamma factor can be calculated through the following equation.

$$\gamma = \left(1 - \frac{v^2}{c^2}\right)^{-\frac{1}{2}} \quad (1)$$

Where  $v$  is the speed of the muon given to be 0.99 times the speed of light and  $c$  is the speed of light given to be  $2.998 \times 10^8 \text{ m/s}$ . Here the gamma factor is calculated to be 7.08. With this information we can create two graphs shown in figures 3 and 4 showing how the flux is expected to be affected with altitude with and without involving the gamma factor.

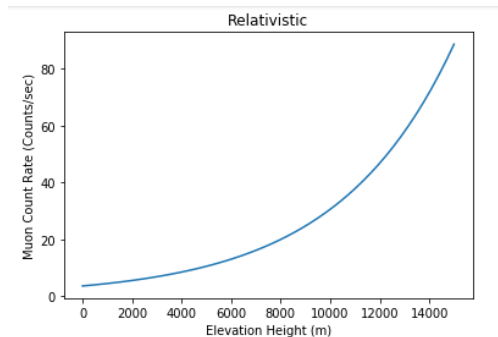


Figure 3: Counts/sec (Muons Rate) vs Elevation Change Considering Time Dilation

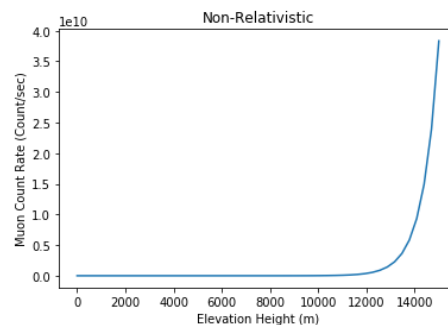


Figure 4: Counts/sec (Muon Rate) vs Elevation Change Not Considering Time Dilation

Notice the difference in muon production at 50000ft(15km). In Figure 4 the number of muons per second being created in a 175 cm<sup>2</sup> area would be around  $3.5 \times 10^{10}$  muons. There is not enough atmosphere at that height to harbor that number of muons. The expected number of muons at their production height match better with Figure 3 where around 75 muons are produced per 175 cm<sup>2</sup> per second.

## Results

Elevation (m)	Counts	Time (s)	Measured Muon Rate(counts/s)
32	66864	18000	$3.72 \pm 0.014$
1402	84646	18000	$4.70 \pm 0.016$
1890	101041	18000	$5.61 \pm 0.018$
2621	121532	18000	$6.75 \pm 0.019$

Table 1: Raw Data taken from various elevations

From this data the experimental gamma factor was calculated to be 6.254 giving the muons an average velocity of  $2.959 \times 10^8$  m/s which is 0.987c. The majority of the error suspected is with the temperature the device was run in. The temperature was about 10 degrees Celsius colder in Yosemite National Park which changed the calibration slightly. The temperature at night changed by 20 degrees Celsius which had the biggest effect. It is not easy to tell how much effect on the data this had but due to the nature of the equipment the calibration could not be changed. This data can be overlaid on the graphs in Figures 3 and 4 to see which fit better. Figure 6 shows the results of the data on the relativistic and non-relativistic expected graphs.

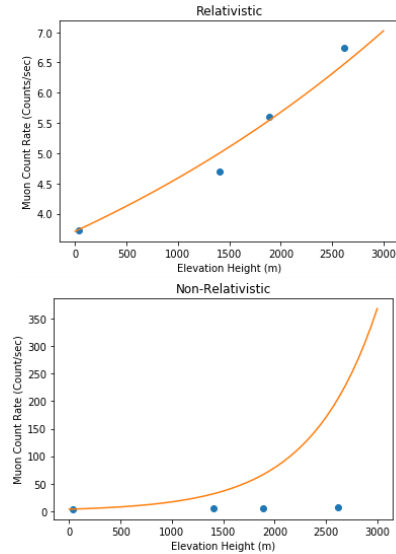


Figure 6: Comparing Relativistic and Nonrelativistic Graphs.

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# Body Dysmorphia in the Age of the Internet

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## Abstract

Social media is becoming increasingly popular among younger generations, and the mental health effects of its usage are widely unknown. Usage of social media may be linked to an increased rate of body dysmorphic disorder (BDD) symptoms among users, and may pose harm to user's body perception, based on prior research establishing correlations between social media usage and body image, satisfaction and surveillance. It is important to study this potential correlation due to the nature of BDD, as those affected typically have distorted perceptions of their own physical appearance (both facial and body features), which is often the focus of social media websites. Previous research has yet to establish a correlation between social media usage and BDD specifically. Social media usage, in the context of this study, refers to participants' engagement with Instagram, due to its popular photo-sharing features. Data has been collected through the use of a survey solicited to university students via SONA. The survey consists of three scales, the Body Dysmorphic Disorder Questionnaire (BDDQ) developed by Dr. Phillips (2009) was used to measure participants' rate of BDD symptoms. The Instagram Intensity Scale (Ellison, 2007) and the Passive and Active Use Measure (PAUM) (Trifiro, 2018) were used to measure participants' activity on Instagram. The data derived from the survey was coded and analyzed in SPSS. Findings indicate positive correlations between participants' BDDQ scores and their scores on both the Instagram Intensity Scale and the PAUM. The age of participants was a significant factor in the scores on both the Instagram activity measures, as well as the BDDQ. Gender was also a significant factor in both of the Instagram activity measures, but was not a significant predictor of BDDQ scores.

*Keywords:* Instagram, social media, body dysmorphia

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## Introduction

Body Dysmorphia has become a term often used casually among adolescents and young adults to describe feeling insecure or upset about their appearance. It is not uncommon to see the term floating around on social media websites, often in the form of self-deprecating humor. However, body dysmorphic disorder can deeply affect individuals in ways that go beyond insecurity. Body dysmorphic disorder (BDD) is a diagnosable disorder of self-perception that can be found under the category of obsessive-compulsive disorders in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5). Those who are diagnosed with BDD perceive flaws in themselves that may be minor or nonexistent from the perspective of others. Those affected may become obsessed with perceived flaws, often going to great lengths to hide or change them (American Psychological Association, 2013). Because BDD is categorized as an obsessive-compulsive disorder, individuals who experience the disorder may exhibit compulsive behaviors in an attempt to change the way they look, including

potentially dangerous habits such as obsessive exercise or dieting.

It is estimated that 0.7%-2.4% of individuals suffer from BDD, but it is believed to be underreported. A study conducted by Dr. Neelam Vashi (2016) presents BDD as a potentially debilitating disorder, rather than a minor psychological phenomenon that it is often believed to be. Because symptoms of BDD revolve around a person's perception of their physical features, it is likely that photo-sharing features on social media websites and applications (often placing focus on physical features) would impact these symptoms.

When a person experiences BDD, triggers are often involved in the manifestation of symptoms. A trigger would most likely include a representation or reference to physical appearances, and this could be a variety of things, such as a photo or video. When exposed to a trigger, a person with BDD may experience various negative thoughts, feelings or behaviors relating to their appearance (Vashi, 2016). For this reason, the abundance of appearance-related content on Instagram could act as a trigger for individuals who experience symptoms of BDD. While not all social media posts

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focus on physical appearances, Instagram in particular is widely known for the sharing of “selfies” (photos of oneself) among users. To some who may experience BDD, this kind of content may elicit anxiety and insecurity about their own appearance.

Although Instagram usage may refer to numerous activities that users are able to perform when engaging with the app, the present study will focus on activities that specifically involve photo-sharing features of Instagram. Previous research has examined the effects of social media usage on the body image of young adult women (ages 18-29), and while this particular study observed participants’ usage of Facebook, the findings may apply to Instagram usage as well. The researchers found that the total time that participants spent on Facebook was not related to body image scores, but the engagement with appearance related content (photos) on Facebook was correlated positively with thin-ideal internalization (the internal acceptance of thin body types as ideal), and body surveillance (Cohen, Newton-John and Slater, 2017). Because the content that individuals consume online often focuses on “ideal” physical appearances (primarily focusing on body types, shapes and sizes), they may begin to internalize these ideal appearances and consequently impact the way they view their own body. Engagement with social media will not inherently cause changes in body perception factors among users. The implementation of photo-based content and photo-sharing features that focus on individuals’ physical appearances are the aspects of social media usage that seem to be associated with body perception. The viewing and sharing of photo-based content is the primary focus of the current research study when measuring Instagram activity.

As stated, those with BDD may demonstrate various behaviors in an attempt to alter their appearance due to negative feelings about how they look. Such behaviors may even be done in an effort to lose or gain weight. One research study assessed the use of Instagram among female university students, as well as appearance-related comparison to detect whether they are correlated with drive for thinness and body dissatisfaction. An Instagram photo activity index was used to determine how often participants are exposed to “ideal” images of others and it was determined that the amount to which participants engaged in photo-based activities on Instagram was a significant predictor of participants’ scores on measures for drive for thinness and body dissatisfaction, with appearance-related comparison as a mediating variable (Hendrickse, Arpan, Clayton and Ridgway, 2017). Drive for thinness is directly related to an individual’s desire to become thinner, and is often experienced by individuals with BDD. As previously discussed, BDD involves individuals’ perception of flaws in their body, and these

perceived flaws likely stem from feelings of dissatisfaction with one’s body.

The findings of Hendrickse et al. (2017) suggest that Instagram can have a potentially harmful effect on young adults, particularly women, in regard to their body satisfaction levels and their tendency to compare themselves socially. The body perception factors analyzed in this study are commonly involved in the manifestation of BDD symptoms, and similar correlations may be found when looking at Instagram usage and its potential relationship with the rate of BDD symptoms among users. The findings of Hendrickse et al. are very similar to another research study in which 273 college students participated in an online survey that contained questions about their use of Instagram, appearance self-schema (beliefs about one’s appearance), self-discrepancy (the discrepancy between a person’s internalized standards of their self-representation, and their outer presentation of the self), body satisfaction (the degree to which one feels positively about their body), and self-esteem (an individual’s sense of value or worth). Results showed that Instagram usage indeed infringes on young adults’ body satisfaction scores. It was also determined that appearance self-schema can lead to higher appearance self-discrepancy, meaning that young adults who pay more attention to their appearance will seek out content that contains information about ideal appearances (Ahadzadeh, Sharif and Ong, 2017). Therefore, on a website such as Instagram, users may seek out images of other people that they deem “ideal” in terms of physical appearance. This consumption of “ideal” appearance content may then fuel body surveillance tendencies, and again, trigger compulsive behaviors that attempt to change one’s appearance.

Factors such as body shame and body surveillance are directly related to body image, depending on the status of a person’s body image. The use of social media and the level of body surveillance and body shame that may occur as a result have been observed in a previous study. The researchers correctly predicted that the link between self-objectified behavior on social media (such as posting photos of oneself) and body shame was dependent on the level to which participants monitored their own body (body surveillance) (Salomon and Brown, 2018). Individuals who are more likely to monitor their own bodies (aligning with criteria for BDD according to the DSM-5) may be more likely to be affected by the appearance-related content that they view on sites such as Instagram, perhaps triggering a higher level of body surveillance and body shame.

Usage of social media often varies depending on the age and gender of users. Prior research has shown that women tend to prefer Instagram over other social media apps compared to men, who prefer Facebook or Twitter. Younger individuals, even in samples with a

limited age range (18-25), continue to use Instagram at higher rates than other social media platforms (Shane-Simpson, Manago, Gaggi, and Gillespie-Lynch, 2018). As for the current study, I hypothesized that participants in the youngest age category (between 18-22 years old) would use Instagram at the highest rates as compared to those in the other age categories. Because I anticipated higher rates of Instagram activity among participants between the ages of 18-22, I also predicted that they would experience BDD symptoms at higher rates. As for female participants, I hypothesized that they would report BDD symptoms at higher rates than male participants. As a general prediction, I anticipated that data would demonstrate connections between higher rates of Instagram usage among all participants and higher rates of BDD symptoms reported on the BDDQ.

Usage of social media may be linked to an increased rate of BDD symptoms among users, and may pose potential harm to users' body perception, based on prior research indicating correlations between social media usage and body image, satisfaction and surveillance. The focus of the current study is to discover whether social media usage is connected to the level at which users experience symptoms of BDD. The aforementioned research collectively demonstrates strong evidence that body image factors and social media usage are correlated. The current study aims to explore the topic further by analyzing Instagram activity, specifically the use of photo-sharing features, in order to determine whether similar trends appear when observing BDD symptoms as a factor.

## Methods

*Participants.* Data was collected from a total of 100 university students, with a majority of participants identifying as female (90%) and the remainder of participants identifying as male (10%). Participants were required to be 18 years old or older in order to participate in the study. When reporting their age, approximately half of participants indicated that they fell between the ages of 18-22 (51%), while the remainder of participants were between the ages of 23-27 (24%) or were 28 years old or older (25%). The majority of participants specified their ethnicity as Latino or Hispanic (57%), while Caucasian was the second most reported ethnicity (23%). The remaining 20% of participants included Asian individuals (7%), African American individuals (3%), Native Hawaiian or Pacific Islanders (1%), individuals with two or more ethnicities (5%), other ethnicities not listed (2%), and individuals who preferred not to report their ethnicity (2%). The majority of participants reported that they were in their junior year (49%) or senior year (33%) of college, while only a small percentage of participants indicated that they were in their freshman (7%) or sophomore year (8%), or studying at the graduate level

(3%). Participation in this study was voluntary, and participants were offered extra credit that they could apply to one of their courses if permitted by the instructor.

*Measures.* The protocols for this study were derived from previously standardized scales that have been used in prior research studies. The three scales were combined into one survey, along with a series of demographic questions. A scale to measure body dysmorphic disorder (BDD) known as the Body Dysmorphic Disorder Questionnaire (BDDQ), created by Dr. Katherine Phillips (2009), was used to measure the level of BDD symptoms that a participant experiences. The BDDQ was chosen as the measure for BDD due to its inclusion of open-ended questions that will allow for participant responses to reflect the wide range of symptoms and how they manifest in each person. The BDDQ has been utilized in clinical and research settings to determine individuals' symptoms of BDD, and it has been a successful tool in this regard.

Two scales were used to determine the level and frequency at which participants engage with various activities on Instagram that involve photo-sharing. Instagram was determined to be the most appropriate social media website to focus on for this study due to its emphasis on photo-sharing and, more specifically, an emphasis on sharing photos of one's body and/or facial features. The two scales that were used to measure Instagram activity were The Instagram Intensity Scale (Ellison, 2007) as adapted by Trifiro (2018), and the Passive and Active Use Measure (PAUM) (Trifiro, 2018). The Instagram Intensity Scale focuses on the "intensity" to which participants engage with activities on Instagram (e.g., it is or is not a part of their daily routine) as well as frequency (i.e., hours per day spent on Instagram). The PAUM was used to measure how often participants perform specific activities on Instagram (e.g., posting photos of themselves, viewing photos, etc.) and whether these activities are being performed actively or passively. The PAUM was a key part of the survey because it allowed for more detailed information regarding participants' Instagram usage; thus, the results not only reflect whether or not participants use Instagram, but how they use it as well. These two scales were chosen as the measures for Instagram activity due to the straight-forward presentation of the questions, and the ability to code each item into numerical values from which total scores were calculated.

*Procedures.* The BDDQ, the Instagram Intensity scale, the PAUM and the demographic questions were compiled into a survey using *Qualtrics*. These measures were reviewed and approved by the Psychology IRB at CSU Stanislaus, and the survey was uploaded onto SONA, the university's research pool for psychology.

Participants were presented with an informed consent form prior to taking the survey, acknowledging that some questions on the survey may be upsetting as they deal with body image. Participants had the option to stop their participation at any point throughout the survey. Upon completion of the survey, participants were provided with a debriefing form explaining details about the study as well as contact information if they required a further explanation.

The BDDQ began with two questions that served as a screening. Participants' responses to the initial questions determined whether or not they were going to complete the rest of the BDDQ. The initial questions asked participants' about their general perceptions of their bodies and if participants answered "no" on either question (indicating that they are satisfied with their appearance), they were not asked any further questions on the BDDQ and they were finished with that portion of the survey. The remaining items on the BDDQ involved more specific questions about participants' body perception, including open-ended questions. The BDDQ was used as suggested by the creator of the scale, Dr. Philips.

*Data Analysis.* SPSS, a common software program used for psychological data analysis, was used to analyze data in this study. The data was uploaded from *Qualtrics* to SPSS, and the responses to each item on the survey were coded into numerical values (e.g., male = 2, female = 1) to allow statistical analyses in SPSS.

Scores for each of the three measures used, the BDDQ, the Instagram Intensity Scale and the PAUM, were coded into numerical values within SPSS. The BDDQ was coded based on the "yes or no" responses to each item ("yes" = 1, "no" = 0) with a total possible score of 8. The Instagram Intensity Scale included 7 items that were scored based on a Likert response scale (strongly agree = 5, agree = 4, neither agree nor disagree = 3, disagree = 2, strongly disagree = 1) with a total possible score of 35. The PAUM measure included 10 items that were also scored based on a Likert response scale (very frequently = 5, somewhat frequently = 4, sometimes = 3, rarely = 2, never = 1) with a total possible score of 50.

Bivariate correlation analyses using Pearson's  $r$  were used to measure the relationship between scores on the BDDQ and the Intensity scale, as well as the BDDQ and the PAUM. Simple linear regression analyses were used to measure the relationships between age and each of the three survey measures, as well as gender and each of the three survey measures. All statistical analyses were done using an alpha level of .05, and the  $p$ -value must be lower than the alpha level in order for the statistical test to be considered significant.

Qualitative data was derived from open-ended questions featured on the BDDQ, and they were coded and summarized into common themes.

## Results

Using Pearson's correlation coefficient, it was found that a positive correlation exists between participants' scores on the BDDQ and their scores on the Intensity scale ( $r(98) = .21, p = .04$ ). A positive correlation was also found between BDDQ scores and scores on the PAUM ( $r(98) = .23, p = .02$ ).

A simple linear regression was used to determine whether scores on the BDDQ could be predicted based on participants' age. A significant linear regression equation was identified ( $F(1,98) = 4.435, p = .04$ ) with an  $R^2$  of .043. Participants' predicted BDDQ score is equal to 3.660 - .701 points when age is categorized into three groups (18-22, 23-27, 28 and older). Participants' scores on the BDDQ decreased by .701 for each increasing age group. A simple linear regression was also used to determine whether BDDQ scores could be predicted based on gender. No significance was found through regression analysis ( $F(1,98) = 1.520, p = .22$ ) with an  $R^2$  of .015.

Simple linear regressions were also used to determine whether scores on the PAUM could be predicted based on the age of participants. A significant linear regression was found ( $F(1,98) = 13.166, p < .001$ ) with an  $R^2$  of .118. Participants' predicted PAUM score is equal to 36.603 - 3.847 points when age is categorized into three groups (18-22, 23-27, 28 and older). Scores on the PAUM decreased by 3.847 points for each increasing age group. When looking at gender as a predictor for PAUM scores, a significant regression was also found ( $F(1,98) = 10.051, p = .002$ ) with an  $R^2$  of .093. Predicted PAUM scores for participants are equal to 40.311 - 9.456 points when gender is coded as "female = 1, male = 2". Scores of male participants were 9.456 points less on average when compared to female participants.

Age of participants was also found to be a significant predictor of scores on the Instagram Intensity scale using linear regression analyses ( $F(1,98) = 5.719, p = .02$ ) with an  $R^2$  of .055. Predicted scores on the Intensity scale were equal to 20.087 - 1.739 points when age is divided into three groups. Scores on the Intensity measure decrease by 1.739 points as the age group of participants increase. A similar finding was identified when examining gender as a predicting variable of Intensity scores ( $F(1,98) = 6.954, p = .01$ ) with an  $R^2$  of .066. Participants' predicted scores on the Instagram Intensity scale was equivalent to 22.878 - 5.289 points when gender is coded as "female = 1, male = 2". Scores for male participants were 5.289 points less on average than female participants.

Qualitative data was also derived from open-ended questions on the BDDQ. The two initial questions on the BDDQ were used to screen participants, and those who answered "yes" to both questions moved on to complete

the rest of the BDDQ. Of the participants that completed the BDDQ ( $n = 40$ ), 38 participants reported body areas of concern. Some body parts were combined and categorized into general body areas. The most frequently reported areas were the “stomach” and/or “waist”, and the “face” and/or specific facial features (e.g., nose, eyes, lips, etc.), both areas reported a total of 21 times each. The next most frequently reported areas were the “legs” and/or “thighs” (reported 11 times) and the “arms” (reported 8 times). Less commonly reported body parts included the “butt” (reported 5 times), “breasts” or “chest” (reported 3 times), “skin” (reported 3 times), and “hair” (reported twice). Areas that were only reported one time each included the “hips”, “back”, “neck” and “feet”. Two participants indicated that they were concerned with their weight or “weight distribution”, and one participant answered “most” when asked about areas of concern.

Participants were also asked questions on the BDDQ about social activities that they avoid, problems they may have at work or school, as well as various other activities that they struggle with due to appearance-related insecurity. Answers varied as participants were able to respond however they chose to, however, several themes appeared to be prominent across all responses and they were as follows: problems with or avoidance of social activities, avoidance of attention from others, and avoidance of wearing certain clothing.

One common theme among participants’ responses to the open-ended items on the BDDQ involved experiencing problems with social activities or avoiding them altogether. When asked how the way they feel about their appearance has affected their social life, many participants reported that they avoid dating, hanging out or “going out” with friends and social situations in which eating or food are involved. Participants also reported that they have often isolated themselves or canceled plans due to appearance-related insecurity.

Another prominent theme among BDDQ responses centered on participants’ avoidance of attention from others, whether it be at work, school, public settings or on social media. Participants’ reported that they avoid going to the gym out of fear of negative attention, act “shy” or “less outgoing” at work or school, and avoid taking and posting photos or “selfies”.

Participants commonly reported that they avoid certain clothing due to their feelings about their body. Many participants reported to avoid wearing bathing suits or “bikinis”, short pants, tank tops, “tight” clothing, and dresses. One participant also reported that they avoid going out in public without first applying makeup.

## Discussion

As predicted, a positive correlation between the BDDQ and Instagram Intensity scale, as well as between the BDDQ and the PAUM, indicates that participants’ rate of Instagram activity is associated with the level at which they experience BDD symptoms. Specifically, as a participant’s Instagram activity increases, so does their chance of experiencing symptoms of BDD, and vice versa. A positive correlation between Instagram activity and BDD symptoms does not indicate causality, therefore, these variables may be related for a number of reasons. It is possible that those who are more engaged with Instagram will experience BDD-like symptoms at higher rates as a result, or that those who are prone to body insecurity will seek out appearance-related content. However, based on this correlational data alone, a cause and effect relationship cannot be determined.

Age was found to be a significant factor in scores on all three measures. As predicted, younger participants reported using Instagram at higher rates. Younger participants also reported higher levels of BDD symptoms on the BDDQ. Gender was also found to be a significant factor in scores on both of the Instagram activity measures, however, it was not a significant predictor of participants’ scores on the BDDQ as I had hypothesized. Although female participants reported Instagram activity at higher rates than male participants, due to a lack of male responses ( $n = 10$ ) it is not likely that this statistic is representative of the gender differences between Instagram users.

Participants that completed the entire BDDQ provided important information regarding the impact that one’s negative self-perception can have on their functioning. Participants shared the obstacles that they face in their daily lives as a result of their dissatisfaction with their appearance, including difficulties they face in school, work and their social activities. Within the diagnostic criteria in the DSM-5, it is noted that BDD symptoms often include the avoidance of social situations or environments (American Psychological Association, 2013). An individual may feel that they are receiving unwanted attention from others in such situations, and this may create problems with their ability to function in the social aspects of their daily life. While a number of prior research studies have already established connections between body perception factors and the use of Instagram, the correlations found in this study between BDD symptoms and Instagram usage suggests that engagement with Instagram is not only associated with a negative body perception, but also with potentially serious obstacles that individuals may face because of their body perception.

## Limitations

The lack of male participants was the primary limitation in this study as it did not allow for meaningful comparisons to be done on the basis of gender. Men may use social media differently than women but this cannot be properly examined using only the data from this study. Participants consisted of only university students and thus, these results focus mainly on younger groups. Because significant correlations were observed between age and Instagram activity and between age and BDDQ scores, it is likely that responses from older age groups not included in this research would vary from the sample studied here. Also, university students may differ from other populations in unique ways, and thus the results may not be applicable to some groups.

## Future Research

Higher scores on the BDDQ were associated with higher scores on the Instagram activity measures, and although this data does not provide evidence of Instagram usage causing higher rates of BDD symptoms, a significant correlation suggests that further research may be necessary to determine if causality exists between these variables. Future research may consider an experimental study, in which confounding variables can be controlled, to discover whether Instagram usage influences a person's level of BDD symptoms, or perhaps that individuals who experience BDD symptoms seek out appearance-related content on Instagram.

## Conclusion

While participants who scored higher on the BDDQ also reported higher rates of Instagram usage, many participants indicated on the BDDQ that they avoid posting photos of themselves on social media, which suggests that not all types of Instagram activity may be associated with higher levels of BDD symptoms. This finding aligns with previous research specifying that general usage of social media is not necessarily associated with users' perceptions of their bodies but certain aspects of its usage, such as exposure to appearance-related content (i.e., photos of other people), is associated with negative body perception and higher rates of body surveillance (Cohen, Newton-John and Slater, 2017). The intention of this study is not to suggest that social media usage should be avoided, but that individuals should be mindful in their usage, as the issue lies mainly within specific content on social media websites.

The association between Instagram activity and BDD, as well as other body perception factors observed in prior research, demonstrates that the usage of social media is connected in some ways to the state of users' mental health. As social media continues to grow more popular among adolescents and young adults in

particular, it is important to assess the possible consequences of its usage. As we find out more about how it is associated with our mental wellbeing, it is necessary that users of social media websites are aware of safe practices. Safe social media usage may include taking breaks from social media websites or filtering the content that one views as to avoid upsetting or triggering images.

Social media has become a useful tool used by individuals to keep in touch with friends and family, stay connected and informed about current events, seek entertainment, as well as for various other purposes. It is my hope that the findings of this study will help open up significant discussion about the usage of social media websites among young adults and adolescents, due to their prominence in the current social culture and individual social environments.

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# A Textual Analysis of Yogācāra and Western Psychology

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## Abstract

Contemporary psychology is awash in Buddhist ideas. These ideas from a very long and ancient tradition may contain new insights into how we understand the mind today. Can we find constructs that could open new doors into our assessment of the human condition? Analysis of this question will consist of a reading on the central idea from the Yogacara Buddhist school, the storehouse consciousness and its seeds. Clear conceptual overlap is found between the ideas from the school and those of Piaget and Freud. Piaget's ideas of intelligence development, and the structural functioning of cognition are one area. Another is Freud's dynamic unconscious, seen as the psychic energy we are not aware of that drives our minds. The ideas of the West could be used to give a language for understanding the concepts of the Buddhist school. I believe that these concepts will give insight into better understanding the human mind and treating suffering.

*Keywords:* yogacara, storehouse, experience

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## Introduction

Eastern thinking has been finding more and more of a welcome reception in the field of psychology here in the West, in particular Buddhism. Buddhism can be understood as a philosophically based approach to lessening human suffering, and it has grown and adapted to the cultures in which it has found a home. However, it is, at its core, deeply rooted in the psychology of human and experience and the relationship of that experience to suffering. Standing out as a very sophisticated and in-depth survey of human psychology is the school of Yogācāra Buddhism. So, as one of the most psychologically oriented schools of Buddhist thought, can anything be found in their texts and ideas to help forge a new perspective in the West and to expand knowledge of the human condition? The key development of this school is the Alayavijnana (storehouse consciousness), developed by Vasubandhu, a co-founder of the school and a main source of writings that can be explored.

The Alayavijnana is the core concept of the Yogācāra school and could be used in a radical change in our understanding of cognition. This consciousness is the ground of all consciousness but cannot itself be known. It is both all of conscious experience and all of the elements that work to influence or are influenced by that experience. The school posits that everything is appearance only, meaning that our experience is really that of transforming consciousness. The inner "I", the outside world and all objects are merely internal mental appearances. We cannot have direct contact with or knowledge of an exterior world. This is important

because the experience of the individual is vitally in applied psychology settings.

Coleman (2010) sketches out the development of the school of Yogācāra. In the early first millennium CE two brothers in India, Asanga and Vasubandhu, took the systematic psychological understanding from one school of Buddhism and wove it together with the philosophical underpinnings of another. Their efforts were a response to disputes within the Buddhist community. One approach, the Abhidharma school, had put forward a theory that another school disagreed with. Asanga convinced Vasubandhu to leave the Abhidharma school and they founded the Yogācāra school, which was focused on examining and understanding the most subtle aspects of experience, particularly the workings of their own minds in meditation. Their main area of concern became the unconscious aspects of the human mind. Although they could observe the most subtle aspects of their mental activity, still there were areas they could not seem to access directly. And so they worked to develop and understand this mental activity, in an effort to align the ideas of their psychology with the doctrine of emptiness.

Jiang (2001) discusses the development within the school of a concept, the ālāyavijñāna, or storehouse consciousness, which was the foundation of all conscious awareness experienced by a person. The consciousness was viewed as a dynamic process that shaped experience and action, while at the same time being shaped by those very things. It was seen as serving as the basis for experience, in the same way a riverbed channels the flow of a river. This storehouse was also



fundamentally unobservable in conscious experience as it was seen to be conscious experience itself, however, through inference and careful observation of the most subtle aspects of conscious mind they could piece together what was happening under the surface and develop a practice to teach this understanding. Moreover, the ideas of consciousness and experience are nearly inseparable and we see that here.

Chanda (2015) establishes the Yogācāra school was very phenomenologically focused and viewed human experience as the end result of numerous cognitive processes, or transformations of consciousness, that constructed our reality from sense data we take in. The school believed that the human experience was only representation. Their view was that our experience is not the same as any external reality that may be providing the sensory data of the experience, but that it is a representation of that reality in human consciousness and as such was considered consciousness only. This is not to say that the school was one of idealism, they simply did not comment on an external reality other than to say we do not access it directly and have no knowledge of it. There is more than the construction of reality to the storehouse though, but also what's inside.

Jiang (2006) shows another constructive aspect of the storehouse consciousness was it serving as the container for the *bija*, or karmic seeds. These seeds were seen as the element of the storehouse upon which the transformations of consciousness were contingent. These seeds represented actions done by an individual, with each act said to be planting a new seed for its sort of action. These seeds influence the further behaviors; as an angry person plants a seed of anger by yelling, he is now more likely to yell in a future transformation of consciousness. Thus, the seeds affect the storehouse by building patterns of behavior in the flow of consciousness. Yet, despite its psychological nature the Yogācāra school is deeply grounded in a particular philosophy.

There is a lot to be found in the scholarship about the Yogācāra school of thought, in particular the storehouse consciousness (Jiang, 2004), however most of what is found is philosophical in nature than psychological, focusing themselves on attempts to interpret and comment on the school's thinking. And, what psychological attention the school does get primarily focuses on the comparisons and contrasts with psychodynamic theory and the subconscious. However, comparatively little is said about the relationship between the structure and process of the storehouse with ideas of Western psychology, such as Jean Piaget's concept of schemas, or the similarities of automatic cognitive processes, found in dual processing theories. However the similarities may not be enough to overcome a large challenge inherent in relating these ideas to a Western audience.

The ideas of the school have been debated, commented upon, and passed down through tradition. They speak to things that are of interest in the East and the West, our own experience, who we are, and what we know. Bowker (2008) situates the tradition in the context of Buddhist philosophy at that time and positions the Yogācāra tradition as a continuation of the Mahayana development of Nagarjuna and his explanation of *sunyata* (emptiness). Cross (2013) also puts the Yogācāra school as the further developing of the *Prajnaparamita* (perfection of wisdom) and that the position of appearance (or mind) only is the subtle development of karma and karmic seeds, into a systematized synthesis. But, as Mosig (2006) illustrates, a difficult gap between East and West is the concept of Self in the two traditions. So examining the ideas of one may have to be filtered through the lens of understanding of the other in order to find ideas of merit. Goleman (1981) discusses the commonalities and differences between Buddhist and Western Psychology. He maintains that while there may be similarities that those are superficial in the face of the fundamental underlying paradigm. Buddhism puts forward the idea of a radical change so radical that Westerners will be too skeptical of its applicability. Additionally, Joshanloo (2014) points out a major obstacle for the idea of seeking insight into therapy here in the West from the literature of Buddhism is the fundamental difference in happiness outlined in the West versus the East. Here happiness is often a matter of success at goals, and is tied to an outcome. However, in Buddhism happiness can be better said to be tied to equanimity, and is not the same end goal as in the East.

So, the question remains, can we examine the texts of the Yogācāra school of Buddhism to search for parallels with our understanding of cognition here in the West in order to develop better understanding and, with insight, more effective treatment practice? I believe, despite the challenges presented by the difficult nature of the philosophy supporting the school, the analysis of Yogācāra schools will yield a new direction for understanding the human condition. And this understanding will aid in bettering the treatment of those who suffer.

## Methods

*Overview.* The first step of this analysis is a very close reading of the 30 Verses of Vasubandhu. Working with my mentor, using his training as a Buddhist priest, I am grounding my understanding of the Buddhist conception of mind, and the Yogacara conception of consciousness and perception. The analysis of the text is directed at the school's idea of the storehouse consciousness and its function of creating our experience. The main aspects examined are the nature of the concept's structure and mode of operation. After

this, comparison between several translations of the text is performed in order to ensure the proper understanding of the ideas are grasped and coming through in the translation to English. Next, careful reading of Freud and Piaget is conducted. Freud is read looking at the ideas of unconsciousness and the development of the Ego from the Id. The reading on Piaget focuses on his idea of schemas and their modification through assimilation and accommodation. Lastly, comparison of the ideas of the two traditions is done at an abstract level looking for philosophical and conceptual elements contained within. In particular focus is given to structural and functional aspects of the concepts, looking to see how the two traditions identify components of mental functions.

This reading will analyze three concepts from the Yogācāra school: human experience, the *alayavijñāna*, and *bija*. The first will be taken to mean the study of personal (subjective) experience meaning perception, attention, emotion, thoughts, and judgements. The Yogācāra view of the human experience as a construct of consciousness will be examined. The perspective of the subject is not seen as an experience of any sort outside reality, but as something occurring exclusively within the consciousness. A large implication of this analysis is that we cannot have knowledge of external reality, merely our conscious experience of it, and thus have no way of knowing if the two are the same. This is not to make the claim of idealism, that there is not any sort of external reality outside of our own minds, but that the experience we have is that of consciousness being conscious of objects within that same consciousness. This is a subtle understanding, and the only claim that is made is that experience is contained within consciousness only. And as for where the objects within consciousness originate or if they are tied to a material object outside the body, no assertion is made.

The second concept is the ground of all consciousness in the thinking of the school. It is both all of conscious experience and all of the elements that work to influence or are influenced by that experience. Seen as something that is not able to be an object of perception, the storehouse is where all the elements that make up a person reside transforming the consciousness and thus the subjective experience. This storehouse is the source of all the transformations of consciousness that make up our experience. As experience is taken to be contained within consciousness only these transformations are of vital importance. These operations within consciousness are the source of the objects we perceive and even the sense we have of ourselves as an internal watcher looking out. These operations of consciousness aggregate together into human experience.

The last concept is taken to be the individual constituent elements that are contained in the

storehouse. These are the things that happen to us and the things that we do. Through the fruiting of these seeds various transformations of consciousness occur and in turn those transformations lead to actions which plant new seeds. The seeds are the source and product of action and can be seen to serve as the mechanism by which the frames of reference we use in judgement and decision making and the actions those frames generate co-create one another. Also, these seeds, as the contents of the storehouse, are fundamentally not graspable by consciousness. The seeds, as the operations within consciousness, are not experienced by it because they are the elements that create experience.

*Materials.* The Thirty Verses on Consciousness Only by Vasubandhu will be the text used in the analysis of Yogācāra concepts. Two versions will be utilized, Ben Connelly's Inside Vasubandhu's Yogācāra and Dan Lusthaus's Buddhist phenomenology, providing four translations and commentary from both. Analysis of Western psychological texts will also be performed to examine the ideas that will be compared and contrasted with the ideas of the Yogācāra school. The Ego and The Id and General Psychological Theory: Papers on Metapsychology by Sigmund Freud will be read looking into the unconscious operations of the mind. Origin of Intelligence in the Child and The Construction of Reality in the Child from Jean Piaget will be examined with a focus on the development of mental operation.

*Procedure.* This textual analysis will explore three concepts from several translations of a key Yogācāra text. This text will serve to formulate the clear and operational definitions of the three core concepts being examined and set them up to be compared with ideas from the West. Next the analysis will attend to four texts from Western psychology, from Piaget and Freud. All woven together these ideas in the West can be understood through the lens of this school and will serve to help depict Yogācāra ideas on grounds already being used in the West. Because this school is very deeply influenced by Buddhist thinking some care and attention will have to be given to the outlining of some of the more challenging aspects of the teachings. In particular the notions of *anatman* (no self) and interdependent origination are central to Buddhist philosophy and will present the most challenging ideas to relate to a Western audience. As such, more of the research will be focused on developing the Buddhist philosophical ideas than the philosophical foundations of the Western ideas examined.

## Results

Within the Buddhist psychology consciousness is seen as an attending awareness. Reading the Verses shows the Buddhist conception of this clearly, There are, initially, 6 Layers. The first five correspond to the senses (sight, hearing, touch, smell, taste), that is the

contact between a given sense object and that sense consciousness. The sixth layer is that of ideation. This layer of consciousness is the sensory information from the other layers, arranged into the present moment experience. This is also seen as mental consciousness, with the object being the idea created, being sensed by the mind consciousness. Then, the Yogacara school added two more. The seventh and eighth layers are a sort of continuity, and the storehouse. The manas consciousness links together one moment of awareness to the next, leading to continuous experience of a self. And the last is the storehouse. It is the meaning making framework and involved in coordination of decision making, built of experience.

Vasubandhu explains that the storehouse consciousness is not observable by our awareness, even as a mental phenomenon to the sixth consciousness. This storehouse is the ground of experience from which the higher consciousness layers arise as transformations of consciousness. It is the root, and from it grows a sense of self, then that self's continuity, and lastly the pieces of experience that all come together. Additionally, it is viewed as the co-constitutive link between experience and meaning. Because it houses the seeds of experience, it is where experience influences meaning and meaning influences experience.

The seeds, Bija, are seen as karmic energy that forms from impressions of events made on our consciousness, planting the seeds of future action in the very root of our awareness. There is the energy eventually comes to life and acts in some way on experience. Either from the sense data selected to be a part of the experience, or the reaction to the moment, the seed

exerts its energy leading to action, a sort of flowering. These mental structures and the functions that they serve share similarity with concepts from Western psychology, particularly with Piaget and Freud.

Piaget, in his works; *The origins of intelligence in children* and *The construction of reality in the child*, gives a developmental account of mental processes and structures. He describes schemas, which he says are interconnected collections of units of knowledge, and work to create meaning for sensory experience. These schemas are adaptive, and have two ways of responding to new information. The first is assimilation, which is the process that takes new information into a schema, done by adding the new information to the previous. On the other hand, accommodation occurs when the schema must be modified to fit new information and possibly the creation of a new schema for a new collection of information.

Freud presents ideas in the ego and the id and General psychological theory, that also reflect similarities with those of Yogacara. His description of

the necessity of the unconscious, and its dynamic nature. Freud agrees to account for experience parts of the mind are taken to be unconscious. This for Freud means that they are not capable of being visible to Conscious awareness, which is the same conceptualization found from Vasubandhu. Additionally, the Unconscious part of the mind is dynamic. Freud says the unconscious is made up of energies, or drives, that power the mind. His unconscious is populated drives that exert influence and are a part of us deep down.

This first exploratory analysis shows evidence that there is, *prima facie*, conceptual overlap in the ideas of the Yogacara school, and ideas from Freud and Piaget. The storehouse is an unconscious and dynamic generator of action and repository of meaning and finds itself at home in Western minds.

### **Implications**

This analysis stands to offer the benefit of outside insight that might not otherwise have been discovered and has the potential to enhance the state of affairs in our understanding and work with the human mind. A particular limitation of this analysis is the challenge in adapting Eastern ideas of reality and self for a Western audience. The main challenge here is found in attempting to develop a common language between the ideas we hold in the West and the ideas of the East. A difficult hurdle to overcome is the idea of the non-reality of the self or other conceptual objects, something that tends to clash with the subject object dichotomy, which is a foundational basis of Western science. One aspect of this challenge is that the idea common in Western thinking that the Self is a real thing inside looking out at a separate and distinct reality, something that does not line up with the consciousness only view of Yogācāra. Additionally, an aspect that can be challenging is the perception of Buddhism as something of a challenger of social or religious norms in the West. Buddhism of the Mahayana school, of which Yogacara is a branch, sees no single thing as having an essential, independent, existence, and thus all things were empty of self. However, I think at their core, the teachings of the school and the thought in the West are not incompatible, but merely another perspective. Also, I think they can be useful even outside of the Buddhist philosophical tradition. My aim here is to make an effort to present the ideas of this school as something that is not a religious teaching, but as a psychologically oriented school of philosophic thought containing ideas that can enhance Western understanding of the human mind. This analysis is important because it can help to expand the connections between thinking here in the West and elsewhere. And this can be done by grounding the school more in the psychology, rather than the philosophy. Making the attempt to bring outside

thinking into our understanding is expected to aid in treatment. The better we are able to understand our minds and the behavior that is produced the better we will be able to develop ways to help those who suffer from the myriad ways in which our minds can work against us. The proposed audience for this research is those familiar with basic psychological ideas in the West, but who don't necessarily possess a similar familiarity with Eastern philosophy. A large limitation impacting the research is the remoteness of the school, both spatially and temporally. I am having to go far far back and rely on a small number of translated materials to access the ideas. Despite this, I do believe the amount and quality of data I am working with is sufficient for me to generalize, because I am using two sources for the Yogācāra material which offer multiple translations and commentary. However due to a lack of familiarity with the original languages, I am required to accept translations and any mistakes they may contain. Also, the highly abstract nature of the matters being examined presents a special challenge when relating ideas to those less familiar with Eastern philosophical ideas. However, grounding these ideas in more familiar Western terms should be able to overcome these challenges.

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# School Policies and Its Effects on Female Minority Students

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## Abstract

The purpose of this research is to find out how school policies can serve as a predisposition for female students of color to enter the school to prison pipeline. Research shows that students of color receive harsher punishments for the same actions as non-minority students (Abudu, 2017). School policies are not applied evenly. It is important to find out why this is, how it can happen and what can be done to help solve the problem. This study will be using the methodological framework design of Critical Ethnography. This study will use only data as well as the survey administered to the students. The participants will be students from Stanislaus State. The goal of this research is to find if policies such as “zero-tolerance” policies have affected the lives of female students of color both personally and academically.

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## Introduction

Past and ongoing research reveals that female students of color, and or students who are in the minority community, receive harsher punishment in schools for the same practices that every other non-minority student commits. There is a disproportionate number of students of color who end up in prison relative to their total population. These students receive disciplinary actions that are, most of the time, erroneous for their acts. They are suspended or expelled, when in reality the action they committed only required a call of attention from the principal or the parents (Abudu, 2017). This problem is one that has been attributed to implementation of “zero tolerance” policies in schools that started in the early 1990’s (McCarter, 2017). In addition, researches are applying Critical Race Theory because it seems that in most cases the race of the students determines the outcome of the situation. Previous research has identified some of the causes of the School to Prison Pipeline problem and are now working on research that can help reduce the number of students who are victims. This research focuses on how schools can have policies that serve as predisposition for female students of color to enter the prison system and that could possibly affect their lives as adults. The questions used for this research will be, how have school policies affected the life of female students of color; and how do these educational experiences impact the sense of self?

## Literature Review

Muhammad and Stanford (2018) examine the idea that the risk of mental health issues and recidivism increasement is more frequent among those students who are exposed to the justice system earlier in their lives. The recidivism rates are considerably larger for students of color in this case, African Americans.

African Americans who suffer from language disability tend to be more vulnerable than any other children. Most of the teachers in the United States are white and do not have the cultural competency to identify the problems of the students (2018). As a result, when the student is in a difficult situation and cannot communicate to the teacher, the instructor can misinterpret the behavior of the child and give a penalty for the action. This penalty is more frequently given by teachers to students of color than to any other students who have the same disability and cannot communicate (2018). Students are in contact with the justice system early in their lives for reasons that they cannot control. The zero tolerance policy, introduced by the law of Gun-Free Act of 1994, allowed faculty to punish students with severe consequences for misbehavior that could of have been otherwise corrected with parental involvement. The zero tolerance policy allowed officers to arrest a 12 year old girl who wrote her name on the desk with an erasable marker. This 12 year old girl was handcuffed and arrested and was also suspended from school (2018). Furthermore, African Americans as well as other female students of color, experience racism that many say no longer exists. Students diagnosed with a language disorder experience more stress from school work load and they express it with defiant behavior because they cannot articulate it in any other form. The teachers’ response is to suspend them or send them to another classroom because many have a preconceived judgement that has been added by society through many centuries (2018). The misunderstanding between teachers and students puts them in a pathway that makes them be in contact with the justice system multiple times at an early stage in their lives.

McCarter (2017) analyses the correlation between School to Prison Pipeline and students of color, as well as those who have disabilities and who are of a

different sexuality other than heterosexual. McCarter describes six primary effects of the School to Prison Pipeline. The first one is that school discipline methods are left to the local authorities' responsibilities. As a result, each district has the possibility to use the discipline rules that can benefit or impair the students. The second finding is that, the consequences for the offense are more pronounced than they should be and that the ethnicity, or other social construct of the students, influence the outcome of the decision. The third effect is that the discipline within schools is disproportionately applied to students who are a minority, students who have disabilities or students who identify as LGBTQ. The fourth finding is that the school environment influences the suspension rates. The fifth and sixth effects found that the suspension and expulsion of a student as a result of a discipline method expand the possibility of the student being later involved in the justice system (2016).

Annamma et al (2019) analyses the problems that Black girls have by being underrepresented in society in general. It is commonly heard how Black males or Latinos are part of the school to prison pipeline, however, it is very rare to hear women involved. This, as a result, does not show the problems that Black women have to face when they are also being pushed out of schools and being part of the school to prison pipeline. Black girls are the ones who are suspended the most and "Black girls discipline rates are 6 times higher than White girls; they experience suspension rates higher than 67% of boys as well"(Annamma et al). This consequently is correlated with a higher risk of being incarcerated and having sentences that are more punitive compared to the sentences that White female students receive.

Burt (2014) examines the idea to focus on various points, such as understanding the experiences of girls in the school-to-prison pipeline and how that connects to them being in prison. Burt also focuses on how expanded health services, as stated in the article, would help prevent this problem and what other options are available to possibly help girls from being part of the school-to-prison pipeline. In this article, Burt demonstrates how young girls can be put onto the school-to-prison pipeline path. The lack of proper training for teachers to deal with diverse students can increase the rate of schools leading students to take this path. As stated by the author, "school officials react inappropriately by disciplining girls who demonstrate behaviors that are characteristics of coping with trauma." This is connected to the "Zero Tolerance" policy which punishes students for non-violent or non-criminal offenses (2014). The participants in this case are the ones who suffer from abuse and are not provided with mental health services to help them overcome their trauma. On the other hand, when the young girls are

given the opportunity to access more mental health care, they have a better opportunity to stay in school and not be in prison. This study is important because it shows that new implementation of policies would reduce this problem and allow for more young girls of color to have an opportunity to education (2014).

Females students of color are one of the groups that are most affected by the continuance of zero tolerance policies in schools. Andrews, Hines-Datri, & Dorinda (2017) states that although males of black and brown background are also affected, females tend to be punished more by these policies, but there is only limited research on this issue. According Andrews et al., (2017), "A report by the [U.S. Department of Education and Office for Civil Rights \(2014\)](#) indicated that Black boys have more incidences of suspensions ranging from two to three, while Black girls have higher percentages of punishment than female students across all racial and ethnic categories, and at rates that exceed a majority of male students". Female students of color have higher possibilities of being a victim of the zero tolerance policy than any other group of students.

Some people could argue that zero tolerance policies are applied fairly to every student. However, research shows that students of color are more likely to be punished harsher for the same acts that a white student commits. Mallet (2017), states that "since 1975, African American students have been suspended from school at two to three times the rates of Caucasian students". Students of color are at a higher risk of being involved in the school to prison pipeline, especially female students, but the lack or research on the topic can make individuals think otherwise.

McCarter (2017) also provides strategies to help minimize the problem of the School to Prison Pipeline. Among some of those recommendations that are provided are: providing more training for teachers and increasing the number of nonwhite teachers and as a result having more communication between the two. Also, facilitating the opportunity for students to re enroll in school after they have been out-of-school (2017).

Abudu & Miles (2107 ) studies the idea of having a united approach to disassemble the School to Prison Pipeline. The method proposed in the study is Restorative Justice, this method is one that can help to heal the individuals who were involved in the school to prison pipeline. This approach holds the individual accountable for their actions. At the same time, it takes into consideration solutions to the problems and how to restore relationships and improve the community (2017). This approach is one that has been proved successful in Oakland, CA; Denver, CO; and Los Angeles, CA (2017).

Although Blair (1999) argues the idea that implementation of zero tolerance policy in schools worked for the first five years, this policy needs to be

reconsidered. Blair (1999) examines the policy at a general level, but does not consider the specific problems that arise within each sector of the population, especially among minorities. It is stated that the policy works only if teachers and staff cooperate to work together, but it is not analyzed how more training is necessary in instructors in order to understand the needs of the students.

Evans and Lester (2012) state that zero tolerance policies only create problems for students, as well as the teachers. Teachers are mandated to enforce these policies which can harm the students and prevent them from receiving the adequate attention and guidance they need. Research shows that “negative school climates affect students and teachers alike, increasing both teacher turnover and student dropout rates”(Evans & Lester, 2012). Zero tolerance creates situations in which the students cannot communicate with the teachers and sometimes lead to escalating to situations of an “antagonistic” level in which both the teachers and students are harmed. Zero tolerance is a policy that “often contributes to the failure of many students, particularly students with emotional and behavioral disorders, and increases the number of youth who are caught up in the school-to-prison pipeline”(Evans & Lester, 2012). Zero tolerance policies do not help the students to succeed. Instead they are a step in the path for failure in many aspects of some students' lives.

Many would argue that zero tolerance policies help to maintain the safety and security at school. But in fact, there are many professionals who insist on removing these policies. Some of these professional groups include, The American Academy of Pediatrics and American Psychological Association. These bodies of work call for policies that make the students feel welcomed, included and belonging to the school. Zero tolerance policies, according to these professionals, do not allow proper child development and only make the students feel excluded (Evans & Lester, 2012).

Simson 2014, argues that the policies of schools have been pushing out students from schools and that there is inequality that can be tied to the race or ethnicity of the student. In this article, it is also mentioned how restorative justice once again can be a good option for helping the individuals who form part of the school to prison pipeline. Samson also analyzes the perspective of Critical Race Theory which can be a form to explain how the proportion of individuals exist in the school to prison pipeline. Critical Race Theory claims that the school policies in place in today's day recreate the “American racial hierarchies” that have always existed in the country. This problem is maintained due to the social stigma that exists which is in many cases to people of color or anyone who has a disability and cannot defend themselves from the social

system. It is important to have policies in school that will represent and defend every student equally. For this reason, it is important to understand that the school policies in place do not always affect all students the same way. As a result, the students have different consequences for the same offense. In this study, the main questions are “How have school policies affected the life of female students of color? What can be done to control and reduce this aggravating issue?” These questions will help understand the predispositions that school policies have for female students of color to enter the prison system and how that could affect their lives as adults.

### **Methods**

The goal of this study is to investigate and analyze the data and understand how it has affected the lives of the participants. The survey in this study is designed to help understand the struggles of female minority students. The survey has multiple choice questions as well as open ended questions in order to receive a more complete response from the respondents. The survey does not have any rewards of any kind, this will help in obtaining more honest responses from people who have actually experienced difficulties in schools and that wish for their voices to be heard.

### **Design**

In this study, the methodological framework design will be Critical Ethnography. Current data from journals, articles, and books will be analyzed and in addition there will be a part of the design in which students from different schools will have the opportunity to explain their experience with school policies and if it has had any consequences for them.

### **Results**

The number of participants for the survey was not reached, the goal was 50 and the actual number of participants is 14. The survey indicates that all of the female students of color who participated are students who although had a difficult time in getting to higher education they had the necessary resiliency to continue and find their way to university education. Among the participants 85.7% of them are from Latinx background, the rest of the participants are from different ethnic backgrounds such as Asian and African Americans among others. Among these participants 80% of them answered to being in a low socio-economimc status at the time of being in high school expressing the fact that their “experiences were limited” compared to others who had a higher socio-economic status. Most of the students who answered the survey mentioned that detention was very common in their case or of someone close that they knew, “detention was the closest thing to suspension so that's why I chose it. I don't know how



many times it happened in general but my friend was suspended quite often”. Many of them also mentioned that school counselors did not help them to be motivated but rather discouraged them to continue from school, “...they were all rude. Very don't bother trying you wont make it type of advice”. Even though this study is too small, a bigger sample size can help to understand how the lives of female students of color were affected both in their academic and personal lives by school policies.

## Discussion

The sample chosen for this study is one that is very small and does not allow to generalize it to the population or to a specific issue. In order to fully connect the school policies to the School-to-Prison Pipeline the study would need to have a larger sample size that can be generalized to the population being observed. However, this study, although with a small sample size, can help to understand some of the difficulties that female students of color students go through in order to get to higher education and have a better future. It also can help understand that those students who were constantly in detention for minor things could use the help of restorative justice and learn that instead of being punished for minimal mistakes they can correct their mistake by helping the community with their services. This can be beneficial for both the teacher and the students. Students will learn that they are causing harm with their actions and teachers can maintain the students occupied instead of getting in more problems. Restorative justice can also help understand that there are more ways of educating than established punishments .This study can help to understand some of the experiences that female students of color students encounter on their path to higher education and to think of some ways that their experiences can be changed. This study can not make any conclusions and point to any solutions for a problem, however, it can help in making recommendations. Restorative justice for example is one that could help those female students of color and any student in general to understand the consequences of their acts and to not make those mistakes again.

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# Informing the Need of Critical Thinking in Mathematics

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## Abstract

Based on the Smarter Balanced standardized testing results, it seems that the public education system in California is not providing students with problem solving and critical thinking skills in mathematics. Many studies have indicated that students do not think rationally about mathematics word problems. One of the reasons might be outdated, and unrelatable terminology or context of the problem. Giving surveys to schools in the Central Valley, this research will evaluate if word choice and context plays a significant role in students' understanding of nonsensical mathematics word problems. This information will help teachers, textbook authors, and others invested in mathematics education, create better materials for their students.

*Keywords: Nonsensical, SBAC, Critical thinking*

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## Introduction

Reflecting on past elementary, middle, and high school experiences, it is realized that many mathematics word problems are unrelatable for its intended audience. Many of the scenarios chosen in mathematics textbooks are often unlikely occurrences, with confusing vocabulary, and on an unrelatable topic. It is unfair to expect many students to appreciate the subject matter, if there are so many barriers suppressing their interests. For example, a problem from the Smarter Balanced website for high school reads,

“Your friend Abbie is making a movie. She is filming a fancy dinner scene and she has two types of candles on the table. She wants to determine how long the candles will last. She takes a picture, lights the candles, and then lets them burn for 1 hour. She then takes a second picture. You can assume that each candle burns at its own constant rate.

Candle Type A initial height = 20 cm

Candle Type B initial height = 10 cm

Candle Type A height after burning for 1 hour = 16 cm

Candle Type B height after burning for 1 hour = 9 cm

Candles A and B are lit at the same time. What will be the height, in cm, of each candle after 3 hours of burning?”

Thinking like a high schooler, it is evident why one might feel uninterested in this problem. In real life, the average person does not measure out candles to see how long the candles will last, after purchasing them.

Usually the container mentions the expected time length a candle will burn. Plus, most students are not interested in filmmaking, candles, or have long enough dinners that an average candle will burn out. It would be a stretch to assume that students can relate to this problem. It is unfair to believe many students will care about math when most are structured in this fashion.

This math culture makes students numb to mathematics problems, in the sense that they focus on the numeric values given and try to find a way to manipulate those numbers to give a plausible numeric answer. This may give the student the correct answer, but it does not allow the student to think logically and rationally about the proposed problem. Therefore, it presents a possible problem with how math is commonly presented.

In theory, it seems reasonable if problems were posed in a way that makes things more relatable to the students, interest will increase. An increase in interest may make students less numb to mathematics problems and enhance their logical and rational thinking. This hopefully might cause students to be more aware of what the problem is saying, and more effectively answer mathematical problems.

## Background/Literature Review

Many differing studies have been conducted in regards to school aged students' logical and critical thinking capabilities in mathematics (Merseth 1993). The origin of this curiosity stems from the problem, “A ship sails the ocean. It left Boston with a cargo of wool. It grosses 200 tons. It is bound for Le Havre. The mainmast is broken, the cabin boy is on deck, there are

12 passengers aboard, the wind is blowing East-North-East, the clock points to a quarter past three in the afternoon. It is the month of May. How old is the captain?", which was posed by Gustave Flaubert in 1841 in a letter to his sister (Kaplinsky 2013). Reading through this problem, it should be evident that there is not enough information to find the answer. Though, students try to rationalize a numeric value from this information. A more updated version of this question is: "If a ship had 26 sheep and 10 goats onboard, how old is the ship's captain?", which was posed by a group of French researchers in 1979. Again, there is not enough information to solve the problem, yet some students still provide a numeric answer. Since then, similar studies have been created. The study we will be focusing on is an evolution form in the study of "How Old is Shepard?" done by Kurt Reusser.

Reusser posed the question, "There are 125 sheep and 5 dogs in a flock. How old is the shepherd?" in 1986. He surveyed school aged students in the United States, using this question. He found that three out of four school children answered the question with a numerical answer. Another researcher, Robert Kaplinsky, built off Reusser's research in 2013. He asked children the same question Reusser posed, but instead provided video evidence of his discoveries. Again, students did not successfully answer the posed question, and often gave a numerical answer.

Other countries have also conducted research on the phenomenon of students generating number answers for nonsensical problems. In 2011, Csíkos conducted research on fifth grade students all across Hungary, and concluded that students approached word problems unrealistically, in that they attempt to devise a realistic answer with the numbers provided without thinking of the problem rationally. Csíkos and his team of researchers provided a ten-problem worksheet, where six were unsolvable. One of the questions they used was, "There were 12 ducks and 24 frogs in a pond. How old is the grocer?" (Csíkos, 2011). A question many students answered incorrectly, by providing a number response. They looked deeper into the problem and compared their overall class performance to their recognition of nonsensical problems. They discovered that their academic grade in the class had no correlation on students' recognition of unsolvable problems. Proving that it is not just students who struggle in mathematics who do not recognize nonsensical mathematics word problems, but also those who excel in mathematics.

Emphasizing that the ability of students to successfully solve real world mathematics problems does not lie with individual students' success in traditional mathematics; success in real world mathematics lies with how academia is implemented.

This is a call for help for students to be educated differently.

There are a lot of resources and research done in attempt of improving student education practices. However, after speaking to many teachers it is evident that veteran teachers are not being educated in these findings, and those that are entering the field are only introduced to the ideas with little guidance of how to implement the resources or ideologies.

### **Research Question and Rationale**

To build off of Reusser's and Kaplinsky's research, we focused on seeing if word choice plays a factor in how students answer a question. If word choice plays a factor, it may not correctly reflect their participants' mathematical abilities.

According to PISA (Programme for International Student Assessment) results, American students in general, perform poorly in all categories compared to other first world countries, and are particularly worse in mathematics. Considering how affluent our country is compared to others, one would hope that we would perform in the top percentiles. However, the truth is that our mathematics scores are often not even at the international average. PISA receives their data from randomly selecting 60,000 students, who are the age of 15 all across the participating countries, every three years. The PISA scores are often used to rank countries. The lowest scores on the PISA are often just below 400 points with the highest scores being just above 600 points. In 2012 we scored an average of 481, in 2015-2016 we scored a mean of 470 according to the PISA results, and 478 in 2018-2019 (DeSilver, 2017, Fact Maps, n.d., and Barshay 2019). The 2018 PISA showed the United States making a slight improvement compared to the 2015 results, possibly due to the change of curriculum (Common Core) and focus in mathematics. Though, still America is ranked below average, which begs the question: What are we doing wrong? This provides evidence that there is something needs to change in our education system, so students receive the most out of their education.

Looking at California's data, we find evidence that not only our country, but the state is performing poorly in mathematics. According to The Nation's Report Card, California is performing slightly below average in mathematics, compared to other states in the nation. Therefore, in comparison to the world, California is performing poorly.

This is evident that something has to change to put California, and our nation back on track to be high performing areas. Something different has to be done. Seeing our improved mathematics scores under the Common Core curriculum, perhaps that is a step in the right direction.

A possible reason for America's poor performance in mathematics could be our poor word choice in mathematics problems. Research states that "interest-based context personalization can enhance situational interest among learners with low individual interest and perceived competence in mathematics, but this, in turn, did not result in enhanced problem solving" (Høgheim and Reber, 2015). Essentially, researchers are finding evidence that support relatable word problems increase student interest, which increases the likelihood students will put more effort into problems. However, it is important to note that word choice will not magically increase students' ability to problem solve or critically think, but it will add motive for them to try harder. Therefore, word choice can play a role in dictating student performance on word problems in mathematics.

Some concern arises, because this experiment is based on general group interests, rather than individual interests. Obviously, individualizing everyone's worksheet to each person's interests would better assess their capabilities. However, considering our limited knowledge about our participants, this will at least be a better indicator than previous methods used.

To try to collect the most accurate data, we will conduct our research by being mindful of word choice to unsolvable problems. This will generate a better understanding if students are able to critically think better than previously thought, and if the main barrier is language.

### **Methods/ Research Design**

Mary Vardeh and I decided to survey 6th, 8th, and students taking lower division mathematics high school courses (Algebra, Geometry, and Algebra 2) students at two different school districts in the Central Valley in California. This is to try to limit other factors that may influence data. Diversifying school districts may help with saying the specified environment is a major factor that will influence our data. Surveying multiple age groups will also help to determine if with age, students understand the mathematical word problems better. In our case, we will be surveying 6th, 8th, and lower-division high school courses.

Before we begin conducting the actual research, we plan on visiting all the school sites regarding the parent consent and student assent forms. We will explain all the necessary details of our research to the students, and ask if there are any questions. Reminding them that if any questions occur, to email me, my mentor, or my fellow researcher of any concerns they may have. We will also provide students with a Spanish document if they are from a Spanish speaking home. In about two weeks, I will go

to each compliant school in District One and conduct our research.

The actual research will be done on a paper survey, in a format similar to a typical mathematics assignment. The survey will have a total of five math problems, which will be relatively easy problems in relation to their grade level, according to the Smarter Balanced website. We plan on using the same or similar problems posted on their site, except for one problem.

There will be two versions of each paper survey, one with Reusser's original problem, and one using a modernized version of the problem. The determination of which student will receive which exam will be random, though half the students will receive the older version, while the other receives the newer version. In the survey, they will write their gender, age, and school year. The participants will not write their names to maintain confidentiality.

We will do our best with the classroom space to ensure no cheating arises and that students feel comfortable in their environment. The survey will be conducted at the end of the school year, and students will be allotted 20 minutes to complete the worksheet to limit time taken away from normal classroom instruction.

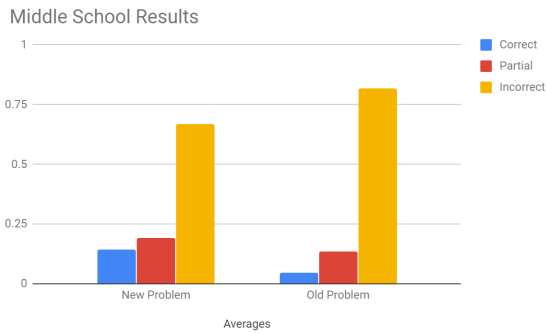
As we collect each survey, we will also collect everyone's assent and parent consent forms. This is to ensure that we can account for everyone's participation, and be able to collect viable data. As rewards for their participation, we will raffle off a puzzle or card game.

After, we will create an answer document to grade all the worksheets. All the information on the worksheet will be kept anonymous. We will transfer all the data collected from the worksheet on a password protected computer. Mary Vardeh and I will store all documents and information securely in our mentor's, Dr. Björg Jóhannsdóttir's care.

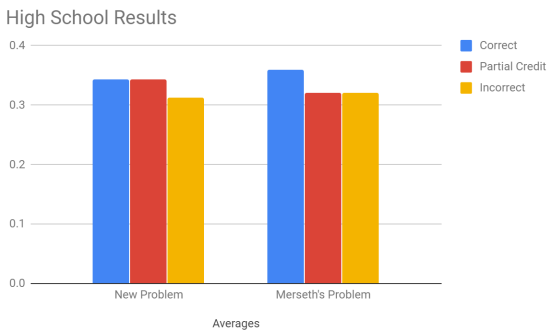
### **Data**

The data I collected is labeled District One and the data Mary collected is under District Two, which is present below. The "Correct" column represents students who correctly identified that the Reusser's or our unique problem did not have enough information to find a solution. The "?" column signifies that the student showed critical thinking, but did not say that there was not enough information, and/or they did not know how to do the problem, but could not give a reason why. The "Incorrect" column shows the students who gave a numerical answer to Reusser's or our problem. When analyzing the data we make a few major finds.

The first major finding was the noticeable improvement in student capabilities of getting a nonsensical problem:



**Graph 1: Middle School Results**



**Graph 2: High School Results**

Graph 1 represents 6th and 8th grade data collected from District 1. Graph 2 represents data on students in lower division high school mathematics classes (Algebra A/B, Algebra 1, Geometry, and Algebra). Looking at the data from Graph 1 and 2, there is a gradual decrease of students generating incorrect answers, and an increase of students writing correct answers. This relation shows that student critical thinking capabilities in District One are increasing as they develop throughout their academic career. This is an important finding, because it does show that students are gradually improving critical thinking skills, and their education is developing their critical thinking skills.

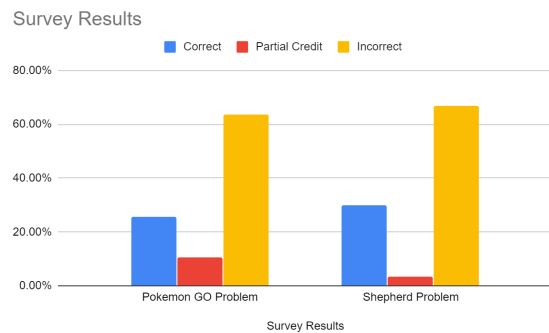
A possible speculation observation may be made from the fact that males tended to perform better on the Pokémon GO problem versus the Shepherd

problem:



**Graph 3: Gender-Percentage Incorrect**

Looking at the totals in each grade level from District One, it also shows that male students performed better on our new problem than Reusser's (old) problem. Better meaning they gave less incorrect answers with this information we turn to the demographics of those who play Pokémon GO. In "Analysis of Pokémon GO: A Success Two Decades in the Making", their findings dictate that there are more males playing Pokémon GO in this age group, compared to females of this age group. By speculation, it is possible that since males of this age group play Pokémon GO more, they are more familiar with it, and that may be a possible indicator that relatability plays a factor. However, we do not have concrete data to support this, though there is a possibility. Another interesting discovery was looking at students' average results, and comparing it to Reusser's results, according to our data students' critical thinking skills.

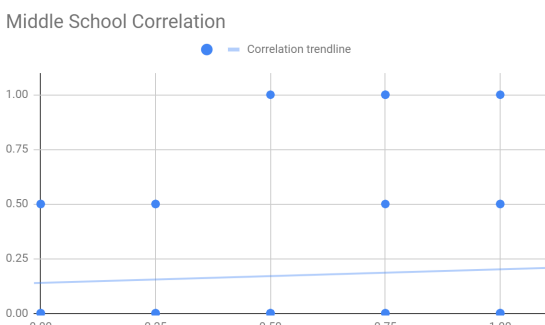


**Graph 4: 6th Grade Results**

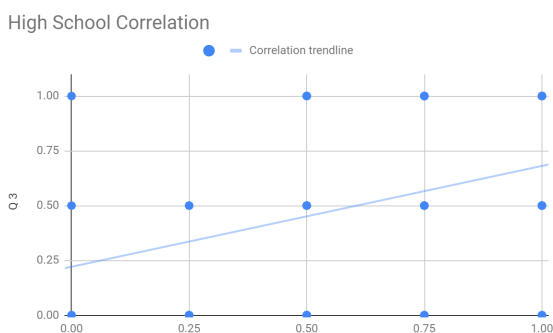
Comparing the 6th grade survey results from District 1 and District 2, where just over 60% of students gave numerical answers, to Reusser's three out of four students giving numerical answers. It shows that critical thinking in students has improved since the 1990s. This is a sign that our education system has improved, which is great evidence for those to notice in the education field. All the Acts and measures taken from the early 1990s until now in the education field has resulted in a higher quality public education system.

Looking again at Graph 4, we can also notice that there isn't a significant difference from the data from the Shepherd problem to the Pokemon GO problem. We were able to confirm this by running a chi square test and receiving a p value of 0.721573, which proves that there is not a significant difference between the two problems. From that data we are able to conclude that in general, word choice does not play a significant role in nonsensical mathematics problems.

After noticing these changes, we looked to see if there is a correlation between traditional SBAC mathematics word problems and nonsensical mathematics word problems in District 1.



**Graph 5: Middle School Correlation**



**Graph 6: High School Correlation**

Looking at the correlation and trend line (the blue line), we can visually see that there is no correlation between SBAC problems and nonsensical problems. In other words, doing well on traditional mathematics problems, does not mean one will perform well on an SBAC problem.

Now seeing the data of the school districts, we are able to formulate some conclusions and speculations with the data.

### Discussion/ Conclusion

The importance of this study is to find out if word choice plays a significant role in students' understanding and performance in mathematics. Despite our expectations that word choice influences critical thinking, according to our data, word play does not play a significant role in performance on

nonsensical mathematics word problems. Perhaps results may be different for other types of mathematics word problems, but for mathematics problems without a numerical answer there is no significance in results. With this our main research question is answered, but we are able to draw some additional conclusions based on our research.

Looking at our data, we can also see that there is no correlation between getting problems correct on the SBAC and performance on a nonsensical question.

There is also evidence that students' critical thinking skills improve as students progress throughout their academic careers.

Our research also supports that the demographics of Pokemon GO may impact student performance. Since male students tended to perform better than females on the Pokemon GO problem, and had improved scores on it. Though, if we would have surveyed if each student was familiar with Pokemon GO we may have been able to formulate a more definitive conclusion on it.

We can also see that from the early 1990s to 2019, there has been a noticeable improvement in critical thinking

With all of this evidence, in general, students need more opportunities to develop their critical thinking skills. Common Core has been implemented for over 5 years, in which it emphasizes critical thinking.

Though, our research also increases my curiosity in further research in this mathematics education topic. With our research, it shows that in general there is no statistical difference (by the chi square test) that word choice matters with nonsensical mathematics problems, but how about regular mathematics problems? Does it help students actually comprehend problems better, or does it just stimulate student engagement? Is it just mathematics problems students have trouble critically thinking in, or is it universal across all disciplines? These are some good questions that future researchers may want to further research.

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I would like to thank Dr. Björg Jóhannsdóttir for being such a great mentor. She taught me from knowing very little about research and the process to giving me an abundance of knowledge about conducting research in mathematics education. She was very hands-on and patient, which was a good fit for my learning style. She gave a lot of great feedback and guidance, which was valuable throughout this learning experience.

I would also like to thank my partner in this research experience, Mary Vardeh. She was my emotional support, and we collaborated throughout

every point in the process. We learned a lot about how to conduct research in mathematics education and how to work with a partner. I could not have asked for a better partner!

I would also like to thank my professors Dr. Bell and Dr. Newton. They have given me a lot of guidance in constructing my research and how to present the

I would also like to thank the McNair Scholars Program and Louis Stokes Alliances for Minority Participation (LSAMP), for providing guidance and funding throughout my whole research experience. They gave me such an invaluable experience that I will be able to cherish throughout my life. I probably would not have been able to do research, if it was not for their help.

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# Improving Quantum Computing Education for Undergraduate Students

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## Abstract

Quantum computing is a promising field of computer science but is difficult to teach to undergraduate students, often requiring extensive backgrounds in computer science, mathematics, and physics. This research project is focused on taking the complex subject of quantum computing and making it more accessible to undergraduate computer science students. I will be examining literature about effective teaching methodology, and then applying these methods to create a hypothetical course syllabus and outline. The syllabus will contain information such as example projects, assignments, and grade breakdowns. The course outline will consist of the most crucial topics necessary to have an acceptable quantum computing introductory course.

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## Introduction

Quantum Computing is a method of computing that uses quantum mechanics to improve upon classical computing, eliminating barriers encountered within modern computers. Classical computers use sequences of bits, which can be either zero or one, to perform computations. Quantum computers use quantum bits, also known as qubits, which can be a combination of both zero and one, which allows quantum computers to perform calculations on many possible combinations of inputs simultaneously (Giles, 2019). Qubits also have a characteristic known as, “entanglement,” which links multiple qubits together and allows quantum computers to drastically reduce the time it takes to perform calculations (Giles, 2019). Both of these characteristics make quantum computing theoretically much more powerful than classical computing, which could introduce new capabilities to computing, such as simulating the behavior of matter, advancing artificial intelligence, and many other possibilities (Giles, 2019). However, Quantum computing is a highly complex field of computer science, involving aspects of classical computing, quantum physics, linear algebra, and several other disciplines, which results in a lack of skilled workers (Giles, 2019). Quantum computing is a very promising field, but due to a lack of education, there is a shortage of people who can actually work in the field. A way to combat this shortage would be to introduce quantum computing in more schools, but this solution is difficult to implement in a practical sense, because most computer science programs don’t provide students with an adequate background to understand a typical quantum computing course, at least not with traditional pedagogy. My research is focused around developing a method of teaching quantum computing in a manner that the average computer science student could understand, without having to introduce more

requirements to the computer science major or sacrifice essential knowledge.

The research I am doing is primarily in the field of quantum computing, therefore that will be the focus of most of the literature to be reviewed. However, my topic could be described as a comparison between quantum and classical computing, and while the paper is focused on quantum computing, some of the underlying explanations will be centered around an understanding of computers in a traditional sense. There will be several topics my research covers, typically requiring first the classical computing explanation, followed by its comparison to quantum computing, but this may vary depending on the complexity of the topic.

## Literature Review

My literature review will be focused on several articles I found regarding quantum computing, and how they could be better explained. Some of these articles lack important details, or they are simply geared more towards readers with adequate backgrounds, so I will be exploring ways they could be better explained to a reader that is less familiar, considering the audience for my proposed course would be an undergraduate student.

One of the first topics about quantum computing to logically start with is why quantum computing is significant, and what it can allow us to do differently. A good piece of introductory literature to quantum computing is an article written by Cardinal (2019). This article covers the basics fairly well, but when it comes to discussing the purpose of quantum computing, it mentions little more than it can change cryptography. The article also does very little to describe how quantum computing can change cryptography. Quantum computing has the capability to change many fields we’re familiar with today, and I’d like to pique students’ interest by showing the incredible capabilities of

quantum computing, which includes cryptography but also includes much more.

As mentioned previously, cyber security is a big concern when it comes to quantum computing. This topic is discussed in an article by Wallden and Kashefi (2019). This article discusses quantum computing's possible changes to cyber security, but seems to shy away from technical details. The topic is very complex, of course, and is difficult to explain well without including some technical information. I, for example, would include more information about how cyber security is currently maintained, and go in depth as to why quantum computers would change these already existing methods. This would ideally contain statistical data and numbers to express efficiency of cyber security methods for example.

I will also, of course, discuss the more technical aspects of quantum computing. To begin, the bit is arguably the most essential part of a computer. Bits convey all information to the computer in the form of zeros and ones, representing two states: off or on. This is not the case when it comes to quantum computing. Quantum computers use bits known as, "qubits" which can exist in a state of both zero and one simultaneously through the concept of superposition. This concept is explained in a book written by Silva (2019). Silva explains that qubits have two extremes representing the base vectors  $|0\rangle$  and  $|1\rangle$ , which can be represented on a sphere by the north and south pole. However, the space in between the two poles can be described as a mixture of the two vectors, allowing them to both exist simultaneously (Silva, 2019). This source is so far one of the most understandable explanations of quantum computing I've come across, but when it comes to quantum computing, that still isn't understandable enough. For example, there is no background information given about the vectors that are a crucial part of qubits, a fundamental characteristic of quantum computing. This is because Silva presumably made the assumption that the reader will have prior knowledge about vectors before reading. This may be true for some readers, but vectors are not always discussed much throughout the computer science curriculum, therefore many students may have trouble understanding this concept.

The next topic I will discuss is logic gates. Logic gates are the basic way that computers use bits to perform logical tasks. Logic gates implement boolean logic, which is essential to computer operation, considering it takes in binary as an input, and returns binary as an output. Gibilisco (2018), gives multiple examples of basic logic gates. The issue with this source, is that it only discusses logic gates in respect to classical computing, which is not very useful when trying to understand quantum computers and how they operate. This is why I will attempt to use some of the

examples from this book and compare them to quantum logic gates found in another one of my sources from Spector (2007). For example, one of the gates listed by Gibilisco is the NOT gate. The NOT gate takes in a bit, and returns the opposite. Therefore, if a NOT gate is applied to a zero, the output is a one (Gibilisco, 2018). Spector also explains a NOT gate, but in relation to quantum computing instead. Spector explains that a quantum NOT gate can be represented by the matrix:

$$\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

(Spector, 2007).

The issue with this explanation is that it assumes the reader has knowledge of matrices, which many computer scientists do not.

Another topic I would like to discuss is the quantified improvements of efficiency using quantum computers as opposed to classical computers. Throughout my paper I will discuss how quantum computing works and how it differs from classical computing, but it is also useful to understand how these differences result in improved performance. Null and Lobur (2019), explains that quantum computing is more efficient because the ability for the qubits to be in superposition allows the computer to process computations for all possible combinations of the bits, resulting in what is known as "quantum parallelism." This source does well explaining this concept, but I believe it would be more useful if it were to also demonstrate a practical application that displayed the superiority of quantum computers, such as searching through an unordered database.

Lastly, when it comes to computers, programming is very important. Quantum computer programming is much different from classical programming, however, a language called Quantum++ has been developed that hopes to merge classical programming with quantum. This language is discussed by Gheorghiu (2018). Gheorghiu gives a lot of information, but it reads a lot like documentation for a programming language. My focus would be centered around a more practical approach. Many programmers use Java, for example, but very few know how it operates. Knowing how a programming language operates is very useful knowledge, but it is unnecessary when it comes to introducing a language. Programming should be emphasized first, and the technical aspects should be taught later. Another useful source regarding quantum programming I found was an article by Sofge (2008). This article discusses the evolution of quantum programming languages, including how quantum programming is different from classical programming. This information can be of use to include in my course content to help better understand what differentiates quantum from classical programming, and how they should be subsequently approached.



There are more sources I will be using as my research develops, but these are some of the sources I have come across in my research thus far. My main approach to bettering the literature I use will be connecting concepts through their relation to both quantum and classical computing, considering most computer science students are more comfortable with classical computing. The next step I make will be taking these concepts and making them understandable to computer scientists that lack a background in some of the more advanced fields involved in quantum computing. My goal is to make quantum computing more understandable to the average computer science student without sacrificing accuracy, and while the existing literature on quantum computing is great, it is most often far from being easily understood.

### Methods

The goal of my research is to develop a simple, yet effective course outline to teach quantum computing to undergraduate computer science students. To accomplish this task, I will be studying quantum computing and examining which topics a quantum computing course generally includes. I will also be studying literature about teaching methods and what methods are most effective to determine how I will structure the course. I will then produce a hypothetical course outline and syllabus that could be used as a guideline for an undergraduate computer science course. The purpose of the course outline and syllabus is to act as a substitute for a full course, as creating a full course is outside the scope of this project. As a senior undergraduate computer science student, I know which courses other students can be expected to have taken, so I will be able to determine which topics need to be simplified due to a lack of background understanding. The course syllabus will also draw from my research on pedagogy, as it will include how assignments are to be performed, how the grades will be determined, and more information that a student would generally expect from a course syllabus to have a full understanding of the expectations of the course.

### Design

I hope to develop a theoretical course on quantum computing, but I can't realistically create material that would span the entire course, assuming it is the length of a normal course. Therefore, I will create a syllabus that could be used to model such a course, including information like necessary prerequisites, projects, and grading policies. I will also include a course outline to grant readers an idea of how the course would be organized and which topics would be covered.

## Results

### SYLLABUS:

#### Introduction to Quantum Computing

Prerequisites: CS 3740 (Computer Organization) and CS 3100 (Data Structures and Algorithms)

#### Course Description:

This course will serve as an introduction to quantum computing. The course will not be as in-depth as a quantum computing course one could typically find within a graduate program, nor will it be as in-depth as a quantum computing course with a long list of prerequisites. This course is designed for undergraduate computer science students and will approach the subject in a way that makes it understandable for students who haven't had extensive backgrounds in physics or math. This course will introduce you to basic quantum computing concepts, the physics behind them (including math), how quantum computers differ from classical computers, and possible ways it can change the world of computing. This course will also introduce you to basic programming with quantum computers.

#### Grading Breakdown:

Regular Assignments: 50%  
Tests/Quizzes: 30%  
Programming assignment(s): 10%  
Final project: 10%

#### Grading Policy:

Late work will be accepted for 80% of the grade received. Test and quiz portion can be adjusted if the student shows improvement. Programming assignments will be graded based on effort (to be determined by the professor).

#### Grading Scale:

This course will be graded on a standard scale. 97–100% A+, 93–96% A, 90–92% A-, 87–89% B+, 83–86% B, 80–82% B-, 77–79% C+, 73–76% C, 70–72% C-, 67–69% D+, 63–66% D, 60–62% D-, <60% F.

#### Final Project:

The final project will be centered around performing a lecture for your peers about a topic of your choice, relating to quantum computing of course.

#### Weekly Homework:

Each week you will be turning in a short summary in your own words of the information covered throughout the week.

**Required Materials:**

Any necessary subject materials will be provided by the professor. These will mostly include learning materials included with your enrollment to the university, provided by the university library.

A large influence on how the syllabus was constructed was the book, Handbook of College Science Teaching by Joel J. Mintzes and William H. Leonard. In the book, Mintzes and Leonard explain that motivating students to learn is incredibly important for a science course. Mintzes and Leonard also give advice on how to motivate students to learn (Mintzes & Leonard 2006). One of the tips the authors provided was to allow students some degree of freedom regarding what to learn and how to learn it. The authors also state that peer instruction has been proven by research to increase conceptual understanding as well as improve the ability to solve quantitative problems. It is for these reasons that the final is a project centered around peer instruction, and the students are able to choose their topic.

Some choices made in the syllabus are more arbitrary, but are guided by principles learned from my research. The grade breakdown is a great example, since research won't tell you exactly how to grade a class, but can give advice to increase student learning. Another source of influence for this syllabus was an article titled, "Teaching About Teaching Science: Aims, Strategies, and Backgrounds of Science Teacher Educators" by Amanda Berry and Jan H. Van Driel. This article explained that teaching educators, when teaching preservice teachers, strongly emphasized focusing on student learning and avoiding traditional teaching methods (Berry & Driel 2012). This motivated me to avoid structuring the class in traditional ways for the sake of familiarity, and instead making decisions I felt best emphasized learning. For example, this class accepts late work for up to 80% of the original grade. This is because students need to be somewhat motivated to turn it in on time so the educator is allowed time to grade, but also not to deter students from completing work simply because the due date is passed. If the late work is not accepted, students are less likely to complete the assignment, but the point of the work should be to help students learn. If the students complete the work later, they still learned the material. This article also motivated me to include details such as the test and quiz portion of the grade being adjusted if the student shows improvement. This is another example of focusing on student learning and shying away from traditional methods.

**COURSE OUTLINE:**

Week 1: Syllabus/What is quantum computing?

Week 2: Classical vs Quantum Computing

Week 3: Linear Algebra Crash Course

Week 4: Superposition

Week 5: Entanglement

Week 6: Classical problems in quantum solutions

Week 7: Quantum algorithms

Week 8: Shor's algorithm

Week 9: Basic quantum programming

Week 10: Review

Week 11: Final presentations

Week 12: Final presentations

The topics to be included in this proposed course are also arbitrary and can be changed in accordance to what the professor may consider to be more important, but this outline can act as a general guideline. My focus was to include important concepts, as well as provide time for practical application in the form of programming. In, Handbook of College Science Teaching, Mintzes and Leonard discuss a study performed on introductory level science courses. The study found that in introductory courses, it was important to focus on fewer concepts and to explore the topics extensively using examples and practical applications (Mintzes & Leonard 2006). As mentioned earlier, the final for the class is a presentation of a quantum computing topic by students, so there is also time allotted for that at the end of the course.

Aside from the organization and policies of the class, it is also important to convey the information in an understandable way, considering the students in this class are simply undergraduate students with limited backgrounds in math and physics. The professor can't simply start mentioning matrices and other advanced concepts without first addressing them and giving some background. This isn't a math course, so there are limitations to how much detail you can dive into, but the professor should make an effort to convey as much information as necessary to understand the topics. For example, in the literature review section, I mentioned that Spector in an article from 2007 explained that the quantum NOT gate can be represented by the matrix:  
[0][1]

[1][0]

(Spector, 2007). In this course, the professor can't assume the students are all familiar with matrices, so the professor would have to first remind students of a classical NOT gate, and then explain that the quantum NOT gate behaves in the same way, but is presented in a  $2 \times 2$  matrix because it is acting on a single qubit, and quantum gates are represented by a  $2^n \times 2^n$  matrix where  $n$  is the number of qubits (Roell 2018). The professor would also give some background regarding vectors and matrix multiplication because quantum gates are inseparable from these concepts and can be best explained by them. However, the professor doesn't need to be certain that students are completely educated in matrix mathematics, but the students need to be introduced to it just enough to be able to understand what is taking place within a quantum gate and have enough of an understanding to read literature about quantum computing and not be discouraged at the mere sight of a matrix. While we are currently discussing matrices and logic gates, the professor would have to take these approaches for all the topics in the course that typically require a more extensive background to discuss.

### Discussion

I feel that the proposed course syllabus and outline can act as an effective guideline for an introductory undergraduate quantum computing course. This project is mostly centered around my own experience and my own conclusions drawn from the literature I studied, so there is no certain way to say this is undoubtedly the best approach to take, but I hope some educators who are also struggling with how to approach introducing quantum computing to undergraduate education can examine this project and draw inspiration from it and make adjustments where they see fit. As mentioned earlier, many details included in the syllabus and outline were arbitrary but were meant to provide a general idea of how one could approach a course like this, so there are plenty of changes one could make if they saw fit. I am hoping that my study can further quantum computing education, even in the smallest ways.

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# The Influence of Jane Austen's Works on Societal Attitudes Regarding Women and Marriage, Education, and Slavery from the Early Nineteenth to Twentieth Centuries

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## Abstract

People question whether fiction actually has the ability to exert influence on its readers, and as such, fiction's influencing effect on its readers is the main subject of interest in this study. Jane Austen, who was a female author writing in the 1810s, will be used as the foundation of this project. Did her three novels: *Pride and Prejudice*, *Mansfield Park*, and *Northanger Abbey* exert influence on the attitudes of middle-and upper-class individuals in American and British society regarding the topics: women and marriage, education, and slavery in the nineteenth and early twentieth centuries? By compiling newspaper articles and books dating from the 1810s to the 1910s, my hypothesis, that these books did exert influence on their readers, but only when it was beneficial for the reader, can be tested. This hypothesis anticipates that the reader was in control of how much he/she was influenced by the novels in question. From this study, the general fields of history and English Literature will be shown to be intricately linked, which may result in individuals realizing the need to place a greater emphasis on the interconnectedness of the two fields. In addition, the limits of fiction's ability to influence may assuage fears about fiction's ability to corrupt, brainwash, or influence any individual absolutely. A close examination of many sources from the period of interest shows that the main topic of influence that these three Jane Austen novels had was on education, specifically on English education. Indeed, fiction does seem to have some power of influence over its readers, but that influence is not all-engrossing.

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## Introduction

It is common knowledge that the written word has great power over the ideals, attitudes and decisions of people in society. Yet, while this is a well investigated aspect for non-fiction, the influence that an author may have through fiction has been less thoroughly examined. The author's indirect suggestion of ideas, how characters are portrayed, and the overarching themes of fiction books alter readers' attitudes towards certain ideas. This influence is supported by Friend's (2010) study where she concludes that literature influences people's attitudes toward "real people, events and situations," despite the nineteenth century belief that fiction was mere entertainment. This current study will focus on Jane Austen and the influence of three of her works. There is research to attest to her influence on modern ideals, but the influence that her books had on individuals in American and British society during the nineteenth and early twentieth centuries remains scant. Specifically, this study aims to demonstrate how Jane

Austen's three novels-- *Pride and Prejudice*, *Mansfield Park*, and *Northanger Abbey*-- influenced middle-and upper-class attitudes in American and British society regarding women and marriage, education, and slavery in the nineteenth and early twentieth centuries. The following literature will be used to better understand this influence.

## Literature Review

Suloway's (2016) book investigates the many controversial ideas that Jane Austen promoted through her novels. Particularly, Suloway points out the fact that Austen was indirectly highlighting the double standard between men and women when it came to education (2016). Austen, through her heroines, often showed the result of educational neglect when it came to females. In addition, *Mansfield Park* points out the inhumanity of slavery, showing Austen to be a woman who was not afraid to espouse her ideas regarding controversial topics

(Suloway, 2016). This book provides a foundation regarding the many disputed topics of Austen's time that she indirectly comments on, but it generally fails to document the reaction of the society at large.

Pollack-Pelzner's (2013) article looks at the comparison between Jane Austen's works and those of Shakespeare. Jane Austen, especially in *Mansfield Park*, writes of scenes reminiscent of a Shakespearean

work, and often has her characters respect Shakespeare. The fact that individuals were comparing Austen to Shakespeare and other renowned authors speaks to the influence that her novels had on individuals' thoughts regarding education. Austen wrote her novels in an innovative style, which became a staple of education (Pollack-Pelzner, 2013). However, while this article goes into *Mansfield Park*, it omits the other books that this study is interested in.

Kitsi-Matako's (2013) article specifically focuses on *Mansfield Park* and Jane Austen's calling out of individuals' hypocrisy regarding slavery. While it was almost taboo for women to comment on such issues as slavery, Austen defiantly lays bare the inhumanity of English white men in how they treat black slaves (Kitsi-Matako, 2013). On a negative note, this article focuses solely on *Mansfield Park*, and so, cannot fully answer this study's research question.

White (2006) specifically focuses on black and white slavery in Austen's *Mansfield Park* and *Pride and Prejudice*. As stated earlier, *Mansfield Park* did draw its readers' attention to their moral hypocrisy, and this was met with resistance, in the form of conscious omission of the novel from important literature reviews that were featured in magazines (White, 2006). Prominent members in American and British society who read the book did not wish for it to be successful, because of the morally right, but financially disastrous, lesson of the novel. Even the publisher of *Mansfield Park*, John Murray, dropped Jane Austen after the first edition of the book, because her book was too politically divisive. In the end, he was afraid that her novel would show its readers the immorality of slavery, which would hurt many of his acquaintances financially, so he decided to no longer publish her book (White, 2006). However, although this novel does show how Austen's books influenced individuals' attitudes regarding slavery, it does not go into the other topics of women and marriage or education.

Brewer's (2015) article is an in-depth study into the fact that quotes from Jane Austen's novels were used repeatedly in the first edition of the Oxford English Dictionary, which gentlemen started compiling in 1884. This emphasizes the fact that Jane Austen's works influenced the editors of the dictionary in such a way that they decided to use quotes from her works hundreds of times. In effect, the men who compiled the Oxford English Dictionary thought that quotes from Jane Austen's books were worth adding to the dictionary, which would become an educational tool for people in multiple societies for many generations. Therefore, this article shows that Jane Austen was able to influence society's view of

education through her work, by having her novels quoted in one of the most prestigious dictionaries (Brewer, 2015). However, Brewer's article does not attest to the influence on the views of women and marriage or slavery that Austen's works may have had on society.

Mazzeno (2011) outlines Jane Austen's reception in the centuries after she published her works and comes to the conclusion that Austen was most effective at influencing individuals' attitudes towards education. Her influence on the structure of the novel and English education really started to flourish in the 1890s, and she was praised by famous novelists, such as Sir Walter Scott and Sir Walter Raleigh for her extraordinary style of writing (Mazzeno, 2011). Although this book deals with Austen's influence on education, it does not deal with the other topics in-depth, which can be seen as a limitation.

Todd's (2005) book assembles many early responses to Jane Austen's work, representing a general feeling among middle-and-upper-class individuals of American and British society towards Austen's novels. Particularly, responses to *Pride and Prejudice* showed that many men in society used the novel to support existing beliefs about woman and marriage, while other parts were skimmed over when it was not convenient for them (Todd, 2006). The middle-and upper-class individuals seemed to embrace the idea of the benefits of female education that Austen advocated through her novels. In addition, Todd also points out that Austen was compared to Shakespeare in the *Quarterly Review*, and this can be taken to show that many individuals believed that Austen's novels needed to be a part of new educational curriculum that focused on literature (2006). The influence of Jane Austen's novels on attitudes relating to education are explored in the novel, but the other topics that are of interest in this study are skimmed over.

Mooneyham White's (1998) book, which is a compilation of essays written by different individuals, goes into how *Northanger Abbey* influenced individuals' beliefs that if the only education that females received was through reading novels, misunderstanding and disaster would ensue. In addition, another essay argues that *Pride and Prejudice* was Austen's most popular novel, because it advocated widely accepted ideas about women and marriage (Mooneyham White, 1998). Although this gathering of essays goes into general ways Austen's novels influenced individuals' attitudes relating to education and women and marriage, it does not

comment much on the issue of slavery in Austen's works.

Harman's (2011) book goes into the initial reactions to Austen's novels. Notably, when Austen's novel *Pride and Prejudice* was first published, upper middle-class individuals looked at it as groundbreaking because of the new style of writing. However, unlike the conclusions that other sources have reached, Harman asserts that *Mansfield Park* was the novel that readers were most influenced by, because it espoused an idealized lesson in morality (2011). In addition, *Northanger Abbey* was the book that changed upper middle-class views of female education and writing (Harman, 2011). However, because this book has such a wide scope, insightful details are lacking.

Bautz's (2007) compilation of private letters and diary entries illuminate how the readers of Jane Austen's books in the mid to late nineteenth century reacted to her works. Specifically, there are various instances of fathers writing to their daughters about paying close attention to the lessons that could be found in Jane Austen's works, such as the lesson that women were especially suited for marriage (Bautz, 2007). By having marriage for women be encouraged by Austen, men took Austen's novels to encourage the idea that women were to be submissive to men, which reinforced male superiority. By using primary sources, this article effectively counters the argument that was popular in the nineteenth century that fiction was mere entertainment. Bautz's article covers almost all of the aspects of this study, and because it does the largest examination of primary sources out of the sources looked at for this literature review, it is the most helpful and pertinent, although the time frame covered is narrow in scope (2007).

There is not much research that brings together Jane Austen's influence on middle-and-upper-class individuals' attitudes in American and British society concerning subjects such as women and marriage, education, and slavery in the nineteenth and early twentieth centuries. The current study hypothesizes that Jane Austen's three works: *Pride and Prejudice*, *Mansfield Park* and *Northanger Abbey* did influence societal attitudes in the 1810s to the 1910s, but the way in which these attitudes were influenced by these works was different for each topic. As a counterargument to this hypothesis, Davis (1987) maintains that fiction novels influence readers to the point where they blur fact and reality, whether the reader wants to be influenced or not. According to Davis (1987), fiction has a brainwashing influence on its readers. Instead of believing that the readers are ultimately in charge of the influencing power that

fiction has, this theory asserts that fiction has an overpowering ability to influence that trumps the reader's ability to resist. Without the proper view of how literature influenced individuals' attitudes in the past, people today may misconstrue this relationship between fiction and its influence on its readers, causing people to be fearful of reading fiction due to the hazard of being unintentionally or absolutely influenced. The current study's intent is to show that history and English/literature are closely connected, and that Jane Austen's influence was not all-encompassing. Her readers decided if it was beneficial or not for them to be influenced by her works.

## Method

*Design:* This study had a qualitative design, consisting of archival research. Specifically, this study required the close analysis of primary sources such as newspaper articles and non-fiction books, as well as letters. Going through primary and secondary sources, some written in the nineteenth century, and some in the early twentieth century, I was able to look intentionally for mentions of how the three Austen novels under examination influenced attitudes of middle-and upper-class individuals regarding the topics of interest.

*Materials:* In order to obtain meaningful results, many primary source documents were consulted. The databases JSTOR and Reader's Guide Retrospective:1890-1932 were accessed as much as possible to help in this. For even more sources, books in the CSU Stanislaus library's 'Jane Austen' section were utilized, in addition to primary sources and articles which were obtained through CSU+. Many of the primary source documents utilized in this study are newspaper articles from *Littell's Living Age* and *Harper's Weekly Magazine*, as well as books that were written in the nineteenth and early twentieth century about Jane Austen's novels (See Appendix A).

*Procedure:* Utilizing the aforementioned resources, I, as the sole participant, found as many primary sources that time permitted that mention Jane Austen and her three specific novels: *Pride and Prejudice*, *Mansfield Park* and *Northanger Abbey*. Then, I noted the manner in which the specific topics in the novels, women and marriage, education, and slavery, were dealt with, what attitude target individuals had towards these topics, and how those attitudes were influenced by Jane Austen's works. In short, in order to measure the influence that these Jane Austen works had on individuals in the nineteenth and twentieth centuries, I looked at how often these specific works of hers were mentioned, what manner they were referred to in, and if there was any indication that the author of the sources had undergone a change

in attitude that was caused by those specific Austen novels.

### Results

I expected the results to show that Jane Austen's three novels: *Pride and Prejudice*, *Mansfield Park* and *Northanger Abbey* did influence middle-and-upper-class individuals' attitudes toward women and marriage, education and slavery in the early nineteenth and twentieth centuries. However, I expected to find that individuals' attitudes were influenced only when it was beneficial for them. Furthermore, I expected to find that individuals resisted the novels' influence when they believed that their money, well-being, or reputation to be at risk.

After analyzing about fifteen primary sources from the nineteenth and twentieth centuries, my hypothesis was proven correct (see Appendix A and Appendix B). Jane Austen's novels: *Pride and Prejudice*, *Mansfield Park* and *Northanger Abbey*, had the most significant effect on upper-middle class individuals' attitude towards education, and her novels made many individuals think about education, particularly English education, in a groundbreaking new way. Her influence on individuals' attitudes toward women and marriage was also clear, but not nearly as significant as her influence on people's attitudes toward education. Analyzing these primary sources did unearth the surprising fact that not one of them mentioned slavery, even when mentioning *Mansfield Park* (see Figure 1 in Appendix B).

These findings supported my hypothesis because it was beneficial for upper middle-class individuals to be influenced by Austen's new way of writing the English novel, and her new approach to education as a whole, because it encouraged society's intellectual growth and achievement. In addition, the finding that Austen also influenced individuals' attitudes about women and marriage through her novels also makes sense within the proposed hypothesis, because the idea that women were best made for marriage kept society stable by keeping a foundational ideal alive, and it also reaffirmed men's dominance in society. Even the fact that there was no mention of slavery in the fifteen primary sources

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analyzed supports my original thesis. It was not advantageous for individuals to adopt the idea promoted by Austen in her novels that slavery was/is immoral because many individuals still made a handsome profit from Caribbean slave labor. If they had allowed themselves to be influenced by Austen's novels promoting the idea that slavery was/is corrupt, their luxurious lifestyle would have become impossible to maintain.

### Discussion

From this study, additional knowledge has been gained regarding specific vital aspects of life and history. Regarding education, these results can help people better understand another component of why the studying of novels became common, and why education was transformed around the late nineteenth and early twentieth centuries. In addition, historians will be able to use this study to comprehend another aspect of public opinion towards slavery. Also, these results can help individuals better appreciate the fact that marriage in modern times is not an automatic obligation for women as it was back in the nineteenth and twentieth centuries.

This study once again proves that the written word is powerful, but that it does not have an all-encompassing ability to influence. Additionally, because there is not a conclusive study on Jane Austen's influence on the nineteenth and twentieth centuries' members of the middle and upper-classes, these results give important insight into a significant era in history. In addition, this research brings together both fields of history and English/literature, which has rarely been done in the past. Individuals, scholars, and universities can see a need to place more emphasis on the interrelatedness of history and English/literature, and this could ultimately result in curriculum changes.

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## Appendix B

Women and Marriage	Slavery	Education
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<p>Evidence</p> <p>This idea was expressly discussed in eight of the fifteen articles that were analyzed.</p>	<p>Evidence</p> <p>There was no direct mention in any of the analyzed documents—only references to the moral of the novel.</p>	<p>Evidence</p> <p>From the fifteen documents analyzed, eleven showed direct influence regarding this topic from Austen’s novels.</p>
<p>Quotes/Phrases</p> <p>Austen’s heroines believe marriage to be their duty and “have too strong a judgment and too strong a sense of humor for their emotions to sweep them off their feet.” (“Jane Austen,” 1898).</p>	<p>Quotes/Phrases</p> <p>“serious moral of the whole work” of <i>Mansfield Park</i> is discussed (Warre-Cornish, 1914).</p> <p><i>Mansfield Park</i> has a “growing tendency to moral on the time, a tendency that points...to didacticism” (Burton, 1909).</p>	<p>Quotes/Phrases</p> <p>“On her was bestowed, though in a humble form, the gift which has been bestowed on Homer, Shakespeare, Cervantes, Scott, and a few others...” (Dawson, 1905).</p> <p>“...she achieved with greater perfection...than almost any other English writer with whom we are acquainted. Never was a definite literary field so clearly marked out and so perfectly mastered as by Miss Austen” (Littell, 1870).</p>

# The Ecological Relationship of Mammals, Their Habitat, And Daily Temporal Shifts

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## Abstract

National Wildlife refuges reside all throughout the United States. These refuges were established to help conserve threatened wildlife along with offering outdoor activities for people to participate in. The San Joaquin River National Wildlife Refuge (SJRNWR) is located approximately 20 miles west of Modesto, CA. This refuge is located very close to large cities such as Modesto and Turlock, yet many valley natives do not know that it exists. Compared to the vast numbers of agricultural fields surrounding the refuge, this area provides a protected habitat for many California native species of animals and plants. This study investigated the mammals encountered at the SJRNWR to see if habitat type and daily temporal shifts influence their activity. This was done by analyzing and comparing mammalian activity of three different habitat types through a digital photo collection collected via digital camera trap. The three habitat types that were compared in this experiment were the riparian habitat, grassland habitat, and the transitional habitat between the two. These habitat types were selected because they are widespread throughout the refuge and house endangered species such as the Riparian brush rabbit (*Sylvilagus bachmani riparius*). The results of this experiment show that mammalian activity at the SJRNWR is more abundant at night and the early hours of the morning in riparian habitat. This is because the riparian habitat has more vegetation for mammals to eat and use as protection.

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## Introduction

The San Joaquin River National Wildlife Refuge (SJRNWR) is a 7,000 acre federally protected area located in Stanislaus County. This site is positioned in an area where three major rivers (San Joaquin, Stanislaus, and Tuolumne) join in the San Joaquin Valley, just 20 miles west of Modesto, CA. Surrounded by numerous agricultural fields and orchards, this protected area serves as a lush haven for many California native species of animals and plants. This California wildlife refuge is home to two known endangered species, the Riparian brush rabbit (*Sylvilagus bachmani riparius*) and the Riparian woodrat (*Neotoma fuscipes riparia*). Both of these endangered species thrive in the riparian habitat of the refuge which consists of thick dense brush and oak deciduous forest. California's San Joaquin Valley has endured a 90% reduction of riparian communities due to anthropogenic influence (Beacham et al. 2000). These two endangered species are currently being pushed out of their natural habitat and forced to seek refuge elsewhere because they are majorly affected by natural disasters such as flooding and wildfires because of climate change and agricultural expansion. Studies of this area have been conducted in an attempt to control and reestablish populations of endangered mammals such as the riparian brush rabbit that had once been

isolated due to flooding in the area and that live in these habitats (Kelt et al. 2014).

This experiment was conducted to examine the activity levels and the interactions that mammals have with their habitat throughout the San Joaquin River National Wildlife Refuge. These activity levels were then explored to determine whether the daily temporal shifts and different habitats within the refuge possibly impacted those levels. Daily temporal shifts refer to the daily change from day to night. This was done by examining a photo collection that was assembled in late 2017 early 2018 using digital game camera traps. Over 340,000 photos were initially collected to help measure the success of a reintroduction project of a Riparian brush rabbit population at the SJRNWR. The photo collection used in this project was excess data collected for that project but has never been utilized. This study will be an offshoot of that project and hopefully the results of this study can contribute to that project and the success of that brush rabbit population. If the results of this project are deemed successful, the data collected may also be used in gaining more funding for on-going conservation efforts at the SJRNWR.

Digital game traps were set up in three different habitat types which include riparian, grassland, and an ecotone. The riparian habitat is a zone where the aquatic habitat of a stream or river meets terrestrial land. This habitat contains dense vegetation such as thistle,

blackberry, California rose, and native trees and bushes. All which provide dense foliage that many animals use for protection and as a food source. The grassland habitat is made up of various invasive and native California grasses. The transitional habitat consisted of an ecotone between the riparian habitat and grassland habitat within the refuge. An ecotone is a transitional region where the edge two different habitats meet.

The expected outcome of this experiment was that mammalian activity at the San Joaquin River National Wildlife Refuge would be dependent on the time of day and the type of habitat the activity was documented in. Also, these factors would influence the amount of activity documented. The results of this study were expected to document higher levels mammalian activity at night and early morning and in riparian habitat. This is expected because larger mammalian carnivores such as coyotes are more active during the early hours of the morning and hours of nightfall. In Chicago wildlife areas that are affected by urbanization the density of activity in coyotes (*Canis lupis*) peak at the hours of 7am and 5pm (Gallo et al. 2019). Also, smaller rodents such as mice and rats are more active at night because they are nocturnal. Since the species of grass that grow in this central valley area grow denser and taller in the spring after receiving the rainfall of winter, the grassland habitat is expected to show less activity. This is because the time window of study occurred during the winter and ended before spring started. Without the thick cover of grasses, smaller mammals are more vulnerable to predators such as coyotes, owls, and hawks. Smaller mammals tend to avoid open areas that the grassland habitat provides. Ecotones are expected to show more sparse documentation of mammalian activity because these areas tend to be less covered and have vegetation that is more spread out. Smaller mammals tend to aggregate to areas covered in dense brush or areas that contain high grasses for protection from predators. If these results are shown to be true, conservation at the SJRNWR can be directed to specific habitat types to protect naturally occurring habitat and enhance it. The increased funding and efforts may hopefully increase the number of mammals in those areas and throughout the refuge. This would directly impact endangered species such as the Riparian brush rabbit and the riparian woodrat but also indirectly have a positive impact on native and migratory bird activity within the refuge as well.

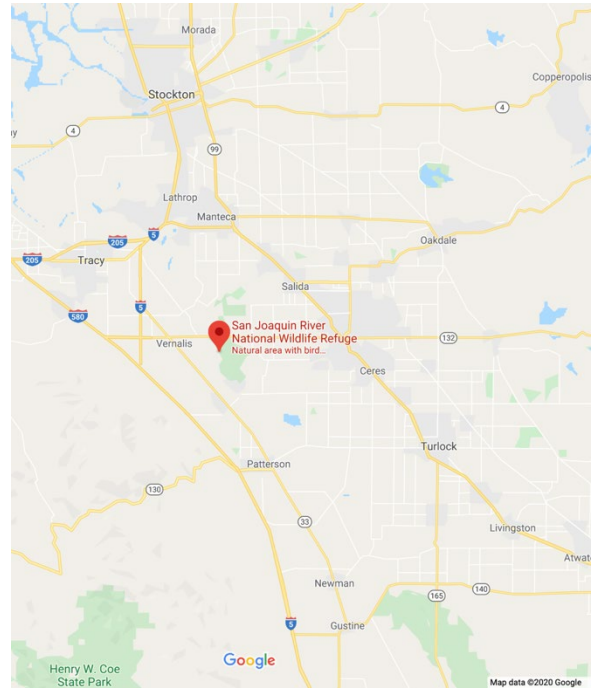


Figure 1. Map of the San Joaquin River National Wildlife Refuge relative to northern California central valley.

## Methods

This project was conducted by analyzing a photo collection of a selected area at the San Joaquin River National Wildlife Refuge. This collection consists of photos collected via 54 camera traps in the year of 2017. The camera traps were set up starting in mid-November and ran for a 14-week period which ended in mid-February. These photos were viewed, electronically tagged, and later had data extracted from them.

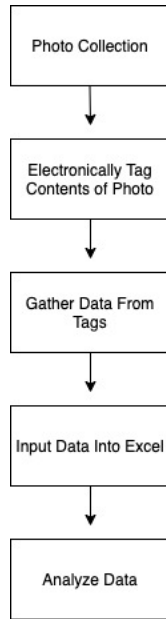


Figure 2. Flow chart of methods

#### Camera Setup

The cameras used were Cuddeback digital game camera which were motion and infrared sensed. Each camera was set up to take five consecutive photos once the motion sensor was triggered and was set to wait for a minute and thirty seconds before it was triggered again. This photo collection was developed from photos taken through three different camera trap transects. In this experiment, a transect is a collection of camera traps set up in a straight line. These transects were set up with a ten-meter distance between each camera. Each camera used in this project was strapped to a wooden stake that was hammered into the ground at each designated trap station. Each station was baited with a tin foil pie plate containing a mixture of corn, oats, wheat, and barley that is better known as sweet corn or sweet cob commonly used to feed livestock. The same transect set up was replicated in three different habitats to compare the mammalian activity between each different habitat. These habitats include riparian, grasslands, and transitional (Fig. 3a-3c). The riparian habitat is a habitat sandwiched between the aquatic habitat of a stream or river and the terrestrial habitat. In the case of this study, the riparian habitat was set up through dense brush running along a creek within the refuge. The grassland transect was set up in a field of grasses that contain both native and invasive grasses. The transitional transect was set up in an ecotone of riparian and grassland habitats.

Figure 3a. Grassland Habitat



Figure 3b. Riparian Habitat

Figure 3c. Transitional Habitat

#### Photo and Data Analysis

Every time the camera was triggered this was considered as a new event to be documented. Each event consisted of the 5 consecutive photos that the camera trap was programmed to take (Fig. 4a-e), and the contents of the photos were only tagged once. Photos were electronically tagged using the photo tagging feature included with MAC ios. The contents of each photo set were tagged to specify which kind of animal was viewed, whether the activity was documented in the morning or night, and if the any animal behavior or interaction could be concluded. The type of mammals present in the photos were identified to taxonomic order. If the species of mammal could be identified, then the species was included as a tag. If the photos were not



clear enough to see or make out what exactly was triggering the camera, the photos were discarded and not included in the analysis. The tags of the photos were then organized, and data was extracted from them. Microsoft excel was used to log all of the data that was extracted from the photos. The spreadsheets made included multiple variables such as: habitat type, time of day, type of animal, and activity in numbers. The data of each habitat type and time of day was included in a comparative analysis that took into account the other environmental factors that were mentioned in the photo tags.



Figure 4a-4e. Sequence of 5 photos captured after infrared sensor was triggered.

## Results

The data analyzed in this project included a 14-week study period. There were 54 cameras total used to collect the data of each week (18 cameras per habitat type). Of the three habitats analyzed, the habitat with the most mammalian activity was the riparian habitat. Mammalian activity in the riparian habitat made up 49% of all the activity documented in this project. The transitional habitat had 34% mammalian activity and the grassland habitat made up 17% of total mammalian activity recorded. This can be seen in Figure 5.

Mammalian Activity and Habitat Type

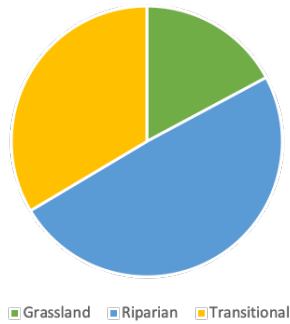


Figure 5. Percentages of all mammal activity.

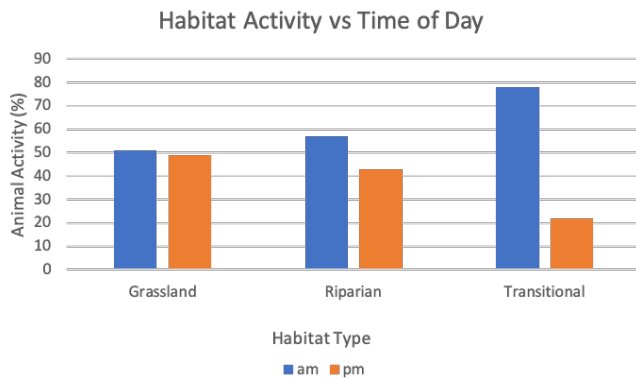


Figure 6. Mammal activity compared to habitat type and time of day.

Of the mammalian activity documented, the morning hours of 12am to 5am were dense with mammalian activity. The same pattern occurred in the night hours of 5pm to 11pm. Both of these trends can be seen in Figure 6. Rodents were the most abundant mammals documented during this time and throughout the whole project. The majority of mammals documented in all three habitats were rodents such as black rats, mice, and voles. Although there were some smaller omnivores documented such as raccoons (*Procyon lotor*) and skunks (*Mephitis mephitis*) but they made up less than one percent of all mammal activity. Overall the transitional and riparian habitats had the most activity.

The activity during early hours of the morning (12-5am) and during the night (5-11pm) were about equal except for the transitional habitat. The grassland habitat had 51% of its mammalian activity occurring

during the morning hours of the day and 49% occurring during the hours of the night. The riparian habitat had a slight change in activity with 57% of the activity occurring during the morning hours and 43% of the activity occurring during the night hours. The transitional habitat had the most different in mammalian activity when compared to time of day. The morning hours had more traffic with 78% of activity occurring during that time and 22% of recorded mammalian activity occurring during the night. The comparisons of each habitat type can be seen in Figure 6.

### Discussion

The richness of wildlife that can be witnessed at the San Joaquin River National Wildlife Refuge is enormous. Not many people living in the central valley are aware of this wildlife haven existing in their backyards. This area was a great place to study many types of animals because there were so many of them and throughout the different habitats of the refuge. This location also provided an exceptional opportunity to conduct an ecological study because of the many species present in the area, including endangered and endemic species. This richness was witnessed throughout the photo collection by not only mammals but also different species of birds. In this study, the ecological relationships that the mammals caught on camera have with their habitat was documented and analyzed. Of the three habitats that were comparatively analyzed, the riparian habitat exhibited more mammalian activity during the early hours of the morning and late hours of the night. Although the activity within this habitat did start in the late evening hours of 5-6pm and end in the morning around 6-7am, the hours of darkness in-between by showed the most mammal activity. The grassland habitat ranked very close in the amount of mammalian activity documented in that area. This proved predictions made prior to analyzing the photo collection wrong. This area also had a high number of bird activity events. If those activity events were considered in the final data, the grassland would have surpassed the riparian habitat for amount of activity documented. However, this study focused on mammals, so those bird accounts captured were not considered in the end analyzation. The grassland habitat contained numerous events were multiple rodents such as black rats were documented together. It is difficult to properly assess animal behavior through just a series of 5 photos at a time but it was assumed that these groups of rodents were drawn to the camera station together to feed on the bait provided.

In the beginning, mammalian carnivores were the main focus of this project. This focus was chosen to see if carnivores and their daily activity had any impact on the Riparian brush rabbit population at the refuge. The further along the project advanced and the more data collected, large carnivores and Riparian brush rabbits were evidently more absent than predicted. The focus of the study was then broadened and redirected to just mammalian species as a whole. This was chosen to explore if mammals as a whole had a high density of activity within the refuge. According to the CA Department of Fish and Wildlife, in 2019 mammals made up approximately 15.5% of all state and federal animal taxa listed as endangered or threatened. Although this number can be considered small or not large enough to show significance, the estimated 15% of mammals include species like the Riparian brush rabbit that are only successful in riparian woodland habitat within the refuge. So it is advantageous to be able to observe mammalian species in California to learn and provide them proper habitat to be able to thrive and be successful.

There were a number of variables that had the potential to possibly skew data of this experiment. Some of the variables that occurred were corrupt files. In these files the camera was triggered but the photos were completely black. Camera malfunctions were witnessed throughout photo analysis. In a specific instance the SD card belonging to the camera was completely empty. Weather interferences were a variable that blurred photos. For example, fog made the photo tagging process more difficult because it was hard to make out what exactly was triggering the camera (Figure 7). Although in the end some of the photos with fog were clear enough to analyze. On windy days in habitats such as grassland and transitional, the cameras were triggered by brush that was moving in the wind. This caused for the camera to be triggered at moments where there were no animals present. This problem could have caused the camera to miss documenting activity events because of how the cameras were programmed. These events were later categorized as unusable. Another variable that may have skewed the data was the vegetation and brush in riparian habitat. In certain instances, the dense vegetation was covering the camera's view of the bait. When an animal was present, the camera was triggered but since view of bait was covered, it made categorizing the animal that was present much harder. This is if the animal could be seen (Figure 8). There were instances throughout the photo collection where the same animal was triggering the camera back to back. This could be determined because majority of the time the animal was sitting in the same area of the photo frame and the event was captured within the same minute that the prior event was captured in. This could have skewed the results a small amount by having the same rat or mouse trigger

the camera more often. This would have shown more activity in the habitat during that specific time of day than there realistically was.

Figure 7. Example of photo that was disregarded due to fog.



Figure 8. Example of animal that could not be identified.



In the future, if this study was repeated the cameras can be checked more often to ensure there were no malfunctions happening or vegetation covering views. A major limitation of this project would be the type of bait used. Since the bait consisted of corn, oats, wheat, and barley, the mammals that were drawn to the area were small herbivores and omnivores. The lack of a meat element in the bait may have caused the lack of carnivores and larger mammals documented. This pitfall could have possibly provided positive feedback in that smaller mammals were drawn to the area where cameras were set up because of the type of bait provided. Some of the omnivores documented may have been drawn to that same area to look for a meal. This predator prey situation may have led to the small



number of omnivorous mammals that were caught on camera. Although the data collected from this study did not demonstrate as much carnivore activity as anticipated, it is possible that some changes can be made to the bait and the study could be repeated with different results. Although the activity of mammals was similar in the grassland and riparian habitat, this gives a deeper look into the habitats within the refuge. Since the photos of this collection represent activity 24 hours a day for a 14-week period, it demonstrates a more accurate representation of mammal activity than just the results of physical live traps alone. Hopefully the results of this provide enough evidence that the riparian habitat does indeed receive a high amount of mammalian activity and that it is important to invest more funds and efforts into protecting this naturally occurring habitat and enhance it. This would contribute to the reintroduction and conservation efforts of the Riparian brush rabbit by giving them more habitat to thrive in.

#### **Acknowledgements**

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# A Sustainability Study into Aquaponics

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## Abstract

Traditional farming methods have grown significantly over the centuries, but many of these are still environmentally due to inefficient utilization of natural resources. In recent years, people are becoming more informed on the status of our natural resources, leading to a rise in research into sustainable methods. One of these growing methods is aquaponics. In aquaponics, plants are grown in a porous substrate through which nutrient rich water is pumped up from a fish tank that is seated near or below it. Aquaponics uses six times less water than traditional farming methods, making it more ecofriendly. The majority of research into aquaponics is specialized to large systems, even though systems can range from all shapes, sizes, and styles. For this experiment a 10-gallon aquarium will be used to determine at what size system becomes cost effective and worth the investment of setting up and maintaining. The system will use the media-based grow bed method. The produce being considered for this experiment include, pak choy, basil, romaine, and wheatgrass. The system will use 7 goldfish to help fertilize the plants. The current size of the system is not expected to be very efficient, but data can be gathered to determine how large the set up would have to become in order for the cost of set up and maintenance on the system to be justified by money saved on produce for a family of four. The information gathered through observations and produce data will be applied for a sustainability study analysis on how an aquaponics set up can be made universal and expanded to fill a niche in urban agriculture and decrease food desert areas in large urban centers.

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## Introduction

From as early as 9,000 BC, farming has played an essential role in the history of man (Lambert 2019). Although farming methods have evolved and diversified in the last century, most can stand to become more environmentally sensitive. The methods used in traditional farming, wastewater and damage the land. In addition to being wasteful and harmful, crops grown with traditional farming methods are incredibly expensive to maintain. They are also grown with the use of chemicals that carry cancer causing carcinogens and chemicals that can cause severe environmental damage, such as ground water pollution and nutrient deficiencies (Saha 2019). These negative aspects of traditional farming have led to an increase in research into other potential methods of farming. One of the most popular alternative farming methods being researched is aquaponics. Aquaponics is the combination of aquaculture (the process of raising fish) and hydroponics (the process of growing plants in a soilless medium) (T. (Ed.) 2017). In recent years, aquaponics has grown in popularity amongst the scientific community, although most scientific research is done on a large scale, with the focus of making commercial use more profitable. One study aimed at analyzing the potential of aquaponics as an effective system for urban agriculture (Lampreia dos Santo 2016). This research

examined where aquaponics could fit in an urban setting, stating that abandoned industrial buildings could become an effective housing area for aquaponics setups. This could decrease the cost of the produce due to the decreased value of the property itself. Along with research done by scientists, individuals in Europe, the United States, and many other countries worldwide are undertaking aquaponics as a hobby (König 2018).

In today's society, it is becoming more expensive for families to purchase food that is considered healthy from a grocery store that they can prepare at home, then it is for them to eat out. A family of four will end up spending anywhere between 856 to 1297 dollars per month just to feed themselves (United States Department of Agriculture (USDA 2019). This does not include the five percent of the household income that is solely dedicated to what the family may spend on eating out in addition to their grocery bills (USDA 2019). The major downside to this eating out habit, is the toll it takes on the overall health of an individual. Foods that are consumed when eating out are much richer than most foods that are

prepared at home (Lampreia dos Santos 2016). The food consumed at restaurants is designed to have more salt, fats, and sugars due to the addition of these ingredients producing a stronger taste (Lampreia dos Santos 2016). Due to a growing interest in eating

healthier, the prospect of growing one's own food is on the rise. Evidence has shown that when individuals grow their own food, they are more likely to eat fresh fruit and vegetables that are healthier, and that by growing one's own food, individuals have more control over the pesticides that encounter their produce (Godman 2012).

In one study, the potential of aquaponics as an effective system for urban agriculture was analyzed (Lampreia dos Santo 2016). One outcome of this research examined where aquaponics could fit in an urban setting, stating that abandoned industrial buildings could become an effective housing area for aquaponics setups. This could decrease the cost of the produce due to the decreased value of the property itself. In addition, using aquaponics in Urban centers could decrease the prevalence of food deserts. These food deserts are areas where either it is difficult to buy affordable, good-quality fresh food or where there is too much distance between grocery stores (Crow 2018).

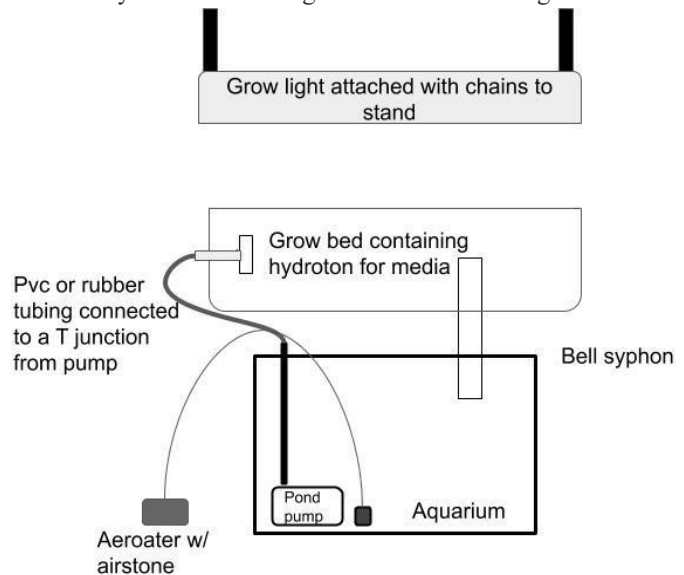
### Methods

This experiment began with the collection of literary research on similar experiments. Research was done into which plants would work best in a media-based system. The use of goldfish in the fish tank are best suited for the tank size and will provide the appropriate amount of fertilization. In addition to background research, supplies were purchased, but the system will still need to be constructed (see Fig. 1). The final setup of the system may differ from the blueprint depending on the supplies that have been purchased. Once the model is constructed, fish will be added to cycle the tank, officially starting the system. Then Pak choy, basil, romaine, and wheatgrass will be used. These plants were chosen based on the hardiness of the plants. At this point, the system will be semi-independent, the only input will be feeding the fish and weekly to biweekly observations. Information on the growth (changes in height and appearance) of the plants will be recorded as part of the observations. Half-way through data collection, analysis will begin. In this phase the data collected will be analyzed, and a guideline for comparison will need to be determined. It will then be possible to see how scaling the project for a cost-effective home system can be achieved. The guideline will then be used to see how it can be applied to Urban Agronomy and filling food desert niches.

### Results

It took a long time to get funding for the experiment, so for a majority of the time the project was just in the preliminary design stage for a large portion of the time. The tank began cycling with the fish in the end of December so that plants could be added by mid

to late January. Once these steps were completed the experiment pretty much ran itself. The main input into the system was feeding and some external light in order



for observations to take place. The blueprint for the experiment (Fig. 1) demonstrates the plan for how the system was set up. The cost of the system deviated slightly from the original budget in the parts, but the overall budget stayed the same. The status of the project is still ongoing, but the preliminary results found that the plants were successful in the system, but due to the size of the system very few plants can be grown at a time. As expected, a 10-gallon tank was not very effective for how much produce a family of four requires. Due to circumstances and environmental factors that occurred during the experimental process, most of my plants died in March. This is most likely due to the fact that I had to completely move my project due to the quarantine and this may have caused imbalances in the chemicals of the tank. As for the results of the analysis part of the experiment, current research being done in multiple countries is demonstrating that it would be feasible for aquaponics to work in Urban environments. In areas that have food deserts, aquaponics warehouses in urban environments could potentially decrease the prevalence of urban food deserts. This would be due to the area selected for the warehouses and if the selected warehouses are in zones where food deserts occur. Although to truly decrease food deserts, smaller aquaponics systems will need to be encouraged in the homes of individual families.

### Discussion

It was not expected for a system with the base of a 10 gallon high fish tank to be very effective in the cost comparison, but a system this size was still be used to gather crucial data to determine at what size the system becomes cost effective vs the produce bill for a

family of four and worth the investment of setting up and maintaining. This system was also used as a scaling point to determine how an aquaponics system can be applied to Urban Agronomy. The main data collected for the small system was used for determining how large the set up would have to become in order to yield enough produce to justify the cost and maintenance of the set up itself when compared to how much money a family of four would spend on produce in a month. The best-case scenario for this experiment was that a system this small would yield enough produce to aid in the grocery bill for a family of four and make the system worth the effort of setting up and maintaining. Although even if the small system does not work, this system would lend itself to an analysis on what size would be most effective. It was hypothesized that the tank size for an efficient set-up would have to be no smaller than a forty-gallon aquarium tank to justify the system costs versus the potential yield of the system.

For the part of the experiment that contributes to urban agronomy, this experiment considered whether in the expansion of the system if another method of growing would be more cost effective in a larger system, or if a media based grow bed is still sufficient for its size. It was found that the raft or the nutrient film technique would work best for the larger set up. It would also focus on applying the data gathered to a sustainability study analyzing how an aquaponics set up can be made universal and expanded to fill a niche in urban agriculture. The expected timeframe for the experiment was to completely finish data collection and analysis by the Honors Capstone Conference, but due to the nature of the experiment, it is still ongoing even though that date has passed.

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# Quantitation of ethanol in kombucha beverages with evidence of bottle fermentation by gas chromatography

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## Abstract

The purpose of this study was to determine the percent of alcohol by volume (ABV) in several commercial kombucha tea beverages and determine whether bottle fermentation can lead to significant increases in ABV values. Kombucha is a popular tea to drink. It is reported to contain trace amounts of alcohol because it is produced by fermenting sweet tea with yeast and bacteria cultures. Kombucha tea is often marketed as a health drink rather than an alcoholic beverage because of its low volume percent of alcohol. If kombucha is at or above 0.5% ABV at any time, it is considered an alcoholic beverage and must follow regulations from the Alcohol and Tobacco Tax and Trade Bureau (TTB). In this study, gas chromatography was used to quantify the ABV of several commercially available kombucha teas. Standard solutions were prepared to generate a standard curve correlating ethanol ABVs to chromatographic peak areas. 1-propanol was used as an internal standard in all samples. Of the kombucha samples represented, there were a sample set of unpasteurized bottles where two were fruit-infused and one was not. These samples were then allowed to bottle ferment at room temperature and analyzed in a weekly study. The fruit-infused samples had initial average ethanol ABVs that were ~1.7-1.6% and at the end of three weeks increased to ~2.8-3.4%. In contrast, the non-infused tea samples were ~0.73% and after three weeks increased to ~1.23%. This is not surprising as the fruit-infused kombucha teas most likely had more residual fermentable sugar available for bottle fermentation. This raises a concern over both the distribution and labeling of kombucha teas that are sold as non-alcoholic beverages. These results also agree with another recently published gas chromatographic study on kombucha tea ABVs.

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## Introduction

Kombucha is fermented tea that has been around for thousands of years. It is just now gaining a rise in revenue in the commercial market. It is a popular beverage to drink because of its probiotics. It is also reported to contain trace amounts of alcohol because it is produced by fermenting sweet tea with yeast and bacteria cultures. This is often referred to as SCOBY: symbiotic culture of bacteria and yeast (Chakravorty, et al., 2016). Ingesting these probiotics is a way to add healthy bacteria to your gut. These bacteria are believed to help improve digestion, the immune system, and weight loss (Brown 2016). There are also several chemical compounds found in kombucha that are known to benefit health. So far, not many studies have been done with humans to analyze the potential health benefits of consuming kombucha. The beneficial effects of consuming kombucha have only been experimentally studied using animals (Dutta & Paul 2019). There have been no human trials done, thus all the claims proposing kombucha's health benefits have not been scientifically validated (Kapp & Summer 2019).

The exact levels of alcohol in these beverages vary between brands and are not known nor listed in the labeling. The Alcohol and Tobacco Tax and Trade

Bureau (TTB) states that all non-alcoholic beverages must contain less than 0.5% alcohol by volume (ABV). Consuming probiotics in a liquid form has become popular among health-conscious people, thus various kombucha brands have popped up into local grocery stores. This raises a concern over both the distribution and labeling of kombucha teas that are sold as non-alcoholic beverages.

This research will investigate what the initial percentage ABV of kombucha beverages is. It will also determine % ABV of kombucha beverages over time when kept in a refrigerator versus when kept at room temperature. It is hypothesized that the kombucha bottles that can bottle ferment at room temperature will have higher levels of alcohol in them than the ones left in the refrigerator. Raw unpasteurized kombucha contains active cultures of yeast and bacteria, thus kombucha will continue to ferment when it isn't kept refrigerated, creating more carbon dioxide and alcohol (Chakravorty, et al., 2016). In this research project, it will be determined to what extent secondary bottle fermentation occurs.

## Literature Review

The alcohol content of kombucha beverages has been questioned by the public. There have been some

recent lawsuits against kombucha brands because of the alcohol content and other details that are not included in the labeling. For instance, in the spring of 2017, a \$8.25 million settlement was approved regarding a group of consumers and the co-defendants: GT's Kombucha, Millennium Products Inc., and Whole Food Market Inc. This class action lawsuit claimed that the three large companies mislead consumers by mislabeling the product's alcohol, antioxidant, and sugar content. The companies were ordered to pay \$8.25 million over the false claims that the product was non-alcoholic and contained antioxidants. GT's Kombucha founder, GT Dave, said in an email exchange with BevNET, an industrial beverage news website, that just because the company settled the lawsuit did not mean that the company had admitted to any fault or wrongdoing (Caballero 2017).

"At the end of the day, the driver behind arriving at a settlement was to circumvent the business distractions and cost of defense that are always associated with these types of litigation," he wrote. "The settlement enables us to focus on running our business and making healthy products instead of dealing with arduous and costly litigation."

When asked how the labeling errors might have occurred, Dave responded: "Honestly, I don't believe 'errors' is the proper language as this is not really about what's 'right' or 'wrong.' These types of claims and their subsequent settlements are truly about eliminating anything about the product that can be perceived as misleading, confusing or inconsistent."

It is interesting to note that in 2010, Whole Foods pulled all kombucha products sold at their stores from their shelves because there had been bottles at their store location in Portland, Maine that had alcohol levels ranging from 0.5%-2.5%. These levels were contrary to the TTB requirement that all non-alcoholic beverages sold must contain less than 0.5% of alcohol by volume (ABV).

It is not just the alcohol content that has caused consumers to feel deceived, however. In the fall of 2017, there was a class action lawsuit filed against another kombucha brand known as KeVita. The company's Master Brew line was cited in this lawsuit for being pasteurized and deceiving consumers who believed they were ingesting raw probiotics (Watson 2017). The practice of sanitizing a bottle with pasteurization is not uncommon and will help deter further fermentation because it kills off the active yeast cultures that would continue to bottle ferment if left at room temperature (Chakravorty, et al., 2016). After pasteurization, shelf-stable probiotics were added to the kombucha beverage. Consumers were misled by the labeling saying the beverage is "handcrafted" and they demanded a more correct

advertisement of the product line from KeVita (Watson 2017).

These two large companies have struggled to comply with standards and correct labeling of their kombucha beverages while making consumers happy. The GT company is under fire for not pasteurizing and having alcohol levels that do not comply with TTB regulations, while the KeVita company is in trouble because it pasteurizes but doesn't clarify if its live probiotics were raw materials produced from the fermentation process or reintroduced.

These potential violations of safety and established regulations reveal the importance of making these regulations appropriate for the commercial sale of kombucha beverages. Is the processing, handling, and labeling of kombucha properly guided and carried out before marketing the beverages to everyday consumers? The legal definitions for kombucha have been confusing for many. Again, kombucha is regulated by the TTB because it must be under 0.5% to not be considered an alcohol, be taxed, and have further regulations. The TTB website says that kombucha is a fermented beverage made from tea and sugar combined with yeast and bacteria, but it does not include any guidelines involving pasteurization or what the final probiotic count should be standardized to.

## Materials and Methods

It is hypothesized that the kombucha bottles that are left at room temperature will undergo a secondary bottle fermentation, while the ones left in the fridge that will not undergo further fermentation. A second stage of bottle fermentation can occur if left at room temperature because of the active cultures still within the beverage. This second stage anaerobic ferment may increase the alcohol to 2 or 3% alcohol (Kasper 2011).

Quantitation of ABV levels in kombucha will be done by using gas chromatography to set up a standard curve by using standard solutions that used ethanol along with 1-propanol as an internal standard. This will allow us to use the peak areas of ethanol over propanol to determine the amount of ethanol within our unknown kombucha samples.

This method follows the guidelines for single-laboratory validation by Association of Official Analytical Chemists (AOAC) International and meets the requirements set by AOAC SPMR 2016.001, "Standard Method Performance Requirements for Determination of Ethanol in Kombucha" (Ebersole 2016).

### 3.1 Design

The research design utilized in this study is the Repeated Measures Design. This particular approach

was chosen because it involves multiple measures of the same variable (alcohol in kombucha) taken on the same or matched kombucha bottles either under different conditions (refrigerated vs. room temperature). This repeated measurement is normally collected in a longitudinal study so that the change over time can be observed.

### 3.2 Participants

In this study, gas chromatography will be used to quantify the percent of alcohol by volume (ABV) of several commercially available kombucha teas. Standard solutions will be prepared to generate a standard curve correlating ethanol ABVs to chromatographic peak areas. 1-propanol will be used as an internal standard in all standard solutions and kombucha samples.

### 3.3 Standards and Materials

**Table 1.** SPMR for the Determination of Ethanol in Kombucha.

Parameters	Value, %
Analytical range (%ABV)	0.3 to 3.8
Limit of quantitation (LOQ) (%ABV)	≤0.05
Accuracy (% of mean spiked recovery over the range of the assay)	97-102
Repeatability (RSD <sub>r</sub> ), %	≤4
Reproducibility (RSD <sub>R</sub> ), %	≤6

### I. Apparatus

- Gas chromatography system with flame-ionization detection
- Glass scintillation vial
- Volumetric flasks
- Volumetric pipettes
- Micropipettes
- Glass beakers
- Sonicator
- Syringe with filter
- Microcentrifuge
- Eppendorf microcentrifuge tubes

### II. GC Conditions

- Column: Porapak Q 80/100 Mesh
- GC mode: Isothermal @ 160 °C
- Run time: 10 min
- Injector temperature: 160°C
- Carrier gas: He at 50mL/min
- Injection volume: 10µL (\*later changed to 15 µL)

### III. Reagents

- Ethanol – (Absolute 200 proof)
- 1-Propanol (Sigma-Aldrich)
- Deionized (DI) water

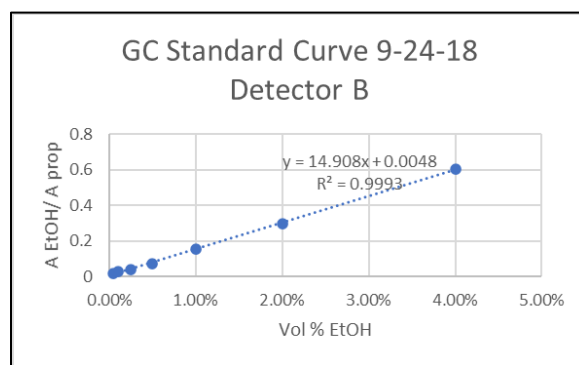
### IV. Sample Collection

A total of six commercial kombucha products were purchased from a local grocery store in Turlock, California. The products were purchased based on their popularity, flavor, and availability. A total of three kombucha flavors were purchased. Two bottles were purchased of each kombucha flavor from the same brand, bottling batch, and expiration date. One was to be kept as a control in the fridge while the other bottle would be left at room temperature (20-23°C). All samples were sealed properly and stored in a 3°C refrigerator before analysis.

- Strawberry-flavored kombucha (Fruit 1)
- Raspberry/lemon-flavored kombucha (Fruit 2)
- Lavender-flavored kombucha (Non-fruit)

### 3.4 Standards Preparation

- A seven-point calibration curve was prepared from the ethanol standard solutions, (0.05%, 0.1%, 0.25%, 0.5%, 1.0%, 2.0% and 4.00%) along with 5% of the internal standard 1-propanol.
- A standard curve was created by plotting the ethanol/propanol peak area ratios versus ethanol volume percentages for all standard solutions.

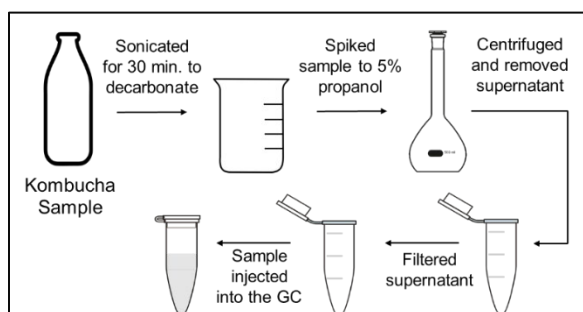


**Figure 1.** Plot of the area of ethanol over the area of 1-propanol vs. the volume percentage of ethanol provides a standard curve.

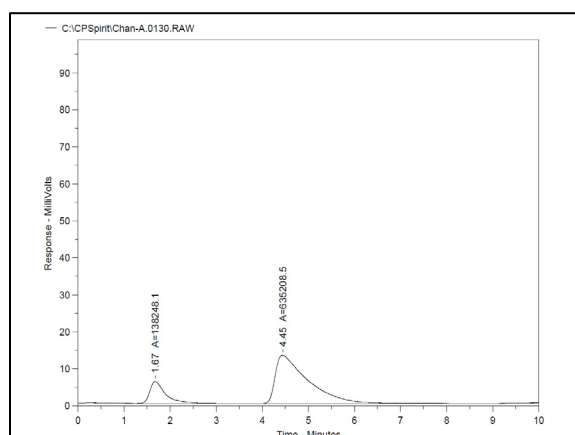
### 3.5 Sample Preparation

- 100 mL of sample was aliquoted from kombucha bottles into labeled glass beakers.

- b. The beakers were sonicated for approximately 30 minutes to decarbonate the kombucha samples
- c. 5 ml of the internal standard (1-propanol) were aliquoted into a 100-mL volumetric flask and 95 mL of the kombucha sample was then added. The flask was inverted several times.
- d. This sample solution was transferred to a 20 mL scintillation vial that was labeled and, if stored for future use, was filled with nitrogen gas.
- e. When ready to run kombucha samples in GC, a small amount of sample solution was transferred to a labeled Eppendorf tube and centrifuged at 10,000xg for 3 minutes.
- f. The sample solution was then collected through a syringe and filtered into a newly labeled Eppendorf tube. The sample was now ready to be run on the GC.
- g. The sample solution was injected into the GC three times to insure precise results.
- h. The data was collected from the GC and analyzed on excel.



**Fig. 2.** Flowchart of Kombucha sample preparation



**Fig. 3.** Sample chromatogram report using Gas Chromatography. From left to right: the first peak is ethanol and the second is the internal standard, 1-propanol.

## Results

It was expected that the initial ABV values of kombucha were to be relatively low in order to follow the guidelines with the TTB. However, all the kombucha tea samples tested were over the 0.5% ABV. The samples left at room temperature gradually increased in the percentage of ethanol after the second stage fermentation.

Each week, new data was collected and calculated on Microsoft Excel for both the refrigerated and room temperature kombucha samples. A total of three bottle fermentation studies were done over the course of three semesters: Summer 2018, Fall 2018, and Spring 2019. The data was then organized to combine all the semester studies of the kombucha sets (Fruit 1, Fruit 2, Non-fruit) that were tested. These were made using line graphs (Fig. 4) and have more variability because they consider variances during the season production.

The chart shows a gradual incline in the percentage ABV while the controls remained constant. The fruit-infused kombucha beverages had a higher fermentation rate than the bottles that were not fruit-infused.

Statistical analysis was done in order to ensure the results are precise and accurate. The standard deviation and a 95% confidence level (CL) was calculated for each sample set studied. With this additional information, the 95% CL could be included in the summary graphs in the form of error bars. They can be visually seen in the line graphs. If there is no overlap between the error bars, that indicates a significant difference between the refrigerated and room-temperature kombucha samples tested each week. A significant difference was seen by the 2<sup>nd</sup> week of the study indicating secondary bottle fermentation was in progress.

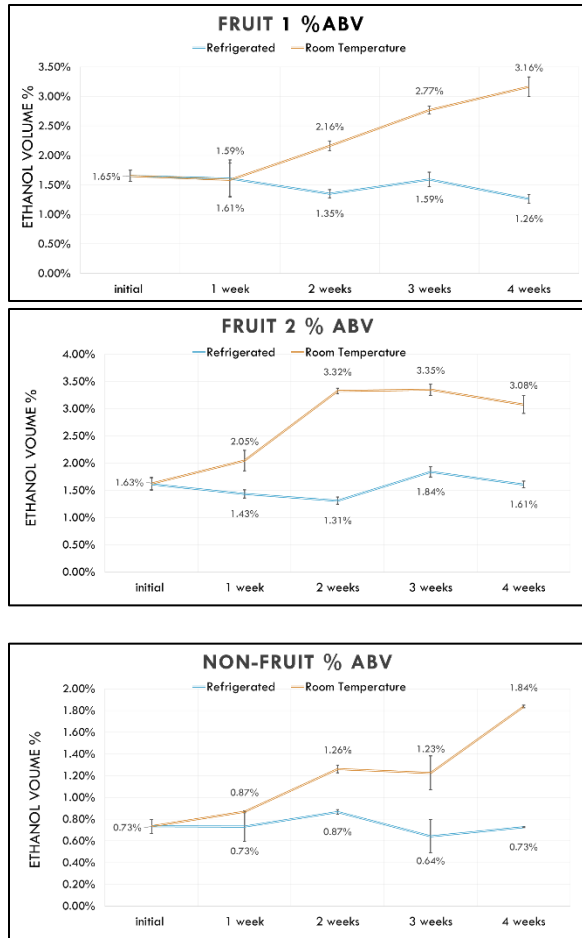
## Discussion

Kombucha has been around for a long time, but in recent years it has become increasingly popular. The proclaimed health benefits regarding improvement to digestion and the immune system sound promising. Future human studies would need to be done in order to have conclusive data on these claims (Kapp and Summer 2019). Since these beverages are a relatively new addition to chain and local supermarkets, there does not appear to be a safe amount of regulation dealing with this type of beverage. Updated regulations on the process and labeling of these beverages is critical in order to ensure safety on the market. There is no denying that there is some alcohol in kombucha beverages.

It would be interesting to test what kombucha brands are still not in compliance with the TTB ruling of 0.5% ABV or less. Improper labeling of what is technically an alcoholic beverage that is being marketed and sold as a regular health drink could lead to unpleasant consequences resulting from not



accurately informing consumers of the contents of their beverages.



**Fig. 4.** Line graphs displaying the initial ethanol volume % of the refrigerated samples and the bottle fermented samples at several time intervals of Fruit 1, Fruit 2, and Non-fruit kombucha beverages

**Table 2.** Percent Alcohol by Volume in Kombucha

Sample Variety	Conditions	Initial ABV (±95% CI)	Week 1 ABV (±95% CI)	Week 2 ABV (±95% CI)	Week 3 ABV <sup>a</sup> (±95% CI)	Week 4 ABV (±95% CI)
<b>Fruit 1</b>	Refrigerated	1.65% (0.096)	1.60% (0.31)	1.35% (0.068)	1.59% (0.12)	1.26% (0.072)
	Room Temperature		1.59% (0.28)	2.16% (0.084)	2.77% (0.071)	3.16% (0.17)
<b>Fruit 2</b>	Refrigerated	1.61% (0.11)	1.43% (0.074)	1.31% (0.064)	1.84% (0.094)	1.61% (0.060)
	Room Temperature		2.05% (0.19)	3.32% (0.050)	3.35% (0.10)	3.08% (0.17)
<b>Non-Fruit</b>	Refrigerated	0.73% (0.065)	0.734% (0.14)	0.867% (0.022)	0.643% (0.15)	0.727% (0.0069)
	Room Temperature		0.870% (0.010)	1.26% (0.035)	1.23% (0.016)	1.84% (0.012)

<sup>a</sup> Week 3 average data included 2.5-week data from Summer 2018

These findings show the need to clearly label these products and inform consumers to store them

## Conclusions

For each set of data analyzed, a general trend was found in the bottles allowed to ferment at room temperature. The fruit-infused kombucha teas had an initial ABV value over 1.0%. By the end of about three weeks, the concentration of ethanol increased. The non-infused tea version increased as well, though was not as high initially. This is likely due to the residual sugars within the fruit-infused ones. Further tests to analyze the amount of residual sugars could confirm or disconfirm this observation. Quantitative analysis of sugar mixtures could be done by Fourier Transform Infrared (FT-IR) Spectroscopy (Kemsley 1992).

The goal of these experiments was to determine the percent of alcohol by volume (ABV) in several commercial kombucha tea beverages and determine whether bottle fermentation can lead to significant increases in ABV values.

In this bottle fermentation study, fruit-infused kombucha teas had initial average ethanol ABVs of 1.65 (±0.096) % and 1.61 (±0.31) %. In contrast was the pure tea sample which was initially 0.734 (±0.065)% ABV. When left at room temperature for 3 weeks, the ABVs of the fruit-infused kombucha teas increased to 2.77 (±0.071)% and 3.35 (±0.10)% while the non-infused tea version increased to 1.23 (±0.016)%. Each week of compiled data can be found in Table 2.

By the fourth week, some of the ABVs of the kombucha teas continued to increase, while Fruit 2 decreased by a small percentage. This may be due to depletion of resources used by SCOBY. In one of the fruit-infused kombucha samples (Fruit 2) a thin film of SCOBY was observed to be forming by the end of the study.

under refrigeration. These results also agree with another recently published gas chromatographic study on kombucha tea ABVs (Ebersole 2016)

Future work will expand the analysis to a larger sample set in order to establish whether or not these findings are representative generally or are unique to the initial samples analyzed.

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# An Examination of Anxiety and Stress Levels in School-Age Children with Autism

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## Abstract

This paper explores the positions of various published articles and their discussions on depression and anxiety symptoms in children with Autism- particularly children who are participating in a public-school setting. Amongst all the articles examined, a common element discussed was the heightened presence of both stress and anxiety in children who are on the Autism spectrum, especially when compared to children who do not have the disorder. Most studies were conducted using school-age children, which was an important factor given that children tend to exhibit higher anxiety levels as a whole when they begin their education process. This paper evaluates in-person interviews with typically developing children and children who have Autism and compares the results to previous studies, which discuss potential causes of heightened stress and anxiety in children with Autism.

*Keywords:* Autism, stress, anxiety

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## Introduction

Over a period of several years, Autism and the Autism Spectrum Disorder have been studied in great detail, with little being known about its cause. There is no cure for Autism, but researchers have done several studies which attempt to explain how individuals with the disorder can cope with their condition and lead healthy, fulfilled lives. The following articles were reviewed in full to examine how stress and anxiety levels in children with autism have been studied; these articles all provided some level of significance to the overall scope of this project.

Children who have Autism and are also enrolled in some type of school setting are thought to be at greater risk of stress and anxiety, and can be negatively affected by these symptoms. Children who have Autism can be negatively affected by stress and anxiety because they typically exhibit low social functioning. Adding environmental stressors to their everyday routines can have a negative effect on their functioning. In this paper, several sources are discussed to further support the hypothesis that children with Autism have a greater susceptibility to stress and anxiety than children who do not have the disorder.

## Literature Review

In a study examining self-injurious behavior in autistic children, Devine (2014) found that self-injurious behavior increased with social and environmental isolation, indicating that children with Autism may benefit from being in social settings. It could be argued that the closer a facility can mimic a school setting, the better it is for a child with Autism

to socialize appropriately. It is the hope of many researchers that children with Autism can learn to socialize on some level with the proper guidance. In order to do so, children with Autism need to feel safe and comfortable in their environment, and this can be a challenge given their susceptibility to stress and anxiety. Nearly half of children on the spectrum engage in self-injurious behavior, so understanding why this behavior occurs, and if it correlates to social anxiety or stress is a crucial step into understanding the disorder as a whole, as well as providing the essential tools needed to help children with Autism live better lives.

In another study, researchers examined stress levels in children who are on the autism spectrum, using the Trier Social Stress Test-Child Version (Kirschbaum et al., 1993). It was found that children who have Autism experience higher levels of anxiety, specifically social anxiety, when compared to typical developmental milestones of other children their age, and even children who suffer from other developmental disabilities. At the completion of the study, researchers also found that nearly one third of children on the spectrum are also diagnosed with Social Anxiety Disorder, which is essentially an acute sense of social anxiety (Lanni et al., 2012). The study examined the differences in cognitive functioning of children with Autism compared to typically developing cognitive processes, which is demonstrated in Appendix A (Figure 1). The study found that the differences in cognitive functioning of children with Autism positively correlated with stress and anxiety levels.

A further study researched anxiety levels of children with Autism and their parents using Spence

Children's Anxiety Scale (SCAS) - Child Version and SCAS - Parent Version and the Parenting Stress Index (Spence, 2003). The study found a positive correlation between autistic children's anxiety and their parents' perception of their anxiety. The higher functioning the child was, the better the parent seemed to understand the child's stress and anxiety symptoms. Furthermore, the higher the child's verbal IQ, the lower the parent's stress was as well. Conversely, this insinuates that when a child exhibits lower cognitive functioning, it becomes more difficult for the parent to understand and relate to the child's emotional strain. This study provides interesting insight into the relationship between children with ASD and their parents. It goes to show how significantly stress and anxiety in children with the disorder can affect parents (Ooi et al., 2016).

In a study by White et al. (2015), researchers examined anxiety and stress levels in children and tweens with Autism; it provides additional evidence that anxiety levels, and even greater morbidity, are associated with the disorder. An important point the researchers elaborated upon is the fact that children with Autism already have poor stress management tactics, and thus have to deal with more stress and anxiety as a result. Because of their conditions, they find difficulty in expressing their emotions and often cannot accurately verbalize their worries or hardships. In the article, researchers also included raw data in Appendix B (Figure 2) which contains a clear frame of reference for the types of social anxiety children with ASD experience. This article discusses the ways in which researchers can better improve their knowledge and understanding of the Autism community by conducting more cohesive research about stress and anxiety levels in the affected individuals. This study makes the argument that not enough testing has been done to date, or at least, not much that has been shown to help children and tweens with Autism. This further supports why a comprehensive study must be done in order to better assist children with Autism who also experience stress and anxiety.

In a final article, researchers published a study in which they delved into different databases, comparing the self-tests of children with Autism as well as their parents, to gain insight on anxiety levels of those who have ASD (Spain et al. 2019). These self-tests took place using a simple question and answer measure, similar to the measure used in the current study. It was found that symptoms of social anxiety were commonly linked with poor stress management systems, social skills, and social functioning in children with Autism. Like the studies discussed above, the researchers who conducted this study heavily emphasized why children with Autism have such a need for better stress management, and what

tactics have been put in place to assist them. In the study, the children were also less motivated to make an effort socially, meaning they did not find joy or entertainment in communicating with others. Although this was a likely outcome, given how difficult it can be for children with ASD to communicate, it only further emphasizes the need for better social support for children with ASD (Spain et al., 2009).

When taking the above information into consideration, it is important to note that a common theme amongst the articles discussed is a lack of comprehensive research concerning how stress and anxiety levels in children with Autism contrast with children who do not have Autism. To promote better social support and healthier coping strategies for these children, it will be important to conduct in-person interviews using questions based on the American Psychological Association (APA) guide to signs of stress in children and adolescents, as very few studies have been conducted using an open-ended interview process. Therefore, the purpose of this study was to prove a need for better stress management tactics in schools.

## **Methods**

To make this assessment, I interviewed two school-age children who have ASD, as well as two students who do not. Based on the students' answers to my interview questions, I used the APA Guide to Stress to determine how stress and anxiety levels differ between the two groups. This information is used to provide more cohesive evidence for the claims made in this paper. If participants with Autism express higher rates of anxiety than participants without Autism, my hypothesis will be proven correct. I will consider my hypothesis correct if participants with Autism demonstrate (explicitly or implicitly) a need for better stress management tactics, and if those participants can attribute their stress to school.

**Participants:** To conduct this study, I recruited four school-age children between the ages of eight to thirteen. Two children had a medical diagnosis of Autism, while the other two did not have a developmental disability. Parents or guardians of the children were present throughout the interview, or waited in a separate room close by, and had signed an informed consent and debriefing form.

**Setting:** This study took place at a charter school, with the permission of the school administrators. It occurred outside of regular school hours to avoid removing the participants from school activities. The interview itself took no more than twenty minutes per person.

**Materials:** Using the American Psychological Association (APA) guide to stress and anxiety in

children, I conducted a short interview based on well-known signs and symptoms of stress and anxiety. For example, the interview included the question: "Have you ever withdrawn or chosen not to participate in an activity that you usually enjoy, because it seemed like too much work at the time?" A sample of this interview can be found in Appendix C.

**Procedure:** The interview consisted of ten total questions, with five questions concerning anxiety, and five concerning stress. Eight of the questions were open-ended discussion questions, similar to the question listed above; two questions were written in a Likert Scale format. The two scale questions were self-scoring measures, asking participants to rate their stress and anxiety on a scale of 1-7, with 1 being not stressed or anxious, and 7 being very stressed or anxious. Questions were randomized. Participants' answers were recorded on a password protected device, and did not use any identifiers that might allude to participants' identities.

**Results:** Using the transcriptions of the four interviews, an assessment was made determining whether the results of the study confirmed the hypothesis. If the participants with Autism expressed higher levels of anxiety in reference to school and extracurricular activities than participants who do not have Autism, the hypothesis was considered correct.

## **Results**

Overall, the hypothesis was proven partially correct. As discussed previously, I would consider the hypothesis proven correct if participants with Autism expressed, whether explicitly or implicitly, that they would benefit from better stress management tactics in schools. It would also be considered true if students with Autism demonstrated feelings of anxiety or stress in relation to school. After analyzing the interview transcriptions and constructing the themes of this project, I was able to show that yes, these students with Autism expressed a need for better stress management. Two important themes became clear at the conclusion of this study.

The first theme was the fact that all participants had self-described close relationships with their parents, regardless of an Autism diagnosis. For example, Participant 1, who did not have Autism, said that they were happy knowing that their parent was close by, and felt comfortable with their relationship. One participant with Autism (Participant 2) relied heavily on their relationship with their parent, but also had to rely on that close relationship as a form of communication, as that participant was also nonverbal. They also felt happier knowing that their parent played a role in their education, and the participant was overall very positive toward their parent. In addition to these observations, participants

who did not have Autism were more likely to cite their relationships with friends as another reason for their positive attitudes toward school, and had comparatively low scores when answering questions concerning whether school made them stressed or anxious.

The second theme found in the research was that participants with Autism felt it was difficult to be heard or understood in a classroom setting. For different reasons, both participants with Autism described how difficult it could be to express themselves accurately in a classroom. Participant 2, as mentioned before, was nonverbal, so their difficulty in expressing themselves was expected. They described classroom discussions as, "Difficult, because I am trapped in my own mind." This observation, however, did not stop the participant from participating in classroom discussions and activities, although they did need to participate differently and make accommodations for their learning style. The second participant with an Autism diagnosis, Participant 3, also discussed how difficult it could be to speak up or become involved in class activities, but their experiences were much different than Participant 2. According to this participant, they struggled with aggressive behavior, and were highly sensitive to the actions of peers, especially when peers made remarks concerning mental health or developmental disorders. This participant was neutral about participating in classroom activities, but again, was highly sensitive and easily aggravated by the views or actions of others, which presented a different type of barrier to communication, but a barrier nonetheless. Participants 1 and 4, who did not have an Autism diagnosis, both appeared more comfortable discussing their involvement in classroom activities, and expressed relatively low anxiety toward open-ended classroom participation.

## **Discussion**

The hypothesis of this study was considered partially supported, but there is still much to be taken from the results of this study. Since the first part of the hypothesis was considered correct, it shows that students with an Autism diagnosis would greatly benefit from the addition of better stress management tactics at school. Given more time or resources, this theory could have been tested further, but it was important to prove an initial need for different stress management strategies in school settings, much like the study by Lanni et al., (2012). In that particular study, researchers proved that there was a positive correlation between adolescent stress and Autism.

The second part of the hypothesis, however, was not able to be proven successfully, because overall, participants with Autism did not express

higher anxiety in relation to school. While participants with Autism did express greater levels of stress and anxiety, this does not necessarily mean that their anxiety or stress could be attributed only to their involvement at school. There are many other public places in which one can experience anxiety (church, grocery stores, playdates, etc.), as supported in the study by White et al., (2009), which examined general stress and anxiety disorders in children and adults with Autism. Though the questions on the participants' questionnaire specifically targeted school functions, participants' responses did not signify any real correlation between school and anxiety. This is a crucial finding, because while little can be done to limit stress in other public settings, teachers, parents, and administrators in schools can work together to develop a stronger plan to support students with Autism in the future.

There were of course, some limitations to this study. A very small sample was used, and while this was intended, it did limit the number of potential data points available. For future studies, an updated questionnaire may be needed to better identify stress related to school functions. Additionally, this study could be replicated across an assorted age group, to better identify age-related differences among participants.

There is much to be said for how school administration handles stress and anxiety among students. It is my hope that the research I conducted may be used to offer additional evidence to support the need for a better understanding of the causes, symptoms, and useful coping mechanisms for stress and anxiety in children with Autism.

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Appendix A

Neuropsychological Test Performance

Information	High Functioning Autism	Typical Development
	M(SD)	M(SD)
DKEFS Verbal Fluency		
Letter Fluency	7.31(3.15)	10.73(3.08)
Category Fluency	6.92(4.05)	11.47(2.88)
Category Switching (Total Correct)	6.23(4.76)	11.33(2.82)
Category Switching <sup>b</sup> (Total Switching Accuracy)	4.38(2.76)	11.47(2.23)
NEPSY Narrative Memory <sup>a</sup>	3.69(3.90)	11.93(2.60)

Note. DKEFS: Delis-Kaplan Executive Function System.

<sup>a</sup> p<0.05.

<sup>b</sup> p<0.01.

Figure 1. Comparison of cognitive functioning in children with autism and children with typical brain development.

**Table 2**  
Studies of Anxiety in Children and Adolescents with ASD with Focus on Phenomenology

Author (year)	N <sup>a</sup>	Sample Characteristics <sup>b</sup>	Anxiety measure <sup>c</sup>	Control group(s) <sup>d</sup>	Primary Findings
Bellini (2006)	41	AD(19), AS (16), PDD-NOS(6). Age range: 12-18 (M: 14); No MR	P, S	None	Social skill deficits and physiological hyperarousal contributed to variance seen in symptoms of social anxiety in teens with ASD ( $R^2 = .341, p < .0005$ ).
Burnette et al. (2005)	31	HFA. Age range: NA(M: 11); VIQ M: 109; PIQ M:110	S	Learning disabled(17) TD (16)	Autistic subjects self-reported significantly more social anxiety $F = 4.11, p = .05$ ; no relationship was found between anxiety and weak central coherence.
Famugia & Hudson (2006)	29	AS. Age range: 12-16 (M: 13)	P, S	Anxiety disordered (34); TD (30)	Self-reported symptoms of anxiety were equivalent to those of teens with anxiety disorders; anxiety symptoms, neg. automatic thoughts were significantly higher than in control group.
Gillott et al. (2001)	15	HFA. Age range: 8-12 (M: 10)	P, S	Specific language imp (15); TD(15),age & gender matched	Rate of anxiety was higher in HFA group than in typically developing or language impaired children; 7 of 15 children with HFA were at or above clinical mean score.
Green et al. (2000)	20	AS. Age range: 11-19 (M: 13); IQ>70	Int	Conduct disorder (20)	Significantly greater general anxiety and OCD symptoms on clinical interview with AS than conduct disordered sample.
Juraneck et al. (2006)	42	AD. Age range: 3-14 (M: 7)	P	None	Significant correlation found between amygdala volume (total and right side) and parent-reported anxiety/depression scores
Kanai et al. (2004)	74	PDD-NOS (53), HFA (21). Age range: 2-23 (M: 6)	Obs	None	Subjects with PDD-NOS exhibited stronger anxiety reaction than those with HFA.
Meyer et al. (2006)	31	AS. Age range: 7-13 (M:10)	P, S	TD (33)	Child-reported social anxiety correlated with parent-report social competence.
Pearson et al. (2006)	51	AD(26), PDD NOS(25). Age range: 4-18(M:10)	P	None	No significant differences found between children with PDD-NOS and AD on anxiety symptoms, although both groups approached clinical significance.
Pfeiffer et al. (2005)	50	AS. Age range: 6-17 (M:9)	P	None	Significant correlation found between sensory defensiveness and anxiety in children with AD.
Russell & Sofronoff (2005)	65	AS. Ages: 10-13 (M: NA)	P, S	None	Children with AS rated themselves equally anxious as children diagnosed with social phobia but did not endorse high levels of social worries.
Thede & Coolidge (2006)	31	AS(16), HFA (15). Age range: 5-17 (M: 10)	P	Age, gender matched TD (31)	Children with AS had more symptoms of anxiety than did children with HFA; 10 of 16 children with AS had elevated GAD scale scores.
Tonge et al. (1999)	127	AS (52), HFA (75). Age range: 4-18 (M for AD: 7; M for AS: 9)	P	None	Subjects with AS received higher ratings of overall psychopathology and higher anxiety

Figure 2. Self reports from children with ASD examining levels of social anxiety.



## Appendix C: Stress and Anxiety Quiz

Begin the interview by reminding participants that there are no right or wrong answers, and that you are simply trying to figure out what we can do to help them. Tell them that you do not mean to make them anxious, and if they start feeling stressed out or need a break, they can take a moment to get ready.

1. Have you ever decided not to participate in an activity you used to have fun doing, because it seemed like too much to handle?
2. Have you ever stayed home from school because the idea of going to school that day felt too scary?
3. Do you have friends or classmates who make you happy to be at school?
4. Are there some days when you don't feel like eating lunch because you're upset?
5. On a scale of one to five, with one being "not at all like me," to five being "very like me," how much do you relate to this sentence?
  - a. "I feel stressed when I come to school."
6. Do you often participate in classroom discussions and activities?
7. Are you afraid to speak up in class or sit by yourself?
8. When mom/dad drops you off, do you feel scared or nervous to go to class?
9. Do you feel better when you are able to stay close to mom/dad at school?
10. On a scale of one to five, with one being "not at all like me," to five being "very like me," how much do you relate to this sentence?
  - a. "Being at school makes me anxious."

# Brain Stimulation as a Viable Treatment for Antisocial Spectrum Disorders

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## Abstract

Individuals with Antisocial Personality Disorder (ASPD) and psychopathy are characterized by a failure to conform to social norms, reckless disregard for their own safety and that of others and a lack of empathy and remorse. In interpersonal relationships, the defining features of these disorders include deceitfulness, consistent irresponsibility, impulsivity, irritability and aggressiveness. Although symptoms manifest behaviorally, the source of the disordered behavior may be organic, as brain regions such as the ventromedial prefrontal cortex, the anterior cingulate cortex, and the amygdala, are thought to contribute to the severity of the disorders. Despite this knowledge, viable treatment options for ASPD and psychopathy have not been established due to the complexity and range of traits exhibited. ASPD and Psychopathy, although distinct, are similar in that they typically negatively impact society both through acts of manipulation and acts of crime. Because standard psychiatric treatments such as talk therapy, medication, and electroconvulsive therapy (ECT) have been ineffective, I explored the potential viability of the experimental neuromodulatory procedures of Deep Brain Stimulation and Transcranial Magnetic Stimulation in the reduction of maladaptive traits exhibited by individuals with ASPD and Psychopathy. If these procedures demonstrate potential, they should be implemented into medical practice as viable treatment options.

*Keywords:* Neuromodulation, Deep Brain Stimulation, Transcranial Magnetic Stimulation

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## Introduction

The etymology of the terms “antisocial” and “psychopath” can hold many negative connotations and are therefore commonly misused. The Diagnostic and Statistical Manual of Mental Disorders (DSM5) recognizes Antisocial Personality Disorder (ASPD) and psychopathy as a singular disorder. However, psychopaths are thought to have been *born* with the genetic predisposition for disordered behavior whereas individuals with ASPD are thought to have been *made* by being exposed to a damaging environment (Koenigs, 2012). Despite this difference in how the disorders are thought to have originated, they often share strikingly similar characteristics. ASPD and psychopathy are disorders characterized by behavior such as a failure to conform to social norms, reckless disregard for their own safety and that of others, and a lack of empathy and remorse. These characteristics can be exhibited in a variety of ways, but the most common outward expressions of these traits are observable in the form of deceitfulness, consistent irresponsibility, impulsivity, irritability and aggressiveness (American Psychiatric Association, 2013). Because of the dysfunctional nature of the attributes exhibited by individuals with ASPD and psychopathy, they often clash with the norms imposed upon them by society which can result in trouble in interpersonal relationships, work environments, and with the law.

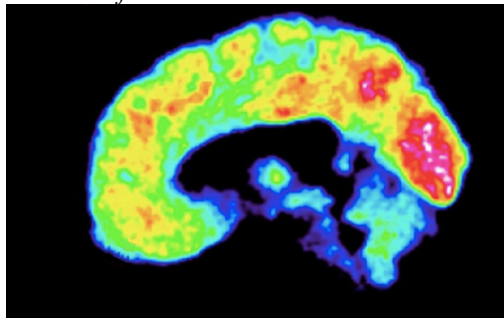
A subset of individuals with ASPD and psychopathy negatively impact society through persistent and violent criminal actions. An estimated 1% of males meet the criteria for psychopathy, which roughly equals 1,150,000 adult psychopathic males in the United States. A vast majority of this population, almost 93%, are in prison, jail or on probation. This leaves 7% of the psychopathic population that haven't committed crimes or haven't yet been caught (Kiehl et al., 2012; Koenigs, 2012). Although these individuals may not engage in violent crime, their interpersonal relationships and mental health may suffer greatly from their disorder. It is suggested that the ventromedial prefrontal cortex (*processing risk, fear*), the anterior cingulate cortex (*empathy, impulse control, emotion, decision-making*), the amygdala (*anger, fear, aggression control*), and the density of grey matter (*sensory perception, decision making, self-control, emotion regulation*) in the brain are involved in the severity of the disorders (Figure 1) (Koenigs, 2012). It is also important to note that even though the brain is affected, it does not mean individuals with ASPD and psychopathy are destined to be criminals as they are fully capable of making their own decisions. Unlike other disorders, such as bipolar disorder and obsessive compulsive disorder, ASPD and psychopathy cannot currently be treated with medication due to how little is

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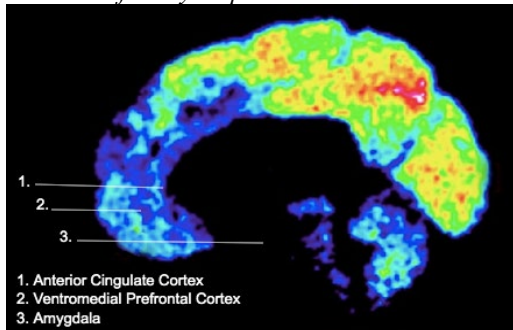
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known about the disorders' underlying mechanisms (Koenigs, 2012). However, a lack of viable treatment options is not indicative of a failure to search for one. In the past, treatments used with the intent to cure psychopaths of their disorder were psychoanalysis, group-therapy, client-centered therapy, psychosurgery, and electroshock and drug therapies. Regardless of past efforts, therapies proved to be ineffective and those who underwent treatment were often more aggressive and showed higher rates of recidivism following their incarceration (Hare, 1970). This exemplifies the need for continued research, and I believe that localizing the neural areas that contribute to ASPD and psychopathy could potentially lead to an effective treatment within Deep Brain Stimulation (DBS) and Transcranial Magnetic Stimulation (TMS) procedures.

Figure 1:  
*Pet Scan of a Normal Brain*



*Pet Scan of a Psychopathic Brain*



<https://www.businessinsider.com/what-a-psychopath-brain-looks-like-2015-7>

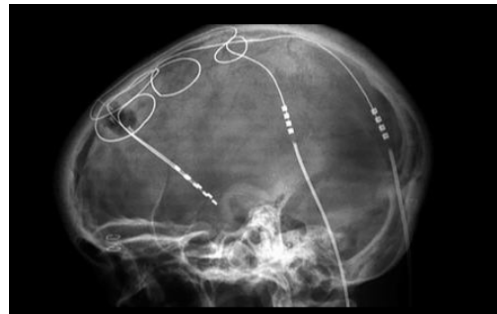
Credit: James Fallon

Note: The top pet scan is characteristic of a normal male brain, whereas the bottom scan is characteristic of a psychopath's brain. The photos above show a heat map of human brain function, warmer colors = more activity, cool colors = less activity. Note that the in the ACC, vPC, and Amygdala show much less activity in the bottom photo.

DBS is a neurosurgical procedure currently used to treat disorders such as epilepsy, Parkinson's Disease, and dystonia by altering the neural activity with electricity (Vitek, 2014) One of the most compelling aspects of DBS is that the procedure is completely reversible and poses a minimal risk of implantation complications due to infection. Deep brain

stimulation is a procedure facilitated by a system with four different components: the DBS electrode(s), the extension wire, the implantable pulse generator (IPG), and the external programming device. In contrast to the electrode with a single contact at the tip that was previously used for DBS before technological advancements were made, the most current system configuration is the "quadripolar DBS electrode". The quadripolar DBS electrode is flexible and equipped with four separate contacts constructed of a platinum-iridium alloy and located near the tip of the rod. This allows for specificity in adjustments to the electric field and provides more accurate therapeutic results. Lastly, the IPG is composed of a titanium frame and lithium batteries. ICP devices range from constant-voltage controlled, to constant-current controlled, and are programmed before implantation to ensure effectiveness (Vitek, p. 10-14).

Figure 2.

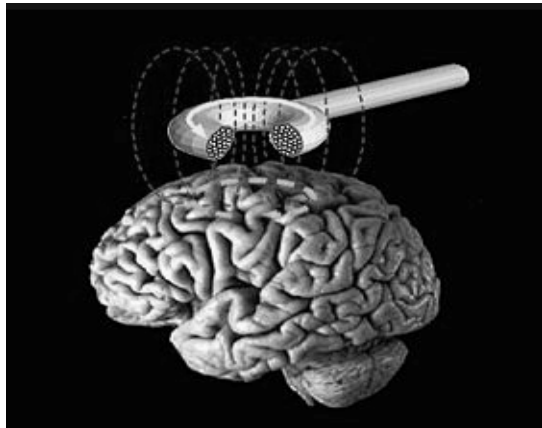


Source: <https://sites.bu.edu/ombs/2018/11/27/deep-brain-stimulation/>

Note: CT image of Deep Brain Stimulation.

Similarly, Transcranial Magnetic Stimulation (TMS) is a procedure commonly used as a treatment method for refractory disorders, and most notably, depression (Bermudes, 2018). In contrast to DBS, TMS uses magnetism and electricity to create a moving electrical current using the brain as a conductor, by rapidly alternating the flow of electricity. All TMS machines are comprised of the same components: a capacitor which is used to contain the electricity, the coils used to induce an electrical field, and a thyristor switch which controls how quickly the electricity flows. In the past, one small circular coil was used but that method soon became outdated due to the limited range created by the coil. Today, the most common TMS method requires two round "butterfly", or "figure-eight" coils which allows for a more a more focused electrical field. The strength of the magnetic field created is dependent on the distance the focal area is from the magnet, as a greater distance from the desired region results in a weaker magnetic field (Bermudes, 2018, p.2-4).

Figure 3.



Source: [https://en.wikipedia.org/wiki/Transcranial\\_magnetic\\_stimulation](https://en.wikipedia.org/wiki/Transcranial_magnetic_stimulation)

Note: TMS Schematic Diagram

## Methods

*Sources:* I used primary sources where original research was conducted, and secondary sources that pertain to disorders that have been evidenced to benefit from brain stimulation. This includes, but is not limited to: Obsessive-Compulsive Disorder, Parkinson's Disease, epilepsy, and the act of self-injurious behavior. In addition to this, I conducted structured interviews as primary sources with experts in Antisocial Personality Disorder, Deep Brain Stimulation, and Transcranial Magnetic Stimulation.

*Procedures:* I examined research articles where DBS was an effective treatment, and how the affected neural areas correspond to those which are believed to influence ASPD and psychopathy. Before conducting the interview, I first obtained IRB Approval. I acquired informed consent by emailing the consent form to each participant once they agreed to participate in the interview process. By consenting, the interviewee gave me permission to record our conversation, and to share their name, profession, responses, and opinions in my final project. Each interview took place via telephone call.

*Measures:* The questions asked pertained to the interviewee's profession, the duration of interest in the subject, and their expertise regarding whether brain stimulation could be used as a treatment for psychopathy and antisocial spectrum disorders.

*Data Analysis:* I examined the qualitative data obtained from these studies and I found a correlation between brain stimulation procedures and the alteration of activity in the prefrontal cortex, the anterior cingulate cortex, the subthalamic nucleus and the amygdala.

*Organizing Results:* I organized my results into the form of a table in order to consolidate the data in a way that is visually comprehensible.

## Results

DBS is a procedure that has been evidenced to provide relief for movement disorders (Parkinson's Disease (PD), epilepsy) and neurological disorders (OCD). However, the impact the procedure has on the mood, impulsivity, and emotion of the patients treated, raises the question of whether DBS could be used to alter the functioning of dysfunctional regions in the human brain. There is an increased effort to understand how the subthalamic nucleus (STN), a neural structure commonly associated with movement, can affect emotional responses. This can be exemplified by a study of seven DBS patients with PD who underwent subthalamic nucleus DBS while watching 1.6-4.7 minute emotion evoking and neutral video clips. (Bick, et. al., 2017) Four negative valence and four positive valence emotional video clips were chosen from a database specifically for their emotion induction properties and were shown at random intervals. During the emotional induction task, infrared spectroscopy was used to monitor oxyhemoglobin concentration during the emotional video clips. This measures the levels of oxygen in the prefrontal cortex and is associated with pleasure. The researchers found that STN DBS alters prefrontal activity during emotion induction by affecting momentary action selection and long-term fine tuning of behavioral repertoire. (Bick, 2017)(Table 1) This study shows that DBS of the STN changed how participants perceived the emotion-invoking videos, and that in turn, their impulsivity and behavior changed as a result, which could be helpful for people with ASPD.

Additionally, twelve anterior thalamic nucleus (ANT) and Anterior Cingulate Cortex (ACC) DBS patients with treatment refractory epilepsy were asked to complete a computer task that tested executive reaction time to go/no-go prompts with added stressors and emotional distractor (Hartikainen et. al., 2014). The test was administered on a computer program that introduced the visual stimuli and subsequently collected the data while each patient was connected to an electroencephalograph (EEG monitor). The test required that the patients discriminate from triangles pointing up or down while a symbol resembling a traffic light signaled for the patient to respond or withhold their response. The distractors included a line drawing of a spider, and a line drawing of a flower that appeared in the center of the go/no-go symbol. The patients were to respond as quickly as possible while following the directions from the symbol. The test was performed in sixteen blocks, with six-to-eight minutes of bipolar DBS stimulation and a consecutive six-to-eight minutes

without stimulation with an alternation of status at each block. Researchers found that ANT and ACC stimulation increased attention-allocation to threat, compromised response inhibition, and impaired cognitive control (Hartikainen, 2014). (Table 1) This study shows that ANT and ACC DBS resulted in an increase of attention placed on threatening stimuli, which is a behavior that most people with ASPD and Psychopathy lack. Additionally, this study showed that stimulation of this region increased the impulsivity of participants, which would be detrimental to someone who already has a decreased sense of self-control. However, this raises the question about whether the stimulation parameters could be adjusted to achieve the opposite result.

Another study that emphasizes how DBS can alter brain functioning was basolateral amygdala DBS, performed on a fourteen-year-old boy diagnosed with severe Kanner's autism, mental retardation, and cerebral palsy, in an attempt to decrease the severity of the child's aggressive behavior (Sturm, et. al., 2012). The patient's disorders were marked by an inability to communicate verbally, frequent anxiety attacks, tantrums, impaired self-regulatory processes in response to auditory and visual stimuli, impaired affect modulation, emotional disturbances, and life-threatening self-injurious behavior (SIB) that required constant restraint. When the patient reached the age of ten he was treated for self-injurious behavior with a daily dosage of 2mg of Risperidone. This resulted in a drastic decrease of SIB until the patient entered puberty and SIB started up again with increased frequency and aggression. The patient was subsequently treated with various other mood stabilizing medications, all of which failed to improve his symptoms. The patient's legal guardians provided consent for the patient to be treated with the DBS of the amygdaloid complex and the supra-amygdaloid projection system which controls fear, anxiety, and emotion. Two quadripolar DBS electrodes were implanted through burr holes in the patient's skull, and stimulation was activated several days after the initial surgery. Twenty-six months after the DBS treatment was implemented, the patient's SIB and aggression steadily improved, and the positive results showed significant signs of continued improvement (Sturm, 2012). (Table 1) This study emphasized the efficacy of DBS in treating aggressive behavior, impairments in self-regulation, and decreased activity in the amygdala, all of which are the prominent features of ASPD and psychopathy.

Table 1. Table of Neural Areas Affected by DBS and Subsequent Results

Sample size	Study	Disease	Location	Findings: Behavior
7	Deep Brain*1 Stimulation Alters Prefrontal Correlates of Emotion Induction. (Newton, 2009)	Parkinson's	SubTNu	Momentary action selection, habitual behavior
12	Immediate*2 effects of deep brain stimulation on executive functions and emotion-attention interaction in humans.	Epilepsy	ATN ACC	increased attention-allocation to threat, compromised response inhibition, and impaired cognitive control.
1	DBS improves*3 symptoms of autism and related self-injurious behavior	Autism	Amy Co	Decreased aggression.  Improved verbal skills,

Note: location abbreviations; Subthalamic Nucleus (SubTNu), Anterior Thalamic Nucleus (ATN), Anterior Cingulate Cortex (ACC), Amygdaloid Complex (Amy Co).

A similar study that examined how stimulation can decrease aggression, was the examination of direct transcranial magnetic stimulation of the dorsolateral prefrontal cortex (dPFC). This study included thirty-nine participants in the TMS group and forty-two participants in the sham group (Choy, et. al., 2018). During stimulation, all participants performed a Psychomotor Vigilance Task, and the Iowa Gambling task which are two experimental procedures known to stimulate the Dorsolateral Prefrontal Cortex. Participants then assessed two hypothetical vignettes used to gauge perceptions of moral wrongness which depicted two scenarios; physical and sexual assault. Participants were then asked to gauge the likeliness they would participate in those aggressive acts from 0 (not at all likely) to 10 (extremely likely). Participants were also assessed in aggressiveness by interacting with a simulated voodoo doll on a computer screen. Users were told that the voodoo doll represented someone close to them, and were subsequently allowed to insert as many pins into the doll as they desired. The more pins that were used indicated higher aggression levels. This study found that the individuals who received anodal stimulation of the DPF resulted in the decreased intent to commit aggressive acts one day after stimulation (Choy, et. al., 2018). (Table 2) This study shows the potential of TMS to decrease aggressive and violent behavior, which is one of the defining features of antisocial behavior.

The final study that I examined, was the Direct Current Transcranial Magnetic Stimulation performed on the medial prefrontal cortex of a group of 40 healthy

subjects (Liao et. al., 2018). A total of twenty subjects each, consisting of ten men and ten women were assigned to anodal, cathodal, and placebo groups. The participants were led to believe that in each trial, they would have the option to help another subject (pain-taker) that would ultimately either be electrically shocked or spared based on the decisions they chose to make, although no one was actually going to be harmed. In each trial, the participants were produced with a cost-analysis of how much it would cost to help the pain-taker and how likely it was that that they would be successful in helping the other person. Forty of the participants that were not included in the sham/placebo group received a constant electrical current from a transcranial stimulator. The results of this study indicated that those receiving both anodal and cathodal stimulation had an increased propensity for helping behavior when the probability of helping was high but diminished when the probability of helping behavior was lower. The purpose of this study was to encourage the participants to empathize with those whom they believed they were inflicting pain upon. This study found that anodal stimulation increased the propensity for helping behavior, whereas cathodal stimulation decreased the propensity for helping behavior (Liao, 2018). (Table 2) This final study shows that anodal/cathodal stimulation may have the potential to cause opposite effects. In addition to this, anodal stimulation was found to increase the empathetic reasoning of participants, resulting in prosocial behavior, something most, if not all, psychopaths lack.

Table 2. Table of Neural Areas Effected by TMS and subsequent results.

Sample Size	Study	Disease	Location	Behavior/ Findings
60	Stimulation* <sup>4</sup> Reduces Intentions to Commit Aggression	none	mPC	Increased propensity for helping behavior
81	Stimulation* <sup>5</sup> modulates the propensity to help in costly helping behavior.	none	PC	Decreased intent to commit aggressive acts

Note: Location abbreviations; Medial Prefrontal Cortex (mPC), Prefrontal Cortex (PC). Sample Size; In the first and second samples only half of the participants (matched for age/gender) received stimulation.

Although the studies examined showed promise, I had the pleasure of interviewing an expert to gain critical insights. I spoke with Dr. Fallon, a neuroscientist with a background in psychology who

studied the brains of psychopaths for over ten years, ultimately discovering that psychopathy could be diagnosed by comparing similarities in the brain structure of psychopaths. In an interview with Dr. Fallon, he mentioned that stimulating the inactive brain regions associated with ASPD and Psychopathy could be a potential treatment option for psychopaths; but that most areas of interest in psychiatry, not in neurology, such as dysregulated emotions and a sense of morality are not very amenable to outside access as the center of those connectomes are at the base of the brain, unless you go in with an electrode. Dr. Fallon exemplifies the fact that although he was born with decreased neural activity, it does not predetermine criminality. Although the studies examined have shown that maladaptive traits could be altered and even improved by DBS or TMS, it is essential for proper studies to be executed before adopting either of these procedures as clinical treatment options for ASPD and psychopathy. Some drawbacks to this review were that the DBS sample sizes were highly limited. The most critical aspect of this review to consider, is that the studies I examined were not directly related to either ASPD or psychopathy, outside of an overlap in brain regions, so there could be a lack of information regarding how affected individuals might respond to these treatments. This includes some potential disadvantages to stimulation, such as the possibility of aggravating other existing symptoms, and putting potentially unstable and socially problematic individuals through trials. Taking into consideration that these studies potentially show promise, exacerbated by the lack of treatment options makes brain stimulation a necessity in exploring future therapies.

## Discussion

I examined studies that involved disorders such as epilepsy, Parkinson’s disease, and autism. The purpose of this research was to examine the neural regions receiving stimulation in neurological conditions and how the resulting behaviors of these individuals were altered. Additionally, I included studies performed on individuals without neurological disorders as they highlighted the neural regions I am interested in and helped in assessing the functionality of using stimulation to alter the behavior of individuals who lack the necessary qualifications for DBS. Although the studies I examined showed promise for both dysregulated and normal samples, the question remaining is whether psychopaths themselves could benefit from treatment, and how the treatment of those individuals would be initiated. Transcranial stimulation, being a non-invasive treatment might be the more desirable treatment option. Deep brain stimulation, however, seems the most practical of the two treatment options, as the implanted probes allow for deeper, more specified access to hard-to-reach regions. However, the

invasive nature of the procedure makes the voluntary treatment of psychopaths questionable, as psychopaths generally do not believe that there is anything *wrong* with them. If DBS and TMS prove to be efficient in improving maladaptive traits expressed by psychopathic and ASPD individuals, a viable step after determining their efficacy may be to provide the treatment option to incarcerated individuals who are willing to receive therapy. As of now, ASPD and psychopathy are elusive, destructive disorders that pose a substantial public safety risk, and the continual research of these disorders is necessary for the well-being of psychopaths, their families, and society.

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# Analysis of Port Wine Stains and Perceived Public Stigma Based on Level of Scientific Knowledge

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## Abstract

Port Wine Stains (PWSs) are vascular malformations caused by mutations in GNAQ genes, which lead to improper blood vessel development near the epidermis. Due to the fear of developing accompanied physiological deficits, it is commonplace to have them removed, even on infants no more than a few weeks old. Fear of the unknown and fear of knowing cause people to avoid confrontation with the subject in question and instead develop opinions with the little knowledge they possess; because this small amount of knowledge made them fearful of the subject, they begin to regard it with hostility. This is the basis of stigma. Because PWSs are notably rare, 0.3% of the population, they are more likely to be an unfamiliar concept to the average person, and thus more likely to be a target of negative stigma; this gives rise to self-stigma in individuals with Port Wine Stains, leading to the decreased mental health and self-confidence. I hypothesized bias against PWSs would be less prevalent in individuals with higher amounts of scientific knowledge. I developed a survey where participants were grouped based on their scientific education levels and portraits with and without PWSs were rated on initial attraction, intelligence, and trustworthiness. Results indicated ER medical staff gave significantly higher ratings to PWS portraits than STEM students, non-STEM students, and participants with GED/high school diplomas. These results suggest the bias may not be correlated with general scientific knowledge, but instead with knowledge of and experience with physical abnormalities. Findings support the need for future education of physically-altering medical conditions, which can serve as an initial step towards encouraging acceptance of physical abnormalities and improving the mental health and self-confidence of PWS individuals.

*Keywords:* Port Wine Stain, stigma, first impressions

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## Introduction and Literature Review

*Port Wine Stain Development.* Port Wine Stains (PWSs) are vascular malformations classified as congenital capillary malformations, and can range from simply cosmetic and benign to 3rd stage hypertrophic (Wang 2017). They are found more commonly in Caucasian ethnicities, and are more prevalent in females than in males (Jacobs 1976). PWSs appear as patches of darkened skin located primarily in the neck and facial regions and can range from pink to dark purple in color. Their development is primarily attributed to somatic mutations in G Protein Subunit Alpha Q (GNAQ) genes, which control the development of progenitor cells in the brain, eyes, and skin. When epidermal cells become hyperactive, PWSs can also be accompanied by nodules and other hypertrophic formations; this causes cell vesicles, mitochondria, and ribosomes to develop in a larger state of existence than normal and gives the appearance of swollen node-like figures over the birthmark (Dymerska 2017, L. 2017).

*Underlying Health Risks.* Depending on the location and severity of the PWS, a variety of health complications may develop at both infant and adult levels; males are known to be more likely affected by secondary health risks than females. The most visibly noticeable complication is the development of hypertrophic formations over the PWS, which can lead to swelling of afflicted regions, telangiectasia (dilation of blood vessels throughout the skin), and, at highest severity, sudden ruptures when in contact with mild to moderate frictional forces such as brushing against a wall (Pathol 2010, Wang 2017). If the PWS is located relatively close to the eyes, there is an increased chance of visual deficits or neurological complications developing; as noted in Wu's study (2017), approximately 20% of the 569 tested patients had glaucoma, while a further 20% had early-stage glaucoma. PWSs are also a distinct feature in a neurological condition known as Sturge-Weber Syndrome. The condition appears physically the same as a benign PWS near the scalp or eyes, but the vascular malformations are also present within the brain; this condition can disrupt cognitive processes and increase risks of developmental delays, stroke-like

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episodes, and seizures; much like PWSs, this condition is present from birth and encompasses approximately 6% of all individuals with these markings (Dymerska 2017). As noted by Pathol (2010), various other conditions can develop if the location of the PWS is lower, including airway restriction if located near the throat and dental complications if located near the mouth.

*Public Stigma and PWS Intervention.* Public stigma is often placed on objects, concepts, or conditions found to be “abnormal” or not befitting the majority of the immediate population; in many cases, mechanisms are developed to reduce or remove the cause of these negative perceptions from the public’s view. In the case of PWSs, multiple laser and surgical removal methods have been developed, and many are carried out on infants only a few weeks old; examples of these mechanisms include surgical excision, laser therapy, freezing, and tattooing over the affected region (Sharif 2013). After the development of these removal mechanisms gained publicity, individuals with PWSs began to subconsciously distribute themselves into two categories: those who supported removals and proceeded with the removal of their own marking, and those who found the idea of removal disrespectful to the PWS population and experienced decreases in their mental health; the latter group has become more socially isolated from society due to this constant beration and disapproval from “normal-appearing” individuals. As noted by Corrigan and Shapiro (2010), cognitive stereotypes can give rise to public stigma, which then leads to self-stigma in the affected group; this emotional impact can cause changes in their behaviors and, by chance, their actions may then further the initial stereotypes that were placed on them.

*Psychology of First Impressions.* There is debate over whether first impressions can be altered or altogether changed from their initial state of being. It is known that attitudes towards objects can be split into “explicit,” meaning they are quicker to shift when provided little counter attitudinal information, and “implicit,” meaning they are less likely to be changed unless a sufficient or powerful amount of counter-attitudinal evidence is provided (Rydell and McConnell (2006)).

It remains unknown where first impressions belong in regards to these two categories, as they are developed in brief periods of time and require fast learning as explicit attitudes do, but are often seen as difficult to change once made, similar to implicit attitudes. Thus, as suggested by Nosek (2002) and McGuire (1973), it may be better to adopt a more pragmatic approach to this type of research and begin with the inference that first impressions may be either inflexible as implicit attitudes or malleable as explicit

attitudes depending on the nature of how, where, when, and why the impressions were made.

*Development of Public Stigma.* Corrigan and Shapiro (2010) state cognitive stereotypes against concepts, features, and objects eventually develop into widely-renown public stigma; this is most often seen when the subject in question is unfamiliar or completely unknown to the target audience, and is less often seen when prior knowledge of the subject is known and the individuals have opted in favor of logical thinking instead of emotional thinking. Thus, it stands to reason that if individuals were to know more about the subjects that are unfamiliar to them, they would likely shift their initial negative perceptions, not necessarily to a positive point of view, but at least to a more logical or neutral view of the subject in question.

The main argument connecting knowledge and fear are the ideas of both fear of the unknown and fear of knowing. Though these two concepts appear to be polar opposites, it is believed by Maslow (1968) that they are rather isomorphic in nature to one another. The term foresight is used as a mechanism for this fear to act upon, causing individuals to avoid interaction and confrontation with these unfamiliar ideas and instead isolate themselves from the situation; this type of behavior has led to the well-known phrase and ideal that ignorance is bliss. This research suggests those who are exposed to an unfamiliar point of interest or concept do indeed regard it with fear and possibly even hostility, but instead of allowing their perspectives to adjust as they gain more knowledge of it, they instead opt to ignore what they learn and continue to regard it as negatively as they did initially; this implies that these first impressions of unfamiliar objects/ideas do indeed fall under both implicit and explicit attitudes rather than under a single category.

The present research aims to answer the following question: Is there a correlation between reduced stigma towards individuals with Port Wine Stains and increased levels of scientific knowledge?

## Methods

*Participants.* Participants were separated into four groups based on their level of scientific knowledge: individuals who have acquired a high school diploma or GED and no further education, current college students at CSU Stanislaus in non-STEM majors, current college students at CSU Stanislaus in STEM majors, and trained medical staff in the Memorial Medical Center Emergency Department. Responses from the education question in the survey’s demographic section was used to separate participants into these 4 groups of interest. Participating CSU Stanislaus students were categorized into the STEM and non-STEM groups

using the STEM Designated Degree Program List (STEM 2017).

Based on the proposed methodology and the variables in this study, a G\*Power analysis was obtained to determine the appropriate sample size for this study. Using a desired power level of 0.80 and a 0.05 alpha level, the total minimum sample size required for this study was determined to be 30 participants. Inclusion criteria for the project was as follows: participants must be able to read English, must have internet access, and must be 18 years of age or older. Individuals were excluded from participating if they had any form of visual impairment that prevented the ability to read and answer the survey questions.

*Materials, Procedures, and Design.* The survey was a blind study conducted online via Qualtrics, an online survey tool designed to permit the creation of survey instruments, distribution of surveys, data storage, and analysis; physical interaction with the principal investigator was limited to avoid response bias from subjects who would otherwise have a view of my PWS or body language while participating in the survey.

Prior to data collection, an informed consent form was presented as the first image of the survey. Participants were required to agree to the consent form to continue with the study. Participants were then asked demographic questions regarding age, gender, education, college major if applicable, and occupation. Twelve portraits were obtained from an article portraying individuals with Port Wine Stain birthmarks (Jaruševičiūtė 2017). Original copies of these photos were used, and each portrait was photoshopped by myself to remove each birthmark. Portraits without PWS markings were primarily used to deter participants from understanding the concept of this survey prior to completion, thus attempting to reduce potential response bias. These 24 portraits were then presented to participants in an apparently random order (images of the same individual with and without the PWS were presented exactly 12 photos apart). For each portrait, three 10-point rating scales were available to adjust based on the participant's impression of the individual's attractiveness, intelligence, and trustworthiness; ratings were given from 1 (lowest) to 10 (highest). Each portrait and set of rating scales were available to edit for 15 seconds before automatically changing to the next portrait and set of scales. Age, sex, and ethnicity varied between portraits.

## Results

A total of 94 responses were collected: 15 ER medical staff, 41 STEM, 7 non-STEM, and 14 GED. Fifteen responses were excluded from data analysis

due to incomplete surveys and inability to categorize in any of the four groups of interest. Ratings from ER medical staff were consistently higher on 11 of 12 PWS portraits, and ratings from STEM responses were higher than non-STEM and GED on 10 of 12 portraits (Fig. 1). The average ratings from each group correlated with their level of scientific knowledge, with the highest ratings being from ER staff and the lowest from GED responses (Fig. 2). When average rating values of each portrait between groups were compared against one another, ER staff responses were significantly higher than responses from the STEM ( $p = 0.011$ ), non-STEM ( $p = 6.69 \times 10^{-5}$ ), and GED groups ( $p = 6.69 \times 10^{-5}$ ). STEM responses were significantly higher than responses from the non-STEM ( $p = 0.039$ ) and GED groups ( $p = 0.006$ ). No significant difference was identified between the responses from non-STEM and GED groups ( $p = 0.486$ ).

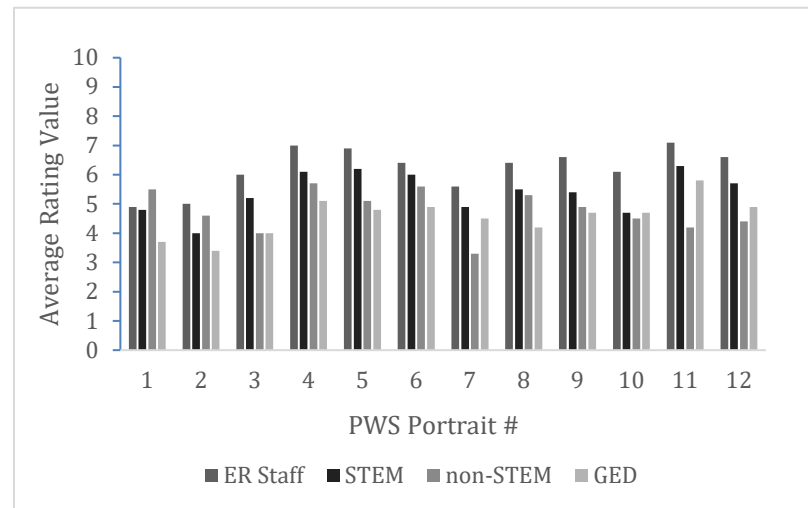


Figure 1: Average ratings of each PWS portrait by each of the four groups

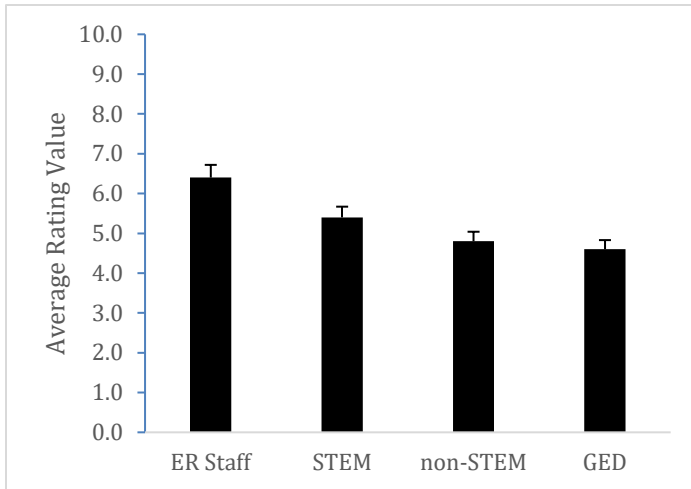


Figure 2: Average rating value by given each group

### Discussion

The hypothesis of this study was that stigma against PWSs would appear in lower concentrations as scientific knowledge increased, with the least amount being found in responses from trained medical staff. The results indicated a significant difference in the rating values between ER staff and the other three groups and between STEM/non-STEM and STEM/GED groups; no other significant differences were identified, as was initially predicted. This suggests the bias against PWSs may not be correlated with general scientific knowledge, but instead with knowledge of and experience with physical abnormalities. Thus, bias against physical differences may be most closely related to habituation or sensitization to the subject in question. While efforts were taken to reduce limitations in this study, some are noted from the data collection:

1. Number of responses varied greatly among the four groups, ranging from 7 to 41
2. 15 responses were excluded from analysis because they either were unable to be categorized or were less than 50% complete
3. Some rating values were left blank on multiple portraits due to the survey's time constraints
4. I was unable to control whether participants retook the survey
5. Portraits varied in gender, ethnicity, and age, which may have allowed for additional bias

Additionally, it is possible participants may have selected the incorrect education level in the

demographic section of the survey, which would lead to inaccurate grouping of survey responses.

### Future Implications and Significance

Results suggest the bias may not be correlated with general scientific knowledge, but instead with knowledge of and experience with physical abnormalities. The information obtained from this study can be used as support to provide future education of physically-altering medical conditions to younger generations, and to encourage acceptance of these physical differences. This in turn would likely improve the recorded decrease in mental health of individuals with Port Wine Stains, as well as other medical conditions that alter physical appearances.

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# Promoting a Sustainable Future Through Human Attitudes & Actions

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## Abstract

Due to the impending climate crisis caused by human activity, it is essential to change human attitudes and actions to be more sustainable. The purpose of the present study was to investigate psychological barriers to human environmental action, and to establish a link between specific behavior types and different domains of psychological barriers. A sample of 262 students were recruited from California State University's Department of Psychology's online participant pool (SONA). Participants surveyed were presented with four categories of human environmental action: transportation, water, purchasing, and waste. Next, they were presented with the 24-item Dragons of Inaction Psychological Barriers (DIPB) scale (Lacroix et al., 2019), which contains five subscales to measure five types of psychological barriers: Change Unnecessary, Conflicting Goals and Aspirations, Interpersonal Relations, Lacking Knowledge, and Tokenism. Based on previous research, it was hypothesized that behaviors that are more invasive to daily life (ex: driving less) will pose barriers such as conflicting goals and aspirations, whereas less invasive behaviors (ex: purchasing "green" products) may primarily be affected by participants' lack of knowledge. However, contrary to what was expected, results indicated that there was no significant effect of condition relative to lacking knowledge. There was however a significant effect for conflicting goals and aspirations. Participants who selected the "driving less" behavior indicated that their main obstacle was lacking knowledge versus that of conflicting goals and aspirations. Although not significant, as expected, participants who selected behaviors relative to purchasing "green" products indicated that their main obstacle was lacking knowledge.

*Keywords:* psychological barriers, pro-environmental action, human attitudes

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## Introduction

Globally, climate change is occurring at an alarming rate, and the causes have been primarily attributed to human activity. The scientific community has demonstrated the devastating effects of human activity on the environment, which includes global climate change, pollution, loss of biodiversity, and depletion of natural resources, among other key concerns (NASA, 2019). In order to move forward into a more sustainable future, human actions and attitudes must be changed to be more ecologically sustainable. Solutions to environmental problems, while they may include technological developments, like alternative energy and biodegradables, must also focus on human behavioral changes, such as recycling and reducing consumption. By changing unsustainable cultural and individual norms, identifying people's barriers to pro environmental behaviors (PEBs), pushing for new policies to incentivize individual change, and creating behavioral interventions needed to change human behavior, a greener future can be achieved.

While the United States heralds itself as a world leader in many avenues, it falls incredibly short in climate policy and action compared to practically every other developed nation. Developed nations include states that have more established economies and advanced technologies relative to other nations. Such nations are responsible for a disproportionate amount of the carbon footprint, and therefore must

take more responsibility in an effort to achieve sustainability than other less developed nations. As it stands right now, US carbon emissions are projected to remain at a steady level while other countries are taking the necessary steps to cut their emissions in half or more (Plumer & Migliozzi, 2019). Many countries, including Norway, Canada, and Germany serve as accomplished examples of how policy may be used to incentivize individual human environmental action for the better. Norway, for example, offers many incentives for its citizens to make the switch over to electric cars instead of fossil fuel burning vehicles. These incentives include but are not limited to no purchase or import taxes on electric vehicles, free municipal parking, access to bus lanes, and a fifty percent reduction in road tolls, parking fares, ferry rides, and many other costly components of driving. After the implementation of these incentives, Norway can now report that fifty percent of its car sales are electric cars, and their emissions have been significantly reduced ("Norwegian EV Policy", n.d.). This is just one small example of how countries may introduce policies to incentivize individuals to engage in pro-environmental behaviors leading to a tangible reduction in their carbon footprint. In order for policy changes like this to be effective, it is important to understand individuals' barriers to participating in pro environmental behaviors so that they may be properly encouraged.

Lacroix et al. (2019) discussed the process of developing and validating the DIPB (Dragons of Inaction Psychological Barriers) scale for the purpose of examining individual human environmental action. After three extensive studies testing and validating the DIPB scale, Lacroix and her colleagues were able to create a twenty-two item, five factor scale with high reliability, that explores six domains of environmental behaviors. The researchers sought to identify some main barriers people face when engaging in PEBs which have been denoted “the dragons of inaction”. These “dragons” are as follows: Change Unnecessary, Conflicting Goals and Aspirations, Interpersonal Relations, Lacking Knowledge, and Tokenism. The scale is comprised of five subscales designed to measure each of these distinct psychological barrier types. The researchers acknowledged that pro environmental behavior type does in fact play a role in what type of psychological barrier an individual may face when deciding whether to engage in a particular behavior. By looking at six domains of environmental behavior, including food, transportation, energy, water, purchasing, and waste, the DIPB scale was used to determine relationships between these various domains and the different distinct categories of psychological barriers. Results indicated that more invasive behaviors involving transportation, such as driving less, posed obstacles relating to participants’ conflicting goals and aspirations. Less invasive behaviors dealing with purchasing, such as buying green products, were primarily affected by participants’ lack of knowledge. This is the primary scale that was used in the present study because it is a valid and reliable measure for the variables of interest.

Previously, Cheng et al. (2011) examined the crafting of effective environmental messages by looking at message framing as a way to promote environmentally sustainable behaviors. The purpose of looking at message framing is to close the knowledge-action gap that individuals have regarding sustainable behaviors. This “knowledge-action gap” refers to the difference between the behaviors that individuals know they should engage in from those they actually engage in. A predominant amount of research in the field of environmental psychology centers around the concept of a “value-action gap” or “knowledge-action gap” as it is referred to by Cheng et al. (2019). This idea is such a substantial part of the literature on changing human activity because most people know what kinds of behaviors they should be doing, such as exercising regularly, eating healthy, recycling, reducing waste and consumption, etc., yet they fail to engage in those behaviors. If individuals did not know any better, then it would be a simple matter of education. This is not the case for most people, and therefore psychological research into

changing human behavior must then focus on dismantling the barriers and mechanisms that maintain this knowledge-action gap and prevent effective action from occurring.

## **Method**

### ***Participants***

A sample of 262 students (226 females, 36 males), were recruited through the CSU Stanislaus Department of Psychology online participant pool (SONA). The age of the participants ranged from 18 to 53. The sample was predominantly Hispanic/Latino (60.8%), heterosexual (88.3%), and Junior in college (40.8%). All participants were given 1 SONA credit for participating in the study, which may have counted as experimental credit for a psychology class.

### **Design**

The research design was a single factor, four-group, between-subjects design to examine factors pertaining to psychological barriers to human environmental action. The independent variable was the type of behavior selected by the participant (taking public transportation, cycling, or walking rather than driving, reducing water use through shorter showers, or watering less, or making more eco-friendly purchases, recycling all items permitted by local programs and/or composting). Participants were asked to select one of the behavior types that they or others should engage in with intent to help the environment, but that they are not currently engaging in, or not engaging in enough. The dependent variable was type of psychological barrier (change unnecessary, conflicting goals and aspirations, interpersonal relations, lacking knowledge, and tokenism).

### **Measures**

The measures used in the study were a demographics questionnaire, the Green Behavior Scale, and the Dragons of Inaction Psychological Barriers Scale (DIPB) (Lacroix et al., 2019). The demographics questionnaire consisted of 9 questions designed to assess the participants’ personal characteristics. The Green Behavior Scale consisted of 3 questions, 1 multiple choice which was designed to assess the participant’s behavior type (taking public transportation, cycling, or walking rather than driving, reducing water use through shorter showers, or watering less, or making more eco-friendly purchases, recycling all items permitted by local programs and/or composting) with 2 open ended questions designed to allow the participant to express their reasons for not doing the selected behavior and to express what types of eco-friendly behaviors they do engage in. The DIPB scale consisted of 24 questions designed to measure the participants’ perceived psychological barriers to

whichever green behavior they chose using a 5-point Likert scale of measurement, with 1 being Strongly Disagree and 5 being Strongly Agree.

1.58,  $p = .194$ ,  $\eta_p^2 = .019$ , interpersonal relationships,  $F(3, 251) = 0.17$ ,  $p = .915$ ,  $\eta_p^2 = .002$ , lacking knowledge,  $F(3, 251) = 0.68$ ,  $p = .565$ ,  $\eta_p^2 = .008$ , or

**Table 1**  
*Descriptive Statistics for Mean Psychological Barrier Scores by Behavior Type*

"Green" Behavior	<i>n</i>	Psychological Barrier									
		Change Unnecessary		Conflicting Goals		Interpersonal Relations		Lacking Knowledge		Tokenism	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Driving less	107	1.9	0.59	2.5	0.85	1.8	0.76	2.6	0.93	2.2	0.62
Reducing water use	40	2.0	0.66	2.2	0.83	1.7	0.82	2.5	0.93	2.2	0.81
Purchasing	76	2.0	0.63	2.4	0.67	1.8	0.75	2.7	0.92	2.2	0.69
Recycling	32	1.8	0.52	2.1	0.78	1.7	0.73	2.7	1.08	2.1	0.85

### Procedures

Participants were recruited through SONA. Those who were interested were able to access further information about the study, the Consent Form, questionnaires, and scales through Qualtrics. Once a participant agreed to participate, they were instructed on how to advance through all portions of each section, beginning with the Consent Form.

Upon completion of the Consent Form, the participants were then instructed to complete a demographics questionnaire. Participants were then asked to complete the Green Behavior Scale, followed by the DIPB scale.

At the conclusion of the experiment, the participants were then directed to the debriefing sheet, at which time they were thanked for their participation, and the purpose of the study was explained to them. It was clarified to them that the study's purpose was to examine factors pertaining to psychological barriers to human environmental action and type of environmental behavior.

### Results

To determine whether there were psychological barriers to environmental action as an effect of environmentally friendly behavior between our four conditions, data were analyzed using a multivariate ANOVA. The research hypothesis was not supported. Results indicated that there was no significant effect of condition relative to change unnecessary,  $F(3, 251) =$

tokenism,  $F(3, 251) = 0.30$ ,  $p = .829$ ,  $\eta_p^2 = .004$ . There was however a significant effect for conflicting goals and aspirations,  $F(3, 251) = 3.66$ ,  $p = .013$ ,  $\eta_p^2 = .042$ . Contrary to what was expected, participants who selected behaviors that interfere greatly with daily life, specifically driving less, indicated that their main obstacle was lacking knowledge ( $n = 107$ ,  $M = 2.6$ ,  $SD = 0.93$ ) versus that of conflicting goals and aspirations ( $n = 107$ ,  $M = 2.5$ ,  $SD = 0.85$ ). Although not significant, as expected, participants who selected behaviors relative to purchasing "green" products indicated that their main obstacle was lacking

knowledge ( $n = 76$ ,  $M = 2.7$ ,  $SD = 0.92$ ; see Table 1 & Figure 1).



## Discussion

The results of the present study did not support the hypotheses that more invasive behaviors like driving less would be primarily affected by the conflicting goals and aspirations barrier, while less invasive behaviors such as purchasing eco-friendly products would be more affected by the lacking knowledge barrier. Participants who selected the behavior of “taking public transport, cycling, or walking rather than driving” indicated that “Lacking Knowledge” was their most prominent barrier to this activity. Considering the population sampled and the geographical area in which the majority of the participants live, this makes perfect sense. Students of CSU Stanislaus live primarily in California’s central valley, which is a largely rural area severely lacking in public transportation. CSU Stanislaus is considered a “commuter school”, meaning most of its students do not live on campus. Many students drive from other cities to attend class. It is simply not feasible for these students to walk or ride a bike to school from great distances, nor can they rely on public transportation to be available to them in their route. Because public transportation is so rarely used by the majority of the population sampled, lacking knowledge of how to go about engaging in this green behavior is certainly a barrier.

Regarding the second part of the hypothesis, those participants who selected the less invasive behavior of “making more eco-friendly purchases” did in fact indicate that “Lacking Knowledge” was the primary barrier to this behavior. Although this data does support the hypothesis, it was not significant. These results are inconsistent with the previous studies done by Lacroix et al. (2019).

These results have important implications for the future of our planet and the continuing research avenues in the field of environmental psychology. It is essential to continue to add to this body of research and gather data on many different populations in order to effectively address the knowledge-action gap in differing populations and craft policy that properly deals with the human behaviors that contribute to the climate crisis at hand.

Limitations of the current study involved that of a small sample size and the sample being restricted to one college campus. The sample studied was overwhelmingly comprised of women (over 86%). Future research would benefit from having a closer ratio of men and women in the sample to more closely mirror the population demographics. Another limiting factor was that this sample was comprised 100% of college students, all of which were students enrolled in Psychology courses. This particular group may differ from the overall population in key ways, thus

restricting the generalization of data to individuals not attending college. Future research studies should include larger and more diverse samples that include various age groups outside of what has been captured here, non-college students, and individuals living in other regions outside of California’s central valley.

## Acknowledgements

I would like to thank the California State University, Stanislaus Honors Program for support throughout this research. Dr. Jamila Newton has facilitated this process through thoughtful feedback and direction throughout this project. I would like to extend special thanks to Prof. Deborah Forester. Without her supportive mentorship and careful guidance, this research would not have been possible.

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# Studying the effects of touch and pressure therapy on the fingers of the hand for stress relief among college students

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## Abstract

In the college environment, students are faced with many stressors, which can cause physical health problems, mental health diagnosis, and negative coping. The purpose of this study is to test the effects of touch and pressure therapy on the fingers of the hand for stress relief among college students. Multiple networks of neurons connect to pressure points on the body where applied touch and pressure activate a nervous system response that incites overall relaxation. The participants sit down and use their dominant hand to squeeze, or apply hand held pressure, to each of their fingers on the other hand for 15 seconds each. Physiological signs can be assessed for changes in stress level. Participants count their individual heart rate and respiratory rate before and after the therapy for physiological changes. A modified perceived stress index is used to assess stress on a minimal, moderate, or high level. In order to follow COVID-19 health guidelines and social distancing requirements, the research is a virtual group study. The results of the research are lower stress levels and decreased respiratory count. An increase in heart rate is noted in the population. Participant experiences are categorized into three domains: feeling calm, feeling odd, and the hand therapy needing improvement. Past studies show positive implications for touch and pressure on the body for stress relief. The implications for studying the effects of touch and pressure on the fingers of the hand are introducing a potentially new positive coping method that can help improve health outcomes in college students.

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## 1. Introduction

The demanding college environment of academic commitments, independent management of life choices, and financial concerns cause the majority of college students to experience stress and be highly prone to experience stress throughout college (Ah et al., 2004). According to Harvard Medical School, strong associations between exposure to stress and mental health diagnosis, self-harm, and suicidal ideation exist (Younghans, 2018). Chronic stress decreases the body's defense systems by decreasing the production of antibodies, or components that protect the body from infection, thus increasing the body's vulnerability towards illness and disease (American Institute of Stress, n.d.). Likewise, a prolonged state of stress impacts cardiovascular health through the development of atherosclerosis, or the narrowing of blood vessels, and hypertension, or high blood pressure; both of which can increase risk for fatal health occurrences such as stroke, peripheral

vascular disease, and pulmonary embolisms (Lewis et al., 2016). Chronic stress, additionally, impacts cognitive function in the way poor concentration, memory problems, and sleep disturbances can occur; changed eating habits, social withdrawal, and migraines can develop as well (Lewis et al., 2016).

The negative bodily responses that occur from unmanaged stress urge the importance of exploring therapies that can provide stress relief. While well-known therapies such as aromatherapy, acupuncture, massage therapy, and even meditation have been utilized for stress management, research shows adolescents resort to unhealthy coping methods (Böke et al., 2019). Stress can lead college students to seek stress-relieving outlets such as over-eating, alcohol abuse, or resorting to recreational drugs all of which potentially cause serious unhealthy habits and long-term health problems (American Institute of Stress, n.d.). Acupressure, which incorporates the concepts of touch and pressure on the body, has been shown to be effective in



pressure relates to stress. Therefore, by lowering blood pressure, acupressure is able to provide stress relief (Lewis et al., 2016). The results of past research are important for college students, especially for those who utilize negative coping techniques for stress. A different study observed the effects of acupressure therapy on college students.

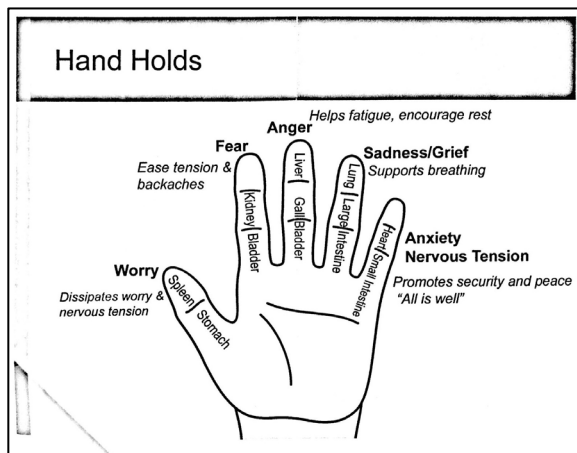


Figure 1b. Hand hold diagram by Carver, Stewart, and Dean (2019).

McFadden et al. (2012) put into action their concerns for stressed college students by conducting a randomized and placebo controlled single blind design study. A sample size of 109 college students with no health conditions went through a 40-minute session of acupressure while lying face up on a massage table (McFadden et al., 2012). Electrodes were attached to the wrists, left ankles, and middle and index fingers of the participants for ECG (electrocardiogram) data (McFadden et al., 2012). The results revealed a decreased heart rate, increased heart rate variability, reduced skin conductance response, and reduced stress response (McFadden et al., 2012). While the study utilized auditory therapy such as crickets and beach sounds during the therapy session, it showed acupressure causes physiological change as observed in the other studies. Nevertheless, it is good to consider complementary therapy such as music as an adjunct that can promote the effects of acupressure.

### 3. Methods & Procedure

3.1. *Design.* A quantitative virtual group study was done.

3.2. *Participants.* The study population was recruited from the course, Professional Nursing, at CSU, Stanislaus during a time of perceived high stress levels, specifically during the time of final examinations in Fall 2020. A sample size of 19 CSU, Stanislaus students above the age of 18 was recruited as participants. Two students declined to participate.

3.3. *Pre-Intervention.* The researcher entered a virtual Zoom meeting with the students, and provided students access to a Google Form link that included an online informed consent form (Appendix A), a demographic survey (Appendix B), and a modified perceived stress index (Appendix C) that inquires the level of stress on certain factors in the college environment. Students who elected to become participants of the study completed these forms. Those who did not elect to be participants were given the opportunity to decline and exit the Google Forms. The researcher who produced the perceived stress index (PSI) gathered 302 college students ranging from freshmen to seniors to test the reliability of the PSI in regards to appropriately addressing particular stressors in student life (Avdija, 2018). The results of the article showed the PSI to be a reliable tool that produces reliable results in repeated testing based on the Cronbach's Alpha level, which tests internal consistency of scales. A range of 0 to 1 measures the internal consistency of a measurable instrument with a score closest to 1 having high internal consistency. The PSI and its subsections scored internal consistency values of 0.08 or above, supporting the PSI as a reliable tool of measurement.

3.4. *Intervention.* The researcher instructed the participants to rate their current overall stress level using a 10-point stress scale (with 10 representing the highest stress level), and to palpate their heart rate (HR) and count their respiratory rate (RR) for 30 seconds each as a baseline of information. The researcher provided a timer for 30 seconds, and had the participants multiply their HR and RR by two after counting to represent a minute of assessment. The participants recorded their findings in the Google Forms.

The researcher then provided a live demonstration of the appropriate sequence for the hand therapy in front of the participants. The researcher firstly applied handheld pressure, or a squeeze, to the thumb for 15 seconds, and, then moved to the index finger, middle finger, ring finger, and pinky finger. It was only one hand that received the therapy.

After the demonstration, the researcher instructed the participants to perform the therapy on himself/herself by placing hand held pressure to each of their own fingers on one hand according to the demonstration. The researcher guided the participants with a timer by prompting participants to advance to the next finger every 15 seconds for every finger on the hand. This procedure took less than two minutes since 15 seconds of handheld pressure was permitted on each finger.

Finally, the researcher instructed the participants to palpate and count their HR and RR for any physiological changes after the hand therapy. The researcher provided a timer for 30 seconds, and had participants multiply their heart rate and respiratory rate by two to represent a minute of assessment. Then, the participants were invited to fill out a questionnaire that inquires about the current stress level after the hand therapy and their personal experiences from the therapy.

*3.5. Data Collection.* The Google Forms acted as a source for collecting recorded participant information from the demographic survey, the modified perceived stress index, and heart rate and respiratory rate readings. The researcher utilized Microsoft Excel spreadsheets to transfer and organize the data.

*3.6. Ethical Considerations.* The University Institutional Review Board (UIRB) at CSU, Stanislaus, approved the research. The UIRB approved the research's modifications that considered the COVID-19 restrictions. The participants were encouraged to ask questions through the private Zoom chat box. The researcher promoted the study as a voluntary opportunity that did not have repercussions for declining to participate. The researcher went over the informed consent with the students.

Table 1. The demographic survey results.

Demographic Data	Percentages
<b>Gender</b>	
Female Gender	84.20%
Male Gender	15.80%
<b>Age</b>	
18 - 29 Years Old	89.50%
30 - 44 Years Old	10.50%
<b>Present College Experience</b>	
Academic Commitments (full time/part time)	100%
Work Responsibilities (full time/part time)	63.20%
Club Memberships	26.30%
Campus Program member	0%
Sports Commitments	0%
<b>Ethnicity</b>	
Hispanic	47.40%
Caucasian	36.80%
Asian/Pacific Islander	10.50%
African American	5.30%
<b>Religion</b>	
Catholicism	36.80%
Christianity	36.80%
No religion	21.10%
Inter/non-denominational	5.30%
Protestantism	0%
Judaism	0%
Islam	0%
Buddhism	0%
Hinduism	0%
Native American	0%
Decline to state religion	5.30%

Table 2. Paired t-test results for statistical significance.

Variables	Mean	Paired t	P - value
Stress Level	-1.2105	-4.652	9.91E-05
RR	-0.8421	-1.7143	0.0518
HR	1.4737	0.6231	0.7295

## 4. Results

*4.1. Participant Information.* Of the 36 students in the nursing course, 21 students accessed the Google Forms link and 19 students elected to participate. The reason for declining participation is

unknown. Table 1 reveals the participant population to be mostly female (84.2%), Hispanic (47.4%), between the ages of 18 – 29 years old (89.5%), a full or part-time student (100%), working full time or part time (63.2%), and Catholic or Christian (36.8%). Table 4 reveals exam preparation (7.79) to be the college stressor that produces the highest stress level among the participants. The course load (7.63) follows as the secondary college stressor that produces high stress levels. The stress of keeping up with required readings (7.37) follows as the tertiary college stressor that produces high stress levels.

4.2. *Data Analysis.* Using a TI-84 calculator, a paired *t*-test was done to calculate the statistical significance (*p*-value) of the differences in HR, RR, and stress level before and after the hand therapy (Table 2). The average differences in HR, RR, and stress level before and after the hand therapy were firstly calculated for the paired *t*-test. An average difference of zero represented the null hypothesis, while an average difference less than zero represented the alternative hypothesis. This alternative hypothesis meant HR, RR, and stress levels decreased after the hand therapy.

4.3. *Data Results.* The hand therapy decreased the average stress level by 1.21 among the participants (Table 5). A paired *t*-test revealed the change in stress level before and after the hand therapy as highly significant ( $p < 0.000$ ). Similarly, the hand therapy decreased the average respiratory rate by 0.85 breaths per minute (Table 6). A paired *t*-test revealed the decrease in respiratory rate as significant as well ( $p = 0.05$ ). The alternative hypothesis is proven by the changes in stress level and respiratory rate; the hand therapy is effective in reducing stress. However, after the hand therapy, the participants experienced an increase in heart rate based on an average increase of 1.47 beats per minute (Table 7). There was no statistical significance found for this change ( $p > 0.05$ ), rejecting the alternative hypothesis. The heart rate trends are analyzed in the discussion section. Regardless of the trends in heart rate, the hand therapy shows effectiveness in reducing stress levels and relaxing the breathing rate.

4.4. *Participant Experiences.* Out of the 19 participants, 16 participants provided descriptions on

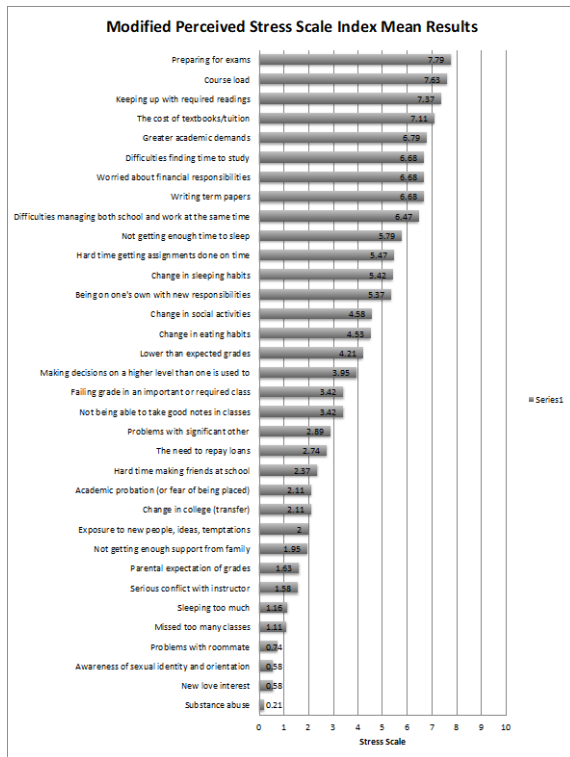
their experience. Three domains were produced to categorize the experiences: *feels relaxing*, *feels odd*, and *needs improvement*. The researcher analyzed all of the participants' descriptive experiences and found these three common characteristics (Table 3).

Table 3. Three common characteristics analyzed from the participants' descriptions of the hand therapy.

Domains	Participant Experience
<i>Feels relaxing</i>	Participant 12: "During this experience, I felt like it was a good way to clear my mind from any stressors. I feel like I will likely try this method in the future."  Participant 7: ""I thought it was a good skill that I would like to try again when I'm feeling stressed during finals...[it] was a good experience."  Participant 9: ""It was a nice method to relieve any stress that I have currently been experiencing. I did not have any negative experiences."
<i>Feels odd</i>	Participant 3: "It felt odd and I did feel a slight decrease in stress."  Participant 4: "It feels a little silly."
<i>Needs Improvement</i>	Participant 15: "No negative experience only improvement is that counting your own respiratory rate can effect how the participant may breathe. We are thinking about it."  Participant 16: "While doing the therapy I felt as though I needed to feel relaxed while applying the pressure on my fingers, so I closed my eyes while doing my therapy and focused on my breathing. I felt as though I was relaxed but after the therapy I still realize my stressors and think of how they are not going anywhere."  Participant 18: "I think the 15 seconds of squeezing my finger was difficult. I will probably implement intermittent squeezing."



Table 4. Average stress level of each college stressor based on a stress scale of one to 10 with 10 being the highest level of stress.



### Significance

Past research articles have focused on alternative therapies such as the effects of body massage, acupuncture, herbal remedies, guided medication, aromatherapy, and even hypnosis as methods for stress relief and relaxation. The effects of touch and pressure on the fingers of the hand have been explored within the limits of alternative therapy called acupressure. By studying the effectiveness of hand and pressure on the fingers of the hand for stress relief, a new coping therapy was investigated.

The introduction of a new therapy for college students that can help manage stress is able to provide more options in stress relief, and promote better health outcomes such as decreased health conditions related to stress and decreased use of negative coping behaviors. While the hand therapy increased heart rates, it produced lowered stress levels and a calmer breathing rate. The results of the study support the effectiveness of acupressure, showing college students may be able to utilize touch and pressure therapy on the fingers of the hand for stress relief.

Table 5. Average stress levels before and after hand therapy.

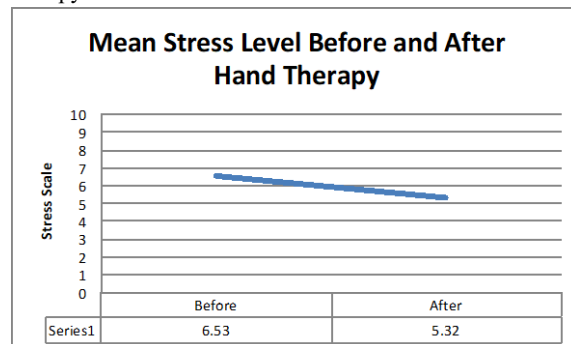


Table 6. Average breathing rate before and after hand therapy.

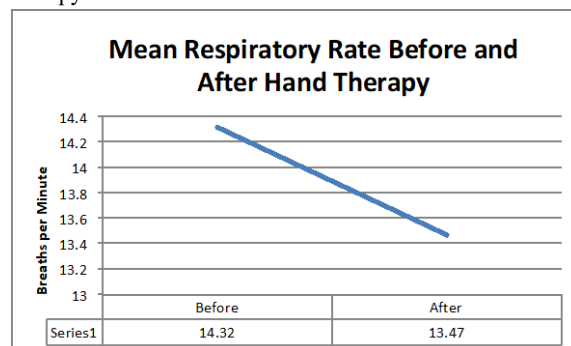
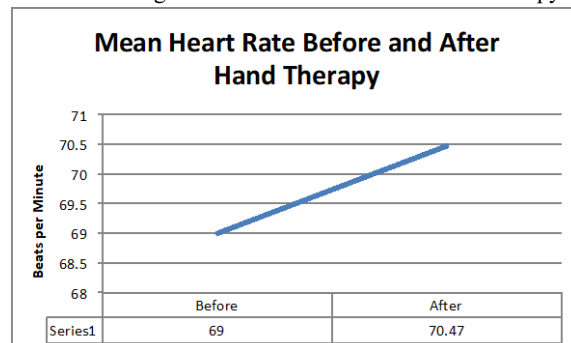


Table 7. Average heart rate before and after hand therapy.



### Discussion

The limitations of the research relate to a small sample size of students from one academic major that cannot be generalizable to a large college population. The sample size would need to include a larger number of students with diverse backgrounds in order to be generalizable to larger college settings. Another limitation includes potential inconsistencies in hand-held pressure in the hand therapy that can produce inaccurate data. The amount of appropriate hand-held pressure for each finger can be studied in

the future. A standardized pressure amount can help avoid inconsistencies.

Pre-COVID-19 research planning included utilizing an automatic wrist blood pressure cuff to obtain blood pressure count, an automatic pulse oximeter to assess heart rate, and nursing training to assess respiration count. An implication for future research is monitoring the effects of the hand therapy on blood pressure. High blood pressure is associated with stress. Another implication for future research is calculating the impact of each stressor in the college environment on the heart rate and respiratory rate. This would promote further investigation on the impact of stress on students. A statistical analysis of the demographic characteristics can be done as well to observe any potential effects on the heart rate and respiratory rate.

The validity and reliability of the study is weakened by the lack of medical equipment such as a calibrated pulse oximeter to monitor heart rate and respiratory. Even though the participants are nursing students with trained assessment skills, human error must be accounted for the heart rate and respiratory count. A calibrated monitoring machine may be able to accurately record physiological responses.

The increase in heart rate could be attributed to a rebound effect as a result of the blood vessels in the fingers experiencing increased pressure. Potentially, pressure that changes the breadth of the blood vessels changes the blood flow and induces a sympathetic nervous system response that increases the heart rate. An increase in heart rate can improve circulation and oxygen delivery to the body's tissues such as the brain, heart, and lungs. The difference between this response and the responses observed in the studies discussed in the literature review that have observed a decrease in heart rate from acupressure therapy is hand-held pressure has not been investigated until now; the studies in the literature review have focused on finger-point pressure on the pressure points on the fingers of the hand. In other words, while the research states pressure points activate the PNS upon receiving pressure and the heart rate decreases, the effects of applying pressure through hand holding has yet been investigated.

Overall, studying the effects of touch and pressure therapy on the fingers of the hand can help students find stress relief and obtain wellness while handling academic, financial, and or work priorities in

the college environment. The study contributes to the field of education in the way it opens up the topic of alternative stress relief for future research.

The sources utilized for the study are reliable for the reason the resources were obtained from the California State University, Stanislaus library database. Likewise, resources were obtained from health-conscious websites that are sponsored by well-known health organizations specializing in human health.

With further research on the effectiveness on the hand therapy, the study may have the potential of impacting a population beyond colleges and universities. This stress relieving method can be introduced to hospitals where costly methods of stress relief such as medication, acupuncture, and massage therapy are done. Applying touch and pressure on the fingers of the hand can replace these costly methods considering it is a cost-effective method that can be utilized by anyone who can be taught it.

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## Appendix A

### California State University, Stanislaus Online Consent to Participate in Research

California State University, Stanislaus  
Mikaela Magwili ([mmagwili@csustan.edu](mailto:mmagwili@csustan.edu))

#### ***Studying the effects of touch and pressure therapy on the fingers of the hand for stress relief***

##### **Purpose of the Research**

The Principal Investigator, Mikaela Magwili, is a student at California State University, Stanislaus conducting research for an honor's thesis in the honors program.

The purpose of this research is to discover the effects of applying momentary handheld touch and pressure to individual fingers of the hand. The hopeful outcome would be a perceived lower stress level in the individual.

##### **Procedures**

Your participation will require approximately 30 minutes and is completed online at your computer.

- Before testing, you will be asked to access a zoom link to participate in the study. The study will be conducted in a group setting. Then, you will be asked to access a Google Forms link to complete a demographic survey that asks about your age, gender, etc., which will take approximately less than 5 minutes to complete.
- After completion, the researcher will ask you to fill out a modified perceived stress scale on the same Google forms link that asks you to rate particular stressors that cause low, moderate, or high stress for you such as the cost of tuition, difficulties managing both school and work, problems with roommate, course load, etc.
- Next, the researcher will ask you to count your own heart rate and respiration for 30 seconds each using palpation.
- The researcher will then demonstrate the proper hand maneuvers to perform for the study, which will involve the dominant hand applying momentary hand held pressure on each finger of the other hand.
- Afterwards, you will be asked to perform the maneuver, which will take less than 2 minutes (15 seconds of hand held pressure would be permitted on each finger of the hand).
- At the end, the researcher will ask you to count your own heart rate using palpation and respiration again for 30 seconds each.
- You will be given an online questionnaire afterward regarding the effects of the procedure and your experience.
- Total time commitment will be 25 – 30 minutes. Participants aged 18 and over may only participate in the study. Participants with any medical conditions that affect their heart rate and or respiratory count may not participate in the study due to the effects on the study's results.

##### **Potential Risks or Discomforts**

*The risks to you for your participation in the study relates to discomfort from having pressure be applied to the wrist and doing the procedure in front of other participants. Another risk to you may relate to reflecting on stress during the questionnaire. If needed, call the Psychological Counseling services on campus with this number (209) – 667 – 3381 for psychological relief from any discomforts. If needed, call the Student Health Center on campus with this number (209) – 667 – 3396 for health-related concerns.*

##### **Potential Benefits of the Research**

*The benefits to you for your participation in the study relates to potentially obtaining spontaneous stress relief from the procedure, and contributing to research for stress relief methods.*

**Confidentiality**

*The information collected by the researcher will be protected from all inappropriate disclosure under the law. All information, including the questionnaire responses, will be kept in a secure location on a password-protected device. Only the researcher, and her faculty sponsor, will have access to the data.*

The researcher **will** keep your research data to use for (future research or other purpose.) We may share your research data with other investigators without asking for your consent again, but it will not contain information that could directly identify you.

**Costs**

There is no cost to you beyond the time and effort required to complete the procedure(s) listed above.

**Compensation**

There will be no compensation for participating in this research.  
There is no anticipated commercial profit related to this research.

**Participation and Withdrawal**

Your participation is voluntary. You may refuse to participate or stop participation at any time without penalty or loss of benefits.

**Questions**

If you have any questions about this research, you may contact me, **Mikaela Magwili**, at **(925) – 984 - 0348** or my faculty sponsor, **Jennifer Peltier** at **+1 (209) – 996 – 4521**.

If you have any questions regarding your rights and participation as a research subject, please contact the IRB Administrator by phone (209) 667-3493 or email [IRBadmin@csustan.edu](mailto:IRBadmin@csustan.edu).

**Consent**

Clicking the "Next" button below indicates that you are 18 years of age or older, and indicates your consent to participate in this survey. Please feel free to print a copy of this consent page to keep for your records.

## **Appendix B**

### Demographic Survey Questions

1. What is your gender?
2. What is your age?
3. Select all that apply to your college experience.
4. What race/ethnicity best describes you?
5. Do you identify with any of the following religions?

## Appendix C

The Modified Perceived Stress Index is a Likert scale of one to 10 that includes college-life related statements for participants to rank based on the level of stress each college-related stressor produces. The number zero is not applicable. The number one is no stress. The number 10 is high stress.

1. Worried about financial responsibilities
2. The cost of textbooks/tuition
3. The need to repay loans
4. Difficulties managing both school and work at the same time
5. Difficulties finding time to study
6. Hard time getting assignments done on time
7. Missed too many classes
8. Not getting enough time to sleep
9. Sleeping too much
10. Change in eating habits
11. Change in sleeping habits
12. Being on one's own with new responsibilities
13. Awareness of sexual identity and orientation
14. New love interest
15. Hard time making friends at school
16. Problems with boyfriend/girlfriend/significant other
17. Change in social activities
18. Making decisions on a higher level than one is used to
19. Substance abuse
20. Exposure to new people, ideas, temptations
21. Problems with roommate
22. Greater academic demands
23. Failing grade in an important or required class
24. Change in college (transfer)
25. Not being able to take good notes in classes
26. Academic probation (or fear of being placed)
27. Serious conflict with instructor
28. Lower than expected grades
29. Course load
30. Preparing for exams
31. Writing term papers
32. Keeping up with required readings
33. I do not get enough support from family
34. My parents' expectations of my grades

# Does Gender Discrimination Still Exist Today?

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## Abstract

Women have battled gender discrimination in the workplace for years. Occupational segregation, pay discrimination, or bias against working mothers, are all battles women have fought in the past within the United States. These three areas of discrimination were the focus of the research in this article. Gender discrimination, for the purpose of this research, is defined as the unfair treatment of women compared to men and the targeting, creating some type of hindrance or injustice in their work or pay, of women in a corporation. Further research on discrimination in the workplace will bring the topic to light and push for policy change. A comparison of peer-reviewed archived data and newspaper articles from January 2000 to April 2020 was done with a table and bar graph depicting the results. The anticipated result is that gender discrimination against women within corporations does exist today based on cognitive and legal evidence uncovered by the articles researched.

*Keywords: gender discrimination corporations, gender discrimination women, gender discrimination men, gender discrimination apple, gender discrimination google, gender discrimination walmart, gender discrimination nike, pay disparity, pay discrimination, occupational segregation, discrimination working mothers*

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## Introduction

With laws put in place to prevent gender discrimination within corporations, many are skeptical of believing whether or not gender discrimination against working mothers, pay disparity, and occupational segregation exist today. Bias against working mothers refers to the issues within a corporation that women face due to specific circumstances such as sick leave, maternity leave, and discrimination in hiring due to being a mother (Glass & Fodor, 2018). Working mothers are viewed as a burden to companies. Women are put in difficult situations in the workplace due to their responsibilities to their children and families. Companies view these responsibilities as a burden as the time taken away from work increases. Pay disparity is the difference in pay between men and women. This is also referred to as pay gap (Watkins, 2018). Women have, statistically, been paid less than men for years and it is unfair. Equal work should be compensated for with equal pay. For most women who work for corporations however, this is not the case. Most companies use pay disparity as a cost saving tactic to help companies financially. Over the years, the difference in pay for men and women has become significant but the tolerance for such inequality has decreased. Occupational segregation is the passing up for promotions and inability to attain a job in a male dominated field simply due to their gender. Such forms of discrimination are common in fields such as

engineering, firefighting, and business (Cohen & Huffman, 2003).

There are many negative effects of gender discrimination not only for women but for their families and on our economy. The issues of gender discrimination are especially significant for single mothers as they are the sole providers for their families. It also effects our economy as women, who contribute to the economy, are unable to contribute as much as men, due to less pay for equal work. When women are passed up for job opportunities to their male counterparts or paid less than male coworkers, this creates a decrease in morale for the corporation. This also creates more stress for women as they are constantly working harder than men to achieve what men can easily attain. Due to the skepticism over whether or not gender discrimination is an issue women face in corporations today, research in this field will help the public identify whether or not this an issue. In the next section, a detailed explanation of the types of discrimination women have faced in certain well-known corporation is studied followed by the results of the study and a discussion of the impacts of such research on the public in the United States.

## Literature Review

### *Pay Disparity: Why should it be eliminated?*

Pay discrimination plays a large role in the out casting of women by large corporations. Women are paid less than their male coworkers for completing the

same job with the same number of hours. There is no reasoning behind why this still exists, however, it is a problem that must be dealt with. Women should receive the same pay as do men, for completing the same jobs. Pay raises, management positions, and simply getting hired by a company should not depend on your gender but rather your qualifications (Watkins, 2018).

Gender pay gap is the sum of women's total earnings divided by men's total earnings. The resulting number is a percentage which shows the difference between what women earn versus what men earn. The number is usually quite significant which proves that women are indeed discriminated against due to their gender. While men complete the same tasks asked of women in their professions, they are paid significantly more than women. The reasoning behind this divide is unknown, however, there are many factors that could possibly play a part in why this still occurs (Watkins, 2018).

The Equal Pay Act of 1963, made it illegal for businesses to discriminate against gender. Men and women were paid equal pay for equal work. (Watkins, 2018) This doctrine was passed in order to eliminate the discrimination women faced in the workforce. This Act left many to believe that pay discrimination against women will no longer exist, however, it continues to be an issue today. In that time period, men were paid more than women for completing the exact same job. The doctrine also includes that no discrimination can be placed based on an employee's previous salary, meaning an individual cannot pay employees according to their previous job salaries. As a method to cheat the system, many businesses turned to viewing women's previous salaries of previous jobs. Due to a history of low earnings for women, this was another way for businesses to discriminate against women. Banning such an idea was a step in the right direction, as it would cut any form of discrimination out for women's equal pay rights (Watkins, 2018).

Women often find themselves in a Catch-22 when it comes to, Salary History Inquiries, on their job applications. Salary History Inquiries, are either required or optional forms to fill out in job applications, which asks for an individual's previous job salary (Watkins, 2018). Although the form is optional in some businesses, women noticed if they chose not to fill out the form, they earned less than everyone in the company, and women who did fill them out earned less than men. Either way, the situation is tough for women who must choose between trying to break the system by not allowing employers the chance to see their previous salaries and making the bare minimum, or settle for pay that is less than their male coworkers (Watkins, 2018).

## **Occupational Segregation for Women in United States**

There are many jobs in large corporations, where men receive more job offers than women. The pay variation in those specific jobs is significant as well. There are many factors that contribute to the gender pay gap including local labor markets, national standards, and demographic composition.

"Beggs (1995) posits that the level of support for equality of opportunity in firms' local institutional environment influences the degree of racial and gender inequality" (Cohen & Huffman, 2003). Slight changes in local labor markets contribute to gender discrimination, as it creates a burden of pressure for those at a higher level in corporate businesses. When situations such as this occur, businesses tend to cut costs and revert back to ideological methods. Through a study conducted by the National Organization, during specifically significant changes in the Local Labor Market, the data showed a close link between gender segregation and earning inequality (Cohen & Huffman, 2003). Specifically, "Our results support the hypothesis that higher levels of occupational segregation at the labor market level are associated with a strongly increased tendency for gender-based devaluation of women's work roles" (Cohen & Huffman, 2003). This shows that the stereotype of, no room for all women in the labor force, is indeed true (Cohen & Huffman, 2003).

In certain professions, women are especially targeted and underrepresented. "Occupational segregation, the historical concentration of women in a few occupations, including domestic work, clerical/secretarial work, sales, teaching, and nursing, has been described as "a crucial barrier to the attainment of economic equality for women" (Grube-Farrell, 2002). These job positions were commonly joined by women when starting in the workforce. As time went on, however, women progressed to finding positions in white collar jobs such as; attorneys, physicians, pharmacists. In specific blue-collar jobs, women were struggling to find jobs in certain fields such as; construction, mechanics, and firefighting. Due to this issue, more jobs were available to both men and women breaking the typical gender roles in those job types (Grube-Farrell, 2002).

"Continued segregation, however, has been linked with occupational niching/stereotypes, gender role socialization, and self-selection (women's need to balance work and family and concerns about their lack of knowledge and skills and about problems such as harassment); men's reactions to competition and in-group preference; employers' bias; and inequality in work organizations" (Grube-Farrell, 2002). While men felt intimidated or skeptical of their female coworkers, women were dominating their roles in such positions

proving their strength and courageousness (Grube-Farrell, 2002).

While introducing changes legally for equal opportunities for men and women in such positions, men would create limitations to “women bureaus”, which only let women complete certain “easy” tasks (Grube-Farrell, 2002). With policy changes, these limitations decreased and women were allowed to choose any job type they wanted (Grube-Farrell, 2002).

### **Bias Against Working Mothers**

Working women, specifically working mothers and recently married women, face discrimination in the workplace. Women are allowed to take maternity leave for the end of their pregnancy to the first two months with their baby. They are also allowed additional baby bonding time which is used for mothers to be able to bond with their babies (Glass & Fodor, 2018).

The issue with working mothers and recently married women is that, the training cost as well as the cost for paid leaves, is too much to hire them. The short amount of time women is given in the United States for maternity leave is significantly shorter than leave time in other countries. “To successfully navigate such jobs in the U.S. context, mothers must engage in *extensive mothering* whereby they outsource the day-to-day care of children to devote themselves fully to paid work” (Glass & Fodor, 2018). Due to the fear of losing their jobs over caring for their children as well as paid leave, women hire extra care for their children so they can focus strictly on work and earn a living for themselves and their children (Glass & Fodor, 2018). Some argue that men deal with the same issues when taking time off to balance their work life and raising their children. “Fathers mention fear of this resistance and negative career consequences as the main reason for not wanting to (or deciding not to vocalize their desire to) work fewer hours” (Vinkenburg, et al., 2012). Working fathers feel the same type of discrimination as do women therefore, the bias against working mothers is no more than that of working fathers. This argument is not fitting as women are discriminated against not only for leave, but in many other aspects as well.

### **Methods**

For this research, I conducted case studies of four large well-known corporations using newspaper articles from reputable sources located through the ProQuest data base. I also used articles from trusted business magazine websites. The two used were Forbes magazine and Bloomberg. The articles used are “Walmart gender discrimination case will proceed, Women against wal-mart, Former Nike executives sue over discrimination, sexual harassment, Judge rejects apple's attempt to throw out gender, age discrimination, &

whistleblower lawsuit by former female employee, and Google LLC: Battling gender discrimination allegations, Google Finds Gender Bias Against Men -- Really?, Nike Women Clear First Hurdle in Lawsuit Over Gender Pay Gap”. I compared the data to one another and detailed the forms of discrimination the women faced within the corporation. With this data we get a clear depiction of whether or not gender discrimination against women still exists today. The forms of discrimination which occurred were bias against working mothers, being passed up for jobs opportunities, denied pay raises, pay discrimination, and occupational segregation. Denied pay raises, passed up for promotions, and pay disparity all fall under the category of pay disparity when referring to the three main forms of discrimination being studied.

### **Design**

In the experiments, the individuals and their gender discrimination situation will come from the articles. The two limitations placed on article collection were location of discrimination and time frame. The location was specific to the United States between January 2000 and April 2020. Participants from the newspaper articles will have faced some form of discrimination within the corporation whether it be pay disparity, bias against working mothers, or occupational segregation.

There are specific guidelines which must be met when deciding which research to look into and use for the purpose of this research. Research which includes the United States as a prime location, explains the bias of either working mothers, recently married women, occupational segregation, or pay discrimination is permissible. Anything that does not include such data will not be viable for this research. The articles that were allowed to be researched were peer-reviewed or newspaper articles. All methods and participants in the articles were already completed and I simply compared the research to decide whether there was enough evidence to prove that gender bias is still existent. The keywords used to search for articles were gender discrimination, gender bias, pay disparity, pay discrimination, occupational segregation, gender bias America, gender bias United States, gender discrimination in corporations, and bias against working mothers.

### **Results**

Gender discrimination against women has been a topic of study for many years. Even after laws have been enacted to prevent the discrimination in corporations, however twenty years later women still face the same issues. These instances of discrimination require greater research to determine the types of discrimination women in corporations face today. In



this paper, I studied four large companies, Apple, Google, Nike, and Walmart to compare the forms of discrimination for which women have reported against the corporations. These situations may give us a better understanding of the issue and where policy change, to benefit the women in these situations, can be beneficial.

### **United States Gender Pay Gap**

The Equal Pay Act of 1963, made it illegal for businesses to discriminate against gender. Men and women were to be paid equally according to this Act (Watkins, 2018). This doctrine was passed in order to eliminate the discrimination women faced in the workforce. According to the US Census Bureau, in 2017, for every dollar a male earned, women were earning 79 cents. This shows that women all around the United States continue to battle issues of gender discrimination. Women who have children show a 3% decrease in earnings compared to women without children whereas men with children show a 15% increase in pay (Sheth & Gould, 2017). The study also shows that women with no children earn more than women with children but men with no children earn more than women with no children. Men with children however, earn more than men with no children and women in general (Sheth & Gould, 2017). The bias against working mothers is prominent today according to this article within the United States. Altogether, women earn \$641 million where men earned \$965 million (Sheth & Gould, 2017). This is a \$324 million difference in pay. Social security shows men receive \$286 million where women earn \$277 million (Sheth & Gould, 2017). The difference, even in social security income shows that women overall have consistently been paid less.

### **Walmart: Is the Retail Giant Known for their Discrimination?**

Starting in 2001, a group of women filed a lawsuit against Walmart, a retail giant, with claims of gender discrimination. These women were denied pay raises and promotions simply based on their gender. The first lawsuit was resolved in favor of Walmart due to an issue of differentiation in evidence and gender discrimination type across the national stores. The women decided to file again, but this time, only for California based stores. A panel of three judges assembled to deliberate on whether the case could move forward and decided it could (Post, 2012). Walmart would like to appeal the decision however, evidence points to discrimination against women within the corporation existing. About 1.6 million female employees have faced pay and promotion denials simply based on their gender (Wedekind & Himmelstein, 2007). This is what led to the 2011 lawsuit against them (Post, 2012). Pay disparity and

occupational segregation seemed to be an ongoing issue with multiple women all throughout the United States moving forward to tell their story and sue the company for their unfair treatment.

### **Apple: Occupational Segregation within the Tech Giant**

One field where occupational segregation is especially prevalent is technology. Women face discrimination in this line of work for multiple reasons. Age and gender are the main factors for which women are discriminated against. One instance of a corporation that has been faced with an issue of occupational segregation is Apple (Shegerian & associates, 2018). In 2016, a case was filed against the tech giant for wrongful termination and gender discrimination due to her age and gender. A judge in California ruled in favor of Levitan on the basis of substantial evidence for the case to move forward (Shegerian & associates, 2018). Levitan claimed that the corporation wrongfully terminated her by creating a hostile work environment. Her performance and impact within the company both prove that her termination had nothing to do with her quality of work, as Apple has repeatedly stated as the reason for termination (Shegerian & associates, 2018).

### **Google: Is there a search engine for Discrimination?**

In 2017, Google was sued with a class action lawsuit, by three female former employees, claiming the corporation discriminated against them by not giving women who work for the corporation equal opportunities to gain higher positions and also unequal pay for same work. The lawsuit was specific to California and raised concerns for the public as they were a corporation known to be fair to their employees. The U.S. Department of Labor sued Google after they discovered discrepancies between pay for males and females in 2017 (Gupta & Bisht, 2020). For Google as a corporation, this proves that gender discrimination, in the forms of pay disparity and occupational segregation, exist even today. Although the case is still open and Google has not been accused of the crimes, the evidence collected by the U.S. Department of Labor is enough to prove that pay disparity is a prominent issue within the corporation. Women are being unfairly treated for the same work (Gupta & Bisht, 2020). A recent 2019 Google pay equity study uncovered that men are actually payed less than women in the corporation. The study claimed the one area where women earned significantly more than men was a Level 4 Software Engineer (Elesser, 2019). However the study was discredited as it did not "capture the true state of gender bias at Google" (Elesser, 2019).

## **Nike: Company Mission Pushed Aside for Discrimination**

Nike, a business that prides itself on equality for all, diversity, and fitness at all levels has been under fire for discriminating against female employees on multiple levels. Women in the corporation have reportedly faced pay discrimination against male counterparts and were passed up for promotions (Garcia, 2018). Two former Nike employees filed a class action lawsuit against Nike due to pay discrimination they faced in the work place. They only expect the number of women to sue to increase by 500 (Blumberg, 2019). Allegedly, the women filed a lawsuit in August of 2018 due to prior salary discrimination. Prior Salary discrimination is the act of taking an employee's past occupation pay and setting it as the starting salary for the new job. According to the Equal Pay Act, it is illegal to determine pay based on employee's previous pay (Dorrian, 2018). With large corporations such as Nike discriminating against women through systematic pay discriminations, such as, "pushing women into jobs and assignments that similarly hurt their chances to get ahead and earn more", the battle of pay discrimination becomes very serious (Dorrian, 2018). Forced ranking systems only allow certain individuals in a company to succeed (Dorrian, 2018).

According to these articles, discrimination against women does indeed exist today. As stated in the articles above, in each gender discrimination case filed by women within the corporations, judges found there was enough evidence to push the cases forward. The severity of the issue especially high in Walmart where over 1.6 million women have dealt with the discrimination in pay disparity and occupational segregation. Apple has also discriminated against women specifically through occupational segregation. Google has discriminated against women specifically through pay disparity and occupational segregation. Google also conducted a study in which they found the corporation was in fact discriminating against men rather than women. This was later proven to be false as the numbers were not accurate.

Nike has systematically discriminated against women through pay disparity and occupational segregation. Overall, in the United States women are discriminated against and paid less than men by \$324 million.

## **Discussion**

Bringing to light the injustices which prevent gender equality is necessary for our society today. Gender discrimination is unfair to women and in an evolving world, such as the one we live in today, it should no longer be an issue women are forced to deal with. Women can do anything and everything men can

do and more. With research in such a topic, we can bring awareness to gender bias issues and demand strict action be taken against corporations which prevent women from reaching success simply due to gender. Awareness on the topic of occupational segregation, pay discrimination, and bias against working mothers is crucial for the United States economy to succeed as well.

The legal aspects of gender discrimination also need more research as there is not enough on the topic which can help women in filing legal cases against the corporations which do not allow them to flourish to their full potential. Consequences for committing these crimes must also be harsh so that they are held accountable for their actions. The laws have loopholes which are used by defense attorneys to silence the women speaking out against these corporations. Therefore, researching this topic can help bring awareness and demand law changes be made to prevent issues like this in the future.

Overall, women deserve equality. Research on this topic will help women land jobs in male dominated work forces, merge the gender pay gap so that women and men are paid the same for doing the same job, and working mothers have better benefits and are not seen as a burden for corporations. The time to change our societal issue of gender discrimination is now. Action must be taken. With this research, the goal is to push law makers, the general public, and corporations to advocate for change and help in the fight against gender bias. This would bring equality to men and women and allow women to flourish in the work force as they deserve.

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# The Effects of Opioid Analgesics on Physical Therapy Effectiveness

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## Abstract

Within the last decade, the Center for Disease Control (CDC) have recorded epidemic levels of prescription opioid use. The increased consumption of these analgesics is leading to several related health issues that have a negative impact on the patient's overall health. In many cases, physical therapy and opioid pain management are used in conjunction with one another to relieve pain. The premise of this study is to shed light on whether opioid use affects physical therapy effectiveness. There are different aspects to physical therapy efficacy, and these could be differentially influenced by opioid use. Opioid-induced hyperalgesia could enhance perception of pain and interfere with pain alleviation during course of treatment. Whereas other, non-nociception-related standards of effectiveness may not be different between the two groups as physical therapy is primarily targeting the musculoskeletal system. The two sample groups consisted of patients that were using opioid analgesics and those who were not, while being treated with physical therapy. The data was collected retrospectively from patients with lower back pain indication. Several therapy tests were analyzed to statistically verify any difference between outcomes and effectiveness between similar patients. The test results taken from patient evaluations were active range of motion (AROM), verbal pain rating, lower extremity (LE) strength, functional outcomes, and therapy goal achievement. The data resulted in significant differences in pain mitigation and achievement of therapy goals which resulted in a rejection of the null hypothesis. However, differences with non-nociceptive related aspects of physical therapy such as AROM and LE strength were not significantly different. This data suggests there are indication of nociception related issues of patients who utilize opioids during physical therapy and could pose a contraindication for opioids in some therapy patients.

*Keywords:* opioid, analgesic, physical therapy, opioid-induced hyperalgesia

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## Introduction

Opioid analgesic use to relieve chronic and acute pain is on the rise in the United States and has led to a rise in secondary conditions such as aggravation of affected areas, addiction, and other physiological/psychological abnormalities (Gladkowski et al. 2014). For some, long term opioid use can result in a condition known as opioid induced hyperalgesia (OIH), whereby the patient experiences a hypersensitivity to painful stimuli (Lee et al. 2011). Physical therapy, in many cases, is also prescribed to treat chronic and acute pain. In many instances, the two are prescribed in conjunction with one another (Thackeray et al. 2017). Which brings us to the question; do opioids interfere or benefit the patient when used in conjunction with physical therapy?

Analgesics are defined as a group or class of drugs that relieve pain by targeting the central and peripheral nervous systems. Analgesics do not completely eliminate sensations or motor control like anesthetics, rather, they dull the feeling of pain by blocking pain receptors (Grady et al 2011). Some of the most common forms of prescribed medications during

therapy are opioids, steroids, muscle relaxants, and anti-inflammatory drugs. Opiate based drugs, or opioids are derived from opium poppies and are highly effective for relieving pain. The most common drug names associated with opioids are morphine, codeine, oxycodone, and hydrocodone (Grady et al 2011). These drugs influence the cerebral serotonin and norepinephrine receptors in the brain and can be highly addictive with long term use and because of this they have contributed to a medical epidemic in the United States (Grady et al 2011). Every year millions of Americans use opioids to manage chronic pain but may not be fixing the root problems leading to chronic use and addiction. There were 214 million prescriptions for opioids in 2016 and more than 11 million people abusing opioids (Scholl et al 2018).

Physical therapy is an alternative treatment method to analgesic pain management. Physical therapy treatments involve biomechanics, kinesiology, manual therapy, exercise therapy, and a variety of modalities (Crossley et al 2002). These strategies help to remediate impairments and promote mobility and function (Hoving et al 2002). The process for a patient

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to receive physical therapy starts with their primary care or orthopedic care physician who will prescribe physical therapy to a patient that is experiencing a loss in mobility or is experiencing musculoskeletal pain (Thackeray et al. 2017). The physical therapist diagnoses the patient's condition and develops a plan to reduce pain and increase mobility of the affected areas which usually involves therapeutic exercise and manual mobilization (Hoving et al 2002). This treatment cycle would continue for 2 to 3 times a week for however many weeks the therapists prescribes. Their progress is measured and compared to their initial results by using standardized questionnaires and measuring techniques for the specific area affected. In this study we will examine the active range of motion (AROM), verbal pain rating, functional outcomes, lower extremity strength (LE strength), and therapy goal achievement to determine if therapy effectiveness was influenced by opioid analgesics.

For this study, lumbar pain was the indication used for the criteria of patient selection and assessment. The lumbar AROM is measured in degrees or mobility for flexion, extension, and lateral bending. Lower extremity (LE) strength was measured using a one through five-point system according to the medical research council criteria. LE strength test is pertinent to lumbar pain and is analyzed as a control for lumbar and pelvic instability (Sousa et al. 2019). Functional outcomes are assessed using the Oswestry disability index questionnaire. These scores are reflective of the patient's percent of disability to perform tasks for daily living. Pain is measured by a verbal pain scale ranging from 1-10 and is reflective of the patient's current and most intense bouts of pain. Physical therapy goals are reasonable progress checkpoints that the patient and therapist agree upon during the initial evaluation. At the end evaluation, the therapist will decide whether it is appropriate to continue therapy or seek other avenues of pain mitigation and restoration of mobility per the patient's pre-established goals.

Though opioid analgesics and physical therapy are used separately and in conjunction with one another, the problem lies with the fact that opioids have the ability to influence the quality of treatment, healing progression, and pain management that is inherent with physical therapy treatments (Gładkowski et al. 2014). Opioids can distort the sensation of pain through OIH and the pain tolerance of the patient can be skewed during evaluations for physical therapy treatment (Lanier et al 2009). There is also speculation that the opioid analgesics could give false mobility and range of motion measurements due to the skewed pain tolerance as well (Lee et al. 2011). After collecting data that quantitatively measures the progression of patients on opioids and those without, we can compare the results

to conclude if there is a difference in physical therapy outcomes.

## Methods

Prior approval of this study was needed to access and collect patient medical records. The CSU Stanislaus Institutional Research Board approved the execution of this study per the given testing parameters and HIPAA compliance procedures (approval# 1920-071). This experiment was carried out on Microsoft Excel. Excel was used to chart data, and an authorized computer was used to collect patient information on a medical record keeping program called 'Clinicient' from the Central Valley Physical Therapy (Stockton CA) medical records database. No patient contact was necessary for this experiment. All data collection was retrospective from dates ranging from 2014 to 2019. After data collection was complete, statistical analyses was used to compare and derive results.

Patients will be allocated to the different conditions set forth by the variables: opioid and non-opioid user for the mitigation of lumbar pain. The data collected attempted to show a correlation between opioid use during physical therapy and their measured progress after treatment. The null-hypothesis states; there is no difference between physical therapy treatment effectiveness/progress in patients who use opioids for pain and physical therapy patients who do not.

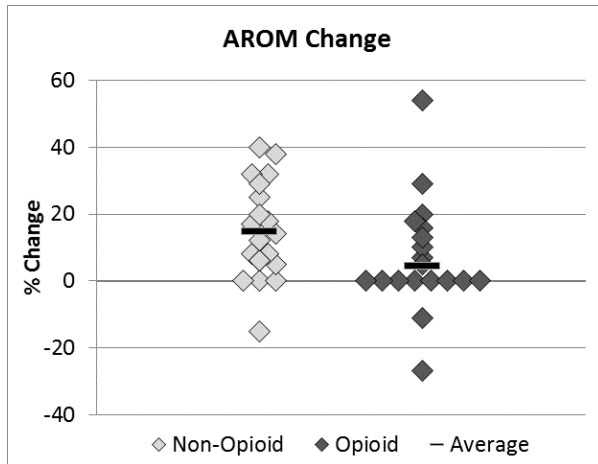
The sample size for this experiment consisted of 40 patient records, 20 allocated to each group that fit the following criteria: All patients must have a lumbar pain related diagnosed condition and have been prescribed a treatment plan. The control group will consist of non-opioid users and the experimental group will consist of opioid users during PT treatment. This variable is classified as a patient that is prescribed a daily regimen of at least one opioid analgesic.

Effectiveness and progress are defined as the amount of progress the patient has made regarding AROM, LE strength, functional outcomes, verbal pain scores, and PT goal achievement. The improvement of these scores from their initial baseline evaluation encompasses the meaning for "progress and effectiveness" and was evaluated in absolute units and percent difference.

## Results

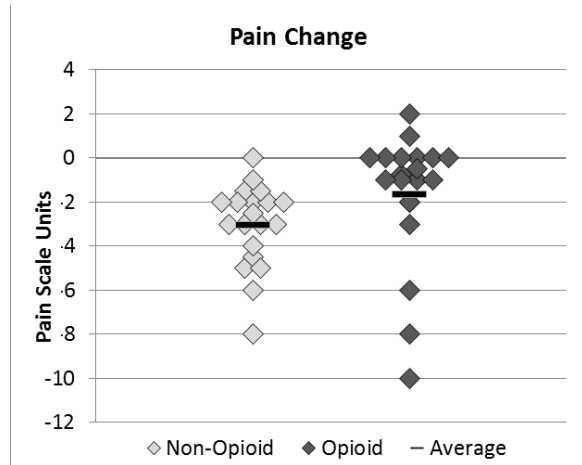
The data for this study was collected for the two groups of twenty patients and consisted of AROM, verbal pain score, LE strength, functional outcomes, and PT goal achievement. Secondary demographic data was collected for this study as well, this included sex, age, health insurance type, and opioid type. AROM results for the non-opioid group were at a 14.75% change on average versus the opioid group that had a 4.35%

positive change on average, see Figure 1. The distribution of the percent change for the control group is more typical with fewer outliers than the opioid group. AROM percent change showed no statistical difference ( $p > 0.05$ ). However, the percent change averages were quite different with 14.75% for non-opioid and 4.35% for opioid patients.



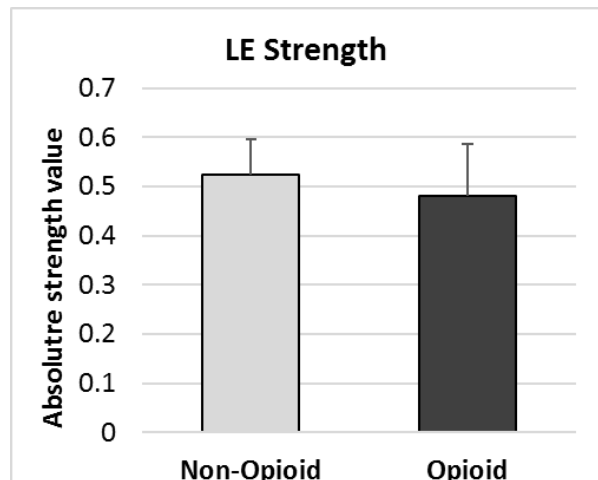
**Figure 1:** The figure above represents the active range of motion (AROM) percent change for the lumbar spine of both the non-opioid and opioid group ( $p > 0.05$ ).

The verbal pain scale absolute change values were calculated by taking the difference of the end of treatment evaluation and the initial evaluation, see Figure 2. The average initial pain score for the non-opioid group was 6.725. The opioid group had an average initial pain score of 8.663. The non-opioid group had an average change of -3.05. The opioid group showed a -1.7 average change with a change median of -0.875. The overall decrease in pain score for the non-opioid group was 95% and 60% for the opioid group. Initial pain was shown to be statistically significant ( $p < 0.001$  \*\*\*). Patients in the non-opioid group had a significantly lower initial pain than the opioid group which could be consistent with opioid induced hyperalgesia. The overall decrease in pain was statistically significant ( $p < 0.01$  \*\*). However, change in pain was not statistically significant ( $p > 0.05$ ). This indicates that the non-opioid group had a significantly higher number of patients who experienced decreases in overall pain after treatment versus opioid patients. Ultimately, physical therapy is meant to decrease the pain in patients, and this supports the effectiveness of therapy without the use of opioids. This assumption is based on the 95% of non-opioid patients experiencing a decrease in pain at the end of treatment versus 60% in opioid patients ( $p < 0.01$  \*\*), see Table 1.



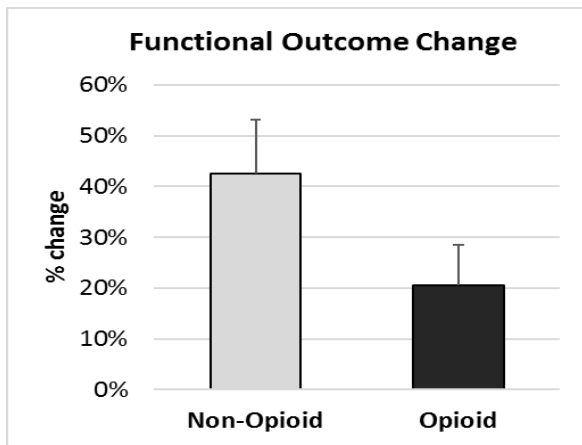
**Figure 2:** The figure above represents the verbal pain scale rating absolute change from the initial and ending treatment evaluations of both opioid and non-opioid group ( $p > 0.05$ ).

Lower extremity strength data was collected for initial and end treatment evaluations for both groups. The scale was 1 to 5 with 5 representing normal to above normal strength. The absolute positive change average was 0.524 for non-opioid group and 0.467 for opioid group, see Figure 3. The standard error of the mean was 0.0731 for the non-opioid group and 0.105 for the opioid group. Overall, LE strength change was not statistically significant ( $p > 0.05$ ). This was a surprising result because it was one of the only tests that seemed to have little variation between the non-opioid and opioid group. As LE strength is a known indicator for pelvic and lumbar instability, the results show very little difference in that regard between groups.

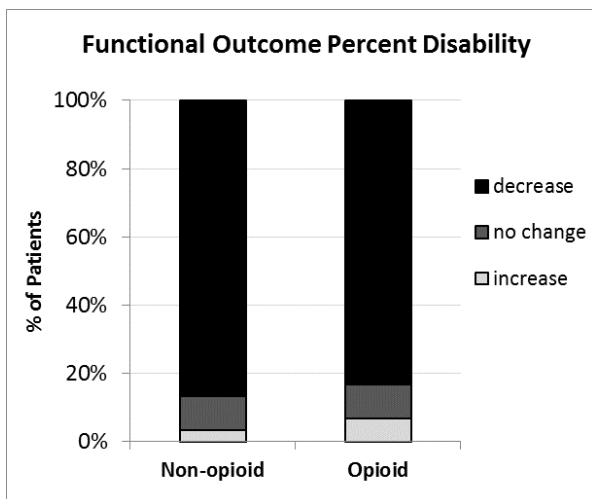


**Figure 3:** The figure above represents the lower extremity strength average change in absolute units from 1-5 along with error bars representing the standard error of the mean of both opioid and non-opioid groups, respectively ( $p > 0.05$ ).

The functional outcome data was analyzed by taking the difference of the final and initial functional outcomes and deriving percent change, see Figure 4. The positive percent change signifies the decrease in disability. The functional outcome percent change average for the non-opioid group was 43% and 21% for the opioid group. The standard error of the mean for the opioid group was 8% and 11% for the non-opioid group. These results were not regarded as significant ( $p > 0.05$ ). The overall decrease in disability percent shown in Figure 5 displays a nominal difference between the groups regarding decrease, no change, and increase in percent disability at the end of treatment.



**Figure 4:** The figure above represents the positive change in functional outcomes of percent disability. The standard error of the mean is represented by the error bars ( $p > 0.05$ ).



**Figure 5:** Functional outcome represents percent of disability using the Oswerty lower back pain questionnaire. This graph displays the percent of patients from each group that experienced a decrease, no change, and increase in percent disability at the end

of their treatment versus their initial evaluation ( $p > 0.05$ ).

The non-opioid group demonstrated a 65% goal achievement and 35% continued treatment recommendation after their prescribed therapy was concluded, see Table 1. The opioid group demonstrated only 20% goal achievement and 80% continued treatment recommendation. These results are statistically significant ( $p < 0.01$  \*\*). This result is an indication that the opioid group showed a higher occurrence of not meeting end treatment goals that were established at the beginning of treatment. This is due to a failure to successfully reach the benchmarks of each test in a way that renders the patient able to perform tasks of daily living with proper mobility and with the absence of pain after physical therapy treatment has concluded.

This data indicates that there is a difference between opioid and non-opioid patients in terms of initial pain, decrease in pain at end of treatment, and therapy goal achievement. Opioid patient group data for these tests are interpreted as being negative for the use of opioids during treatment but had little effect on other musculoskeletal tests.

## Discussion

Some measurements we examined showed a statistically significant difference between the non-opioid group and the opioid group of patients. However, some objective musculoskeletal tests proved to not be significantly different. AROM percent change showed a p-value slight above significant, but the percent change averages were quite different with 14.75% for non-opioid and 4.35% for opioid patients. The p-value could be skewed by using percent change instead of absolute value due to unequal testing parameters taken at the time of patient evaluation. Some patients were missing one or more measurements, for example, some patients only had extension and flexion while others had all four. This made it difficult to compare patient data to one another in absolute terms and we had to use percent change in order to compare the results. No significant correlations were found between age versus AROM and initial pain versus AROM and there was no correlation between change in pain values and AROM.

The LE strength data was found to not have any statistically significant difference between the two groups. This could be due to LE strength not having a significant impact on lumbar pain. Perhaps the patients that were chosen all had stable conditions regarding stability of the lumbar and pelvic regions. This could also have attributed to the reason for AROM not being significantly different between the groups as well. It could be assumed that certain musculoskeletal functions such as range of motion and LE strength are not affected by opioid use to cause a significant difference in percent

change. A similar result was found in the function outcome test which resulted in a p-value of almost double 0.05. Percent change of disability for the non-opioid group was 43% versus 21% for the opioid group which may seem significant, but due to the broader range of the non-opioid group, it resulted in a higher standard deviation which may have affected the p-value for this test. Much like the AROM test, it was difficult to compare results of the patients due to the starting baseline values being different from one another. The percent change for some patients were artificially higher than others due their range of percent disability. Therefore, it was more appropriate to analyze the data by assigning the percent disability to syntax that denoted increase, decrease, and no change.

One of the most significant pieces of data for opioid group differences was the initial verbal pain score given at the beginning treatment evaluation. There was a statistically significant difference regarding the initial pain ratings between the groups ( $p < 0.001^{***}$ ). Patients in the non-opioid group had a significantly lower initial pain rating than the opioid group which could be consistent with opioid induced hyperalgesia. The opioid group also did not experience as much pain mitigation at the conclusion of their therapy treatment. These results indicate the possibility for hypersensitivity for pain or could mean that opioid use is ineffective at managing their pain. Moreover, the non-opioid group data indicated a higher percent of pain mitigation at the end of treatment. Non-opioid patients also showed a higher percentage of goal achievement. Ultimately, physical therapy is meant to decrease the pain in patients and increase mobility for therapy goal achievement. This notion supports the effectiveness of therapy without the use of opioids. For many, failure to

achieve physical therapy goals typically results in continued therapy or may result in continued opioid use.

Due to the results of the study the data suggests that we reject the null hypothesis. Therefore, we recognize there is a significant difference in physical therapy outcomes and effectiveness between opioid using patients and non-opioid using patients. This claim is based on the result for pain improvement and therapy goal achievement.

A possible skewing of results may be related to patient compliance of home exercise programs. This study assumes that all patients had equal participation in home exercise programs and therefore would have similar results in improvement. Another unaccounted-for variable is the dosing and duration of opioid consumption since this could skew the degree at which OIH can skew pain results. There are many variables that are involved with this type of research and not all can be controlled, these include prior conditions, variability in therapy strategy, prior physical fitness of patient, etc. In the future if this study were replicated, I would use a larger sample size and control more variables such as dosages and duration of opioid use. I would make sure all testing parameters were accounted for so that all measurements can be compared using absolute values instead of percent change.

This research will be useful to patients that are seeking a treatment plan for their condition and enlighten care providers to the effects of opioid analgesics on therapy effectiveness. Ultimately, because of the small sample size and range of participants the results will not apply to all cases. Instead, it will be used to inform those affected by pain causing conditions and create awareness. Moreover, this study will serve as a pilot study for more in-depth research due to the results of the study.

**Table 1:** The table below presents the statistically significant data for initial pain mean, decrease in pain, and physical therapy goal achievement. The non-opioid group displayed a positive significant difference in all categories.

	Non-Opioid	Opioid	Significance
<b>Initial Pain Mean (Pain scale units)</b>	6.725	8.663	( $p < 0.001$ ) ***
<b>Decrease in Pain (% of patients)</b>	95	60	( $p < 0.01$ ) **
<b>PT Goal Achievement (% of patients)</b>	65	20	( $p < 0.01$ ) **



## Acknowledgements

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# The Correlation Between Complex Childhood Trauma and Adult Empathy Outcomes

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## Abstract

Researchers Decety and Jackson define three key components of empathy: a correct response to emotions and a sharing of one's emotional state; an ability to cognitively understand the other person's point of view; and an ability to self-regulate and avoid mixing up one's own feelings with another's. Furthermore, they define Complex Childhood Trauma (CCT) as ranging from ongoing severe abuse, to moderate episodes of abuse in childhood (2013). According to the U.S. Department of Health and Human Services (Child Welfare Information Gateway, 2015), close to 686,000 children were victims of CCT in the year 2012. Psychologists have started to analyze the outcome patterns of adults who suffered from CCT in crucial developmental years. Studies have been conducted on a possible correlation between empathy and Complex Childhood Trauma. However, these studies are few and far between and offer conflicting results. Obtaining 248 California State University, Stanislaus student participants, the present study utilized two surveys to understand if a correlation between CCT and adult empathy outcomes exists. The researcher hypothesized that individuals who endured greater levels of abuse in prime developmental years would report lower levels of empathy in adulthood. However, evidence suggested that adults who scored lower in different subsets of CCT generally reported higher levels of empathy. Based on this conclusion, a discussion on the implications on why the hypothesis was not supported follows.

*Keywords:* complex childhood trauma, empathy, correlation

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## Introduction

Empathy is a shared experience; it is the extending of emotions from one person to another. But what exactly is empathy? Is it biological, environmental, or maybe it is all subjective? According to Decety and Jackson, empathy can be defined as the capacity to understand and respond to the affective experiences of another individual (Decety & Jackson, 2013). Research into empathy is becoming more and more focused and extensive in disciplines such as social and forensic psychology as we attempt to understand the minds of those who have low levels of empathy.

Decety and Jackson (2013) outline three important components of empathy: a correct response to emotions and a sharing of one's emotional state; an ability to cognitively understand the other person's point of view; and an ability to self-regulate and avoid mixing up one's own feelings with another's. Studies on empathy have contributed greatly to the field of forensic psychology and work with incarcerated individuals. Forensic psychology is a field that stands at the intersection between science and the Law, and forensic psychologists contribute to the justice system by being

expert witnesses in court and studying behavior and brain anatomy of offenders.

In one study, thirty-three participants with varying levels of psychopathic traits were analyzed under fMRI while they viewed photographs that should cause them to have an empathetic reaction. However, results indicated that psychopathy was correlated with reduced activity in the right amygdala during some of these photographs. This means that, along with environmental factors, brain anatomy may be associated with a lack of empathy (Marsh & Cardinale, 2014).

There exists a gray area between empathy and something called Complex Childhood Trauma (CCT). CCT is defined as, "the dual problem of children's exposure to traumatic events and the impact of such exposure on their development and long-term outcomes," (Cook et al., 2005, p. 4). In 2012, the U.S. Department of Health and Human Services identified that a staggering number of children, an estimated 686,000, were proven to be victims of Complex Childhood Trauma in the U.S. (Child Welfare Information Gateway, 2015). CCT is not only about chronic exposure to abuse; CCT can also mean mild exposure,

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moderate exposure, or extreme exposure. The subsets of CCT are emotional abuse, physical abuse, emotional neglect, physical neglect, sexual abuse, and minimization/denial (Barenblatt et al., 2014).

What becomes of children who suffer from CCT? One theory is that individuals who lack empathy, in addition to many incarcerated individuals, were victims of CCT growing up (Wolff & Shi, 2012). Little research has been conducted in this area, though, therefore more research is needed. Only when we can determine the cause of a lack of empathy and the outcomes of CCT can we help those who have witnessed trauma. With the discipline of social and forensic psychology becoming more popular, though, there is hope that continued research in this area will follow.

As is common with new research topics, many studies present opposing outcomes and therefore must be analyzed and perhaps repeated in order to validate the results. Using a sample of forty-seven young boys and their biological fathers, Bernadett-Shapiro, Ehrensaft, and Shapiro (1996) measured father participation via a self-report on the Parental Involvement in Child Care Index (Bernadett et al., 1996), and the boys' empathy levels through Bryant's (1982) Index of Empathy for Children and Adolescents. Results indicated that, "parents' reports of father participation in childcare were significantly related to boys' empathy regardless of the level of father empathy," (p.76). In short, this means that a lack of father participation in childcare is related to a lack of empathy in children. Though this study focused on children's empathy levels instead of adults, it still shows evidence that childhood environment may be important for empathy levels at all walks of life.

On the contrary, conflicting results were found by Barenblatt et al. (2014). The researchers examined the empathy levels of forty-nine individuals sorted into three groups based on their answers to the Childhood Trauma Questionnaire (Bernstein et al., 1994): a control group, a moderate maltreatment group, and a severe maltreatment group. After watching a film of victims of gross human rights violations, empathy levels were measured both quantitatively and qualitatively. Researchers state: "Quantitative results indicated that self-reported empathy was lower in the moderate maltreatment group compared to the control group. However, qualitative thematic analysis indicated that both maltreatment groups displayed themes of impaired empathy," (Barenblatt et al., 2014, p. 97). The findings indicate that empathy was lower in moderate maltreatment groups than the control, but similar to that of the severe maltreatment group. Essentially, people who suffered moderate trauma had low empathy levels, but people who suffered an abundance of trauma had normal empathy levels similar to that of the control

group. The results, overall, show that yes, childhood trauma is associated with lower reports of self-reported empathy; however, the level of empathy often depends on the severity of the trauma. Thus, it is important to further study this topic and possibly replicate this study in an effort to clarify answers.

The purpose of the present study was to examine factors pertaining to reported childhood trauma and empathy. Participants were asked to complete a childhood trauma scale in order to determine the levels of trauma they have experienced in the past, and an empathy scale. Based on previous research, it was hypothesized that participants who experienced higher levels of childhood trauma would score lower in empathy as compared to those who experienced less severe or no childhood trauma.

## **Method**

### *Participants.*

243 students were recruited for the Qualtrics study via SONA, an online participant pool for Stanislaus State students. Of 243 participants, 31 were male and 208 were female, 1 identified as other, and 3 preferred not to state. The age range was 18-56 ( $M = 23.93$ ). Depending on their professor, some students were able to obtain extra credit for taking the study.

### *Design.*

The present study was a correlational study. The two naturally occurring variables were the level of Complex Childhood Trauma endured and the level of empathy in adulthood. The researcher hypothesized that participants who experienced high levels of childhood trauma would score lower in empathy as compared to those who experienced less severe levels of childhood trauma.

### *Measures.*

A short demographic questionnaire was used to gather information about the participants' gender, age, ethnicity, and year in college. The Childhood Trauma Questionnaire (CTQ, Bernstein, 1994) was utilized as a measure of Complex Childhood Trauma in participants. Finally, the researcher included the Toronto Empathy Questionnaire (TEQ, Spreng et al., 2009). The CTQ consisted of Likert-style questions designed to assess the participant's level of childhood trauma using a 5-point scale. The TEQ consisted of Likert-style questions designed to assess the participant's empathy levels now.

### *Procedure.*

Participants logged onto the SONA system and selected the study. From there, they were shown an informed consent form. After agreeing and electronically signing the informed consent, they began the study. First, participants confirmed that they were

eighteen years old or older by selecting “yes” or “no.” If they were not, they were thanked for their time and signed out of the study. Participants who continued then completed the short demographic questionnaire. From there, participants were taken to the Childhood Trauma Questionnaire, answering twenty-eight questions in total. After completing the questionnaire, participants began the Toronto Empathy Questionnaire. This questionnaire contained sixteen measures that have answers ranging from “never” to “always.” After completing both surveys, participants were taken to the debriefing form. Then, they were thanked for their time and logged out of the study.

## Results

To determine if there was a relationship between childhood trauma scores and empathy scores, data was analyzed using a correlational analysis.

The research hypothesis was not supported, although significant results were found, indicating that there was a significant negative relationship between scores on the Emotional Abuse Scale, Physical Abuse scale, Emotional Neglect scale, and Physical Neglect scale and scores on the TEQ, ( $r(219) = -.15, p = .023$ ;  $r(217) = -.13, p = .049$ ;  $r(217) = -.26, p = .000$ ;  $r(217) = -.271, p = .000$ , respectively).

Contrary to what was expected, participants who scored low in Emotional Abuse ( $n = 231, M = 2.1, SD = 0.95$ ), Physical Abuse ( $n = 231, M = 1.57, SD = .73$ ), Emotional Neglect ( $n = 231, M = .935, SD = 2.13$ ), and Physical Neglect ( $n = 231, M = 1.60, SD = .69$ ), reported high levels of empathy ( $n = 219, M = 67.0, SD = 8.72$ ;  $n = 219, M = 66.6, SD = 8.719$ ;  $n = 219, M = 66.6, SD = 8.719$ ;  $n = 219, M = 66.6, SD = 8.719$ , respectively). No significant relationship was found between Sexual Abuse Scores and scores on the TEQ,  $r(217) = -.09, p = .895$ .

Significant results were also found, indicating that there was a significant positive relationship between the scores on the Minimization/Denial Scale and scores on the TEQ,  $r(217) = .25, p = .000$ . Contrary to what was expected, participants who scored high in minimization/denial ( $n = 231, M = 66.61, SD = 8.72$ ) reported high levels of empathy ( $n = 219, M = 66.6, SD = 8.719$ ) (see Table 1).

## Implications

Though the research hypothesis was not supported, significant results were revealed. Furthermore, the purpose of the study was not to survey a homogeneous sample, yet the general demographic of the SONA research system gave the researchers the unique ability to dive deeper into the experiences and outcomes of women who have lived through at least one form of abuse. The sample indicated relatively high levels of empathy regardless of abuse experienced. This could be

theorized to be due to gender, age, or the fact that all participants gathered were college students at California State University, Stanislaus.

## Future work

There are many potential ways that researchers could improve this study. For example, gathering a larger, randomized sample would be key to validating the results of this study. In future research, it will be vital to study men to see if that alters the mean empathy score of participants. It also would be beneficial for researchers to utilize another way to test for empathy that is not a self-report style survey. Participants may have scored high in empathy because the Toronto Empathy Questionnaire is self-reported. Each of these ideas would expand the capabilities and, thus, minimize the current limitations of the present study.

## Acknowledgements

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## Appendix A

Table 1

*Intercorrelation of Scores on the Childhood Trauma Questionnaire (CTQ) and the Toronto Empathy Questionnaire (TEQ)*

	Emotional Abuse	Physical Abuse	Sexual Abuse	Emotional Neglect	Physical Neglect	Minimization/Denial	Empathy Scale
Emotional Abuse	----						
Physical Abuse	.584**	----					
Sexual Abuse	.444**	.318**	----				
Emotional Neglect	.681**	.372**	.400**	----			
Physical Neglect	.532**	.448**	.496**	.673**	----		
Minimization/Denial	-.676**	-.391**	-.384**	-.727**	-.599**	----	
Empathy Scale	-.154*	-.133*	-0.009	-.257**	-.271**	.252**	----

\*\*Correlation is significant at the 0.01 level (2-tailed).

\*Correlation is significant at the 0.05 level (2-tailed).

# Is There a Correlation Between Time of Day and Academic Performance?

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## Abstract

Studies have shown that if school start times are pushed back to a later time, an improvement in academic performance will occur. The studies I have come across are all subjected to non-college students, none on college students. For that reason, I questioned if a similar trend exists in college students. Since college students vary in start time, I have modified my study to see if there is a correlation between time of day, and the academic performance of college students. By "Academic Performance", I am simply referring to the overall grade a student gets in a course. This information can be useful because students and faculty will now have knowledge of knowing what time of day students are at the highest potential of performing well in classes, considering there is a correlation. If there is no correlation, this information can also be useful because then thoughts that time does affect performance can be laid aside, considering many people prefer later classes than earlier ones. I overall predict that there indeed is a correlation between time of day and academic performance, and that later-timed classes will result in better grades.

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## Literature Review

Lo @ all (April 2018) conducted a study to investigate the short and long term impact of a 45-minute delay in school start time regarding overall sleep and wellbeing of adolescents. The study sampled 375 students ranging from grade 7 to 10 from all-girls schools in Singapore. These schools were delayed from 7:30am to 8:35am. After 1 month, bedtimes on school nights were delayed by 9.0 min, while rise times were delayed by 31.6 min, resulting in an increase in time in bed of 23.2 min. After 9 months, the increase in time in bed was sustained, and the total sleep time increased by 10.0 min relative to baseline. Participants also reported lower levels of subjective sleepiness and improvement in well-being at both follow-ups. Notably, greater increase in sleep duration on school nights was associated with greater improvement in alertness and well-being (2018). The source is very strong in that there was a very detailed discussion regarding how much an improvement was made in the students regarding overall sleep time and wellbeing. The only negative with this source is that only girls were sample, which females will have different sleeping habits and wellbeing's than males. So, with no mix in the sample, there is not as much of a general statement towards all students as desired.

CDC (July 2018) addresses that the American Academy of Pediatrics has recommended that the ideal time for schools to begin (specifically middle and high schools), would be at 8:30am. CDC notes that the School Health Policies and Practice Studies found that

93% of high schools and 83% of middle schools all begin class before 8:30am (2018). As a matter of fact, they found out that 42 of the 50 states had schools where the majority started before 8:30am. CDC stresses that it is ideal for school to begin at a later time so that students can get proper sleep before school. They stress that adolescence become sleepy later in the night compared to adults, which is a primary reason why the schools should begin at a later time. Sleeping later in the night means sleeping later in the morning, which must be accommodated for by pushing the school start time later into the day. This source is very practical, for they not only stress why the school start time needs to be pushed back, but also provide what is to believe to be a fair time for school to begin. However, the source does not mention why 8:30am is the most ideal time, or how that time was obtained, which can remain questionable if there is a more ideal time for school to begin.

Chan, Poon, Leung, Lau, and Lau (July 2018), from the Journal of Adolescence examined the effects on a boarding school in Hong Kong that had decided to delay school start time by an hour for a period of time. The start time was changed from 7:30am to 8:30am. Upon the study, it was observed that there had been an improvement on sleep quality, insomnia, life satisfaction and psychological distress. Students from the school were also reporting that the longer sleep time was improving the quality of their sleep, as well as daytime functioning (2018). The article references a 2002 article from M.A. Carskadon that adolescents are advised to get anywhere from eight to ten hours of sleep

per night for healthy wellbeing. This source also mentions that as children become adolescences, their hormonal change causes a shift in the sleep cycle, making students more prone to becoming sleepy at later times in the night and wanting to sleep more later into the morning. This source is very appreciable due the points addressed are fairly similar to the last source mentioned. The reason this is good is because there is clearly a pattern and consistency being shown. The only flaw that is most accountable in this source is that it fails to address how dramatic of an improvement has occurred. It is unclear how drastic of a change has occurred regarding academic performance, for example.

Science Advances (December 2018) had ran a study on a school district in Seattle where all schools in the district had delayed their start times from 7:50am to 8:45am. What was found from the study is that with this time adjustment, students on average received about an extra 30 minutes of sleep. This 30 minutes of sleep was sufficient enough to improve attendance and academic performance (2018). The study demonstrates a lengthening in the median daily sleep duration from 6 hours and 50 min to 7 hours and 24 min, restoring the historical sleep values present several decades before evenings within brightly lit environments and with access to light-emitting screens were common among teenagers (2018). The results from the study stress that a simple delay of about an hour is helpful enough for students to obtain a healthier night's sleep, an epidemic that this generation of teens struggle to obtain. This study is very ideal for that it stresses that a subtle shift in start time is enough to cause beneficial changes to the students. The study conducted here not only focused on one school, but the entire school district. Being able to obtain similar results throughout multiple schools is a strong backbone of evidence to support the thesis.

Though numerous pieces of recent literature have suggested that it can be beneficial for students to begin school at a later time in the day, all of the studies seem to gravitate to beginning school at the same, or around the same time period. The current study in this course wishes to dive deeper into this delay. It is hypothesized that around this 8:30am period that these studies are having school begin might not be the end of the study. It is hypothesized that even later starts can have a more enhanced effect, or even a different effect. It is desired to find if there is such thing as starting too late in the day, and when the "perfect time" exactly is. All of these sources fail to do that. The sources all suggest that an hour delay makes improvements, but does not address about if an even further delay can have

a better result, or a negative result, and that is where seeing if an overall correlation exists can help solve the question. And by answering this, faculty and students will have better knowledge of a possible potential and can utilize this knowledge to their advantage, especially regarding making schedules for students.

## **Methods**

### **Participants**

The only participants in this study are the professors I am collecting class averages from. The class averages are from a professors' previously taught classes. So, in a sense, the professors can be considered participants, however they are not partaking in any activity or being tested on. They are simply handing me in data.

### **Design**

The design of the study is fairly simple. The experiment is organized in a manner of data collection. I will be collecting class averages from a course taught at different times. The independent variable is the time of day the class is taken, and the dependent variable is the class average. Each professor I collect averages from will supply me with an excel document that I will store on my private computer. This excel document will contain each semester a specific course has been taught. Under each semester, the time the class was taught will be listed, and next to it will be the class average. With this data, I can run a regression analysis and ANOVA testing to study the data.

### **Materials**

Since the experiment is strictly collection of past data, the only materials that are essentially used in this research are the computers each professor makes the excel document in, and the computer I use to store the excel document as well as run a regression analysis in Microsoft Excel.

### **Procedure**

The experiment will start off with me collecting data from professors. I will find professors who have each taught one specific course at numerous amounts of times of day throughout the years. I will ask them to each give me every class average they have had of every time they have taught. Once that data is obtained, I will organize the times into a data table. Note that I will not be cross comparing courses. What I mean by this is I will have numerous data tables, each for each course. The goal here is to run a series of statistical tests to see if I can find a pattern amongst each data table and see if there is a specific time where the class averages seem to be higher. This will be done by essentially relisting the data in Microsoft excel, and running a



regression analysis of the data as well as a scatter plot to see if a correlation exists. I will do this for each data table and see if there is a pattern amongst the tables.

## Results

The following data listed are the class averages from a professor's **Organic Chemistry 1** course taught over the years. This professor confirmed with me that every class experienced the same exact curriculum and every class was equal in difficulty.

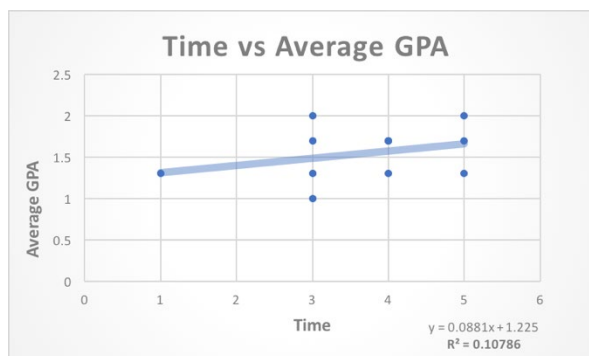
Time	Average %	Average (decimal)	Average GPA
1	47.94%	0.4794	1.3
3	51.82%	0.5182	1.7
3	46.14%	0.4614	1
5	53.91%	0.5391	2
4	52.87%	0.5286	1.7
3	49.68%	0.4968	1.3
5	49.31%	0.4931	1.3
5	50.77%	0.5077	1.7
3	55.32%	0.5532	2
4	48.66%	0.4866	1.3
4	52.01%	0.5201	1.7

Notice how the time is listed as a number. This is because in order to run a regression analysis, the data must be in a form of an integer and must be spaced apart equally. In other words, if the time was listed as "8am" for example, the regression analysis would not be accurate. With that being said, here is a key for each time:

- 1 = 8:00am
- 2 = 9:00am
- 3 = 10:00am
- 4 = 11:00am
- 5 = 12:00am

Also note that the data should not be analyzed as a percentage, which is why the average for each class is also listed in the form of a decimal. This course however, was graded off a curve, so I converted each average into a GPA value for simplicity. The curve remained the same throughout each semester the course was taught. The time is the x-variable and the average in decimal form is the y-variable. These variables were then selected and a regression analysis and ANOVA test were ran in excel, with a 95% confidence interval, and resulted in the following data:

SUMMARY OUTPUT					
<b>Regression Statistics</b>					
Multiple R	0.3114359				
R Square	0.0969923				
Adjusted R S	-0.003342				
Standard Err	0.027393				
Observations	11				
<b>ANOVA</b>					
	df	SS	MS	F	Significance F
Regression	1	0.0007254	0.0007254	0.9666926	0.35119747
Residual	9	0.0067534	0.0007504		
Total	10	0.0074788			



For the ANOVA test, the significance value F (highlighted yellow) is our key of focus here. Because we are running the regression with a 95% confidence interval, our significance value F must be below 5% or 0.05, to reject the null hypothesis. However, our F value comes out to about 0.35 or 35%, approximately 30% higher than our threshold to accept the null hypothesis. For the scatterplot, we look at the R squared value. An R squared value needs to be as close to the value 1.0 as possible to show a correlation. That is not the case here, for it is about 0.11, a value distant from 1.0 for a correlation to exist.

The exact same data analysis above is repeated for an **Organic Chemistry 2** and **Abstract Algebra** class taught among different semesters by one professor each, who again confirmed with me that the material remained consistent among semesters. Both courses also each had their own curve that remained the same for each semester. The following data is for **Organic Chemistry 2**:

### Organic Chemistry 2

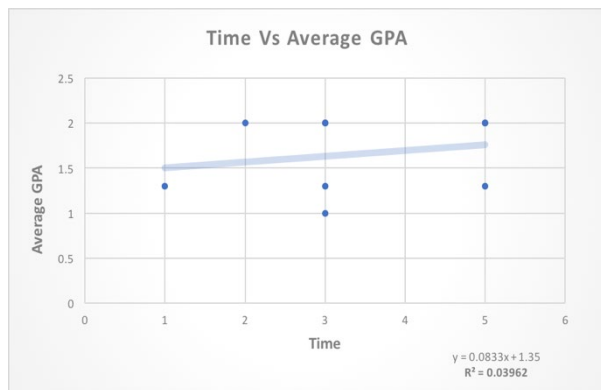
Time	Average %	Average (Decimal)	Average GPA
1	54.64%	0.5464	1.3
5	61.28%	0.6128	2
3	59.55%	0.5955	2
5	58.58%	0.5858	2
3	54.30%	0.543	1.3
5	52.92%	0.5292	1.3
3	57.02%	0.5702	2
3	49.98%	0.4998	1
2	63.14%	0.6314	2

Similar to the last data set, the time values are as follows:

- 1 = 8:00am
- 2 = 9:00am
- 3 = 10:00am
- 4 = 11:00am
- 5 = 12:00am

Data analysis for this set is the exact same to the data analysis of the previous set. The variables, conditions, and tests ran are exact. That said, here are the results for the **Organic Chemistry 2** data set:

SUMMARY OUTPUT					
<i>Regression Statistics</i>					
Multiple R	0.13634416				
R Square	0.01858973				
Adjusted R Square	-0.1216117				
Standard Error	0.04485767				
Observations	9				
<i>ANOVA</i>					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	0.0002668	0.0002668	0.13259297	0.72650892
Residual	7	0.01408548	0.00201221		
Total	8	0.01435228			



For the ANOVA test, we once again ran a 95% confidence interval, meaning we only have 5% (0.05) margin of error. The significance F value for this test came out to about 0.73, which is very well over the 0.05 margin of error. The R squared value for this set also is very distant from the value 1.0. This data set greatly shows that there is no correlation regarding the time and average GPA.

This procedure was conducted one last time on an **Abstract Algebra** course. The data is as follows:

## Abstract Algebra

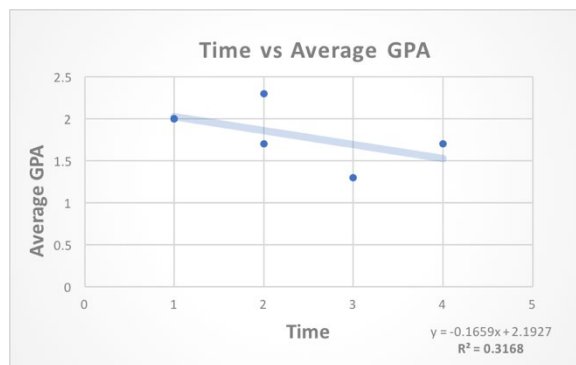
Time	Average %	Average (Decimal)	Average GPA
1	64.02%	0.6402	2
1	65.88%	0.6588	2
2	69.05%	0.6905	2.3
2	61.28%	0.6128	1.7
3	57.44%	0.5744	1.3
4	62.67%	0.6267	1.7

The key for each time is as follows:

- 1 = 8:00am
- 2 = 10:10am
- 3 = 11:15am
- 4 = 1:25pm

Once more, data analysis for this set is the exact same to the data analysis of the previous sets, and the variables, conditions, and tests ran are exact. The following is the results for the **Abstract Algebra** data set:

SUMMARY OUTPUT					
<i>Regression Statistics</i>					
Multiple R	0.45233217				
R Square	0.20460439				
Adjusted R Square	0.00575549				
Standard Error	0.03963607				
Observations	6				
<i>ANOVA</i>					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	0.00161649	0.00161649	1.02894403	0.367776321
Residual	4	0.00628407	0.00157102		
Total	5	0.00790056			



With a 95% confidence interval and a 5% margin of error for the ANOVA test, this set's significance F value is about 0.37, going over the 0.05 margin of error. The R squared value for this set is the highest of the three sets, about 0.32, however this value is still not close

enough to the 1.0 value for a correlation to be present. This data set also results in no correlation.

### Discussion

Due to the F values of all three ANOVA tests being larger than our accepted value of 0.05, we fail to reject our null hypothesis. The R squared values for all three scatterplots also displayed a value that is not close to the 1.0 value. In conclusion, we cannot include that there is a correlation between the time of day a class is taken, and academic performance among college students. I had originally hypothesized that there will be a correlation and that this information is beneficial because now schools as well as students will know around what time students are likely to be at their highest potential regarding academic performance, so more classes can be offered around these times and students will know around what time of day to structure their class schedule.

I do want to point out some potential flaws in the study. The biggest concern is the sample size is fairly small. The study would be more efficient if I had done this data analysis among more courses with a larger amount of averages. The reason for the small sample size was due to difficulty getting professors to be on board with sharing data. A lot of professors simply were not comfortable giving out data, and others were too busy, and some also just did not have courses they have taught numerous amounts of times for there to even be a data set. This study was also conducted from courses at Stanislaus State University, so this introduces the fact that data could vary at a different university.

Even though the study deems to have no correlation, this information can still be provided as useful. A lot of students may believe what I had hypothesized, and think in order to do well, they need to make sure all of their classes are later in the day. However, now that we see there is no correlation, students can come to face the fact and not be worried about taking classes earlier in the day. I personally always thought it was never a good idea to take an early morning class because I thought I wouldn't be awake enough and I would do poorly. However, we can now see that there is no correlation, and that feeling of skepticism can be put aside when making a class schedule. This information is also useful for the school itself and faculty. Understanding that there is no correlation, it should be considered to offer more courses at various times of the day. More night classes can be offered for example, even more early morning classes.

### Acknowledgements

I thank you for taking the time to read my Capstone research paper. Thank you to Dr. Wu from the math department for mentoring me with my research, thank you to the professors who were kind enough to supply

me with their class averages to conduct my research, and thank you to Dr. Newton, Dr. Belle, Dr. Gupta, and Becky for assisting me down the road these past semesters to complete this research.

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### Appendix A

This is the original excel document given to me by the organic chemistry professor whose data was used for this research. The professor supplied me with data for both the Organic Chemistry 1 and Organic Chemistry 2 course.

CSU Stanislaus (CHEM 3010)			
semester	class time	class days	class average
Spring 2009	8:00 - 8:58 am	MWF	47.94%
Fall 2010	10:00 - 10:50 am	MWF	51.82%
Fall 2011	10:00 - 10:50 am	MWF	46.14%
Spring 2012	12:00 - 12:50 pm	MWF	53.91%
Fall 2013	11:00 - 11:50 am	MWF	52.87%
Fall 2014	10:00 - 10:50 am	MWF	49.68%
Spring 2015	12:00 - 12:50 pm	MWF	49.31%
Spring 2016	12:00 - 12:50 pm	MWF	50.77%
Fall 2016	10:00 - 10:50 am	MWF	55.32%
Fall 2017	11:00 - 11:50 am	MWF	48.66%
Fall 2018	11:00 - 11:50 am	MWF	52.01%

CSU Stanislaus (CHEM 3020)			
semester	class time	class days	class average
Spring 2009	10:10 - 11:08 am	MWF	54.64%
Fall 2009	12:20 - 1:18 pm	MWF	61.28%
Spring 2011	10:00 - 10:50	MWF	59.55%
Fall 2012	12:00 - 12:50 pm	MWF	58.58%
Spring 2014	10:00 - 10:50	MWF	54.30%
Fall 2015	12:00 - 12:50 pm	MWF	52.92%
Spring 2017	10:00 - 10:50	MWF	57.02%
Spring 2018	10:00 - 10:50	MWF	49.98%
Spring 2019	10:00 - 10:50	MWF	63.14%

### Appendix B

This is the original excel document given to me by the abstract algebra professor whose data was used for this research.

Semester	Time	Pass Rate	Avg Percentage
S03	MWF 11:15-12:13	52.17	57.44
S04	MWF 1:25-2:23	78.57	62.67
S10	MWF 10:10-11:08	80.77	61.28
S11	MWF 10:10-11:08	91.30	69.05
S16	MWF 8:00-8:50	87.50	65.88
S17	MWF 8:00-8:50	83.87	64.02

# The Impact of Agriculture on Body Condition in the California Ground Squirrel

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## Abstract

California's Central Valley is a drastically altered landscape, with almost every arable square mile converted to agriculture (Mitchell et al. 2015). The impact of agriculture can be detrimental due to habitat loss and the subsequent loss of biodiversity, or beneficial if those crops serve as a supplemental food resource for local species. In California ground squirrels (CGS), populations adjacent to agriculture experience benefits, such as larger-bodied young-of-the-year with a higher body condition (Ulm 2019). However, there are no existing studies that have addressed the impact of agriculture on individual fitness within these populations. Using a geospatial analysis software (ArcGIS v10.6), the foraging range was estimated for each individual squirrel based on capture points, and the percentage of overlap with agriculture was quantified. Analyses using general linear models have found no significant relationship between the percentage of overlap with agriculture and body condition in CGS, but did find sex, site, and year to be significant contributors to variation in body condition.

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## Introduction

The California ground squirrel (*Otospermophilus beecheyi*) is a native California species ranging from Baja California to north-central California (Smith et al. 2016). As the name implies, it is a facultatively social mammal that creates complex, underground burrow systems used for shelter and food storage. However, these burrow systems undermine infrastructure such as irrigation canals, levees, or building foundations (Ordenaña et al. 2012). This, in addition to seasonal crop-raiding, is why *O. beecheyi* continues to remain one of the most destructive agricultural pests in California (Marsh 1998; Baldwin et al. 2014). Despite the documented economic impact that CGS impose on California agriculture, little is known on how crop food resources influence CGS in terms of individual fitness and population persistence. For small mammal species in general, the relative costs and benefits of relying on agricultural food resources is a topic which has not received much attention.

It is well documented that the large-scale production of agriculture can have a significant impact on many native species (Lindenmayer and Fischer 2006; Didham 2010). Standard agricultural practices such as tillage, drainage, and pesticide use can result in soil degradation, water pollution, and habitat fragmentation or loss. Furthermore, seeds from domesticated crops can spread into areas of natural vegetation and outcompete native species which threatens the ecosystem (Driscoll et al. 2014). For these reasons, agriculture is one of the largest contributors to the loss of biodiversity worldwide (McLaughlin et al. 1995).

The impact of agriculture on each species varies, and certain species may benefit directly or indirectly from living in proximity to human food crops. For example, in Argentina during the 20th century, 90% of the Pampas grassland was converted to agriculture and pastures. While certain species suffered a complete regional extinction, other herbivorous birds, rodents, and pollinating/crop-associated insect species seemed to increase in abundance (Medan et al. 2011). In southwestern Idaho, Moulton et al. (2006) observed a higher biomass of common prey species (genera *Peromyscus*, *Mus*, *Perognathus*, *Reithrodontomys*, *Dipodomys*, and *Spermophilus*) adjacent to agricultural fields (alfalfa, sugar beets, and mint) as opposed to natural vegetation.

Generally, animals exhibit a flexible activity budget, where time spent foraging and time devoted to other behaviors such as vigilance, bonding, courting, or mating can be traded-off in response to environmental cues, such as food availability. For example, Gwendolyn Bachman (1993) observed that when juvenile Belding's ground squirrels (*Spermophilus beldingi*) were limited to energy-poor foods for six consecutive days, they increased their foraging duration and decreased their vigilance despite only a moderate reduction in energy stores. Alternatively, Royaute (2017) found an increase in behavioral plasticity in populations of house crickets (*Acheta domesticus*) fed consistently on a high-energy diet. If multiple generations have access to a stable, high-energy food supply, this can even improve the relative fitness of

offspring (*Uroditellus parryii plesius*, Werner et al. 2015).

Although other factors may contribute to these changes, diet has been shown to be a significant population parameter in small mammals (Eva et al. 2016). When studying two rodent species (*Apodemus sylvaticus* and *Microtus arvalis*) near various types of agricultural crop, Eva et. al. found the quantity and quality of their diet to be significantly influenced by the type of crop food available, but not age, month of trapping, sex, or body size. This is supported by Benedek and Sîrbu (2017), who found that among rural mosaic landscapes including farmed and semi-natural habitats in Central Romania, vegetation traits were the most important factors influencing small mammal communities. This suggests that when assessing population dynamics, diet should be a primary area of focus.

While approximately 40% of the land in the United States is dedicated to farmland (NASS 2013), the Central Valley of California has been particularly impacted. According to Mitchell et al. (2015), nearly every square mile of arable land within the Central Valley has been transformed by agriculture. In the Central Valley, it has been documented that CGS engage in crop-raiding and use agriculture to supplement their diet (Smith 2016). McGrann et al. (2014) - found a positive correlation between CGS burrow density and the percent cover of perennial fruit/nut crops in the Central Valley, and reported that CGS were 8.40 times more likely to occur adjacent to perennial nut crops than to grasslands. This suggests that agricultural food resources are being used to maintain abnormally high population densities of CGS.

To date, there have been no studies quantifying the contribution of crop foods to the natural diet of this species, although a clear preference for nut crops over corn has been experimentally determined (Ulm 2019). Additionally, there have been no studies which explore the impact that agriculture - has on population demographics, life history, or survival in CGS. However, while studying three populations of CSG within the Central Valley in proximity to almond orchards (high-energy supplemental food source), corn fields (low-energy supplemental food source), or completely reliant on natural grassland (experimental control), Ulm observed that males have a larger average body condition than females, but only in populations adjacent to agriculture. This species is slightly sexually dimorphic, with males being larger and more muscular than females. Ulm's study did not discriminate between muscle and fat tissue when measuring body condition, but it is possible that higher soft tissue reserves allow males to spend less time foraging and instead allocate more effort toward actively seeking mates or increasing their home range. Ulm also found that young-of-the-

year adjacent to agriculture (corn and almonds) emerged at a larger average skeleton size and higher body condition than young-of-the-year adjacent to shrubland or other natural vegetation. In addition, young-of-the-year in populations adjacent to corn fields emerged from their natal burrows two weeks before the pups in other populations. This raises some questions: what is the impact of agriculture on CGS within a population and do individuals adhere to these population-level patterns?

We hypothesize that access to agriculture influences individual body condition in CGS. - Individual squirrels within the same population that are in close proximity to agriculture will exhibit a higher body condition than squirrels without. If this is true, then we predict that the overlap between the estimated foraging range for individual CGS and agriculture will be positively associated with a high body condition.

## Methods

### **Mark-Recapture and Morphometric Data Collection**

Since 2015, CGS have been studied by California State University, Stanislaus students at three separate locations within the Central Valley: Merced, San Luis and San Joaquin River National Wildlife Refuges (Fig. 1). Trapping seasons generally ranged from February to November with each site visited once every three weeks. During trapping seasons, CGS were live-trapped using Tomahawk traps that were baited with a combination of in-hull sunflower seeds and peanut butter. At San Joaquin River NWR in 2019, the traps were baited with raw walnuts for one month before returning to the sunflower seed and peanut butter mixture. Traps were baited at dawn and checked within four hours to avoid excessive heat exposure. Within each site, 50-75 traps were placed at least 25 feet apart in areas where a high active burrow density was observed. This typically was along roads adjacent to pastures or other grassland. The GPS coordinates for each trap were obtained using a Garmin GPSMAP 64s unit ( $\pm 5$  meters) (2015-2017) and Google Maps ( $\pm 10$  meters) (2018) and updated as trap locations changed. However, from 2015-2017, traps often remained in the same location unless removed due to damage. In 2018, additional traps were placed at the San Luis NWR in order to obtain a higher density of trapping locations. During that trapping year, traps were placed at approximately 10-15 feet apart in select locations regardless of whether the burrow appeared active or not. If a squirrel was caught, the trap was shifted to an adjacent burrow entrance and left until another squirrel was caught.

On initial capture, individuals were placed in a canvas cone-shaped handling bag (Koprowski 2002) and categorized based on sex, age/reproductive status (juvenile, sexually mature, pregnant/lactating) (Glover



2018). Weight was measured using a digital hanging scale (lbs) based on two readings with the average weight recorded. Digital calipers (mm) were used to measure left and right hindfoot length, and anogenital distance was measured to confirm sex. A tissue sample (approximately 1 mm) was collected from the tip of the ear for genetic analysis and unique, self-piercing ear tags were placed at the base of each ear (Ulm 2019). Beginning in 2019 at San Luis NWR, squirrels were also given a unique combination of colored pipe cleaners twisted around each ear tag, which helped identify individuals from a distance. When recaptured, body measurements and weight were updated and any ear tags/pipe cleaners that were missing were replaced. On the rare occasion ( $N < 25$ ) a recaptured squirrel was missing both ear tags and could not be identified, it was treated as a new capture. Individuals were released within 1 meter of the capture site.

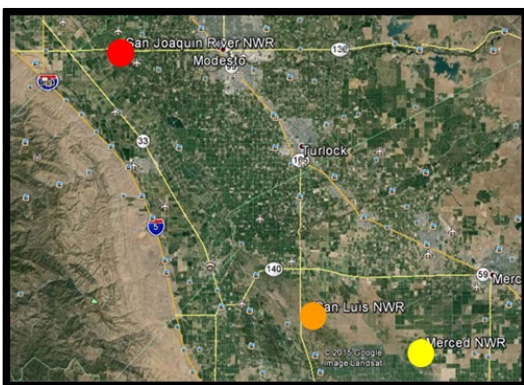


Figure 1: Trapping sites within the Central Valley: San Joaquin River NWR (red), San Luis NWR (orange), and Merced NWR (yellow). Imaging obtained using Google Earth. GPS data were collected using a mobile device with the Google Maps app.

### ***Agricultural Crop Data Collection***

Within each National Wildlife Refuge, I delineated plots by eye and assigned into categories: hardscape, natural vegetation, shrubland, pastures/alfalfa, corn, almonds, or seasonal vegetable crops. While each NWR is surrounded by a patchy mosaic of natural grassland, shrubland, and grazed pastures or alfalfa crops (all with the same relative caloric output), Merced NWR and San Joaquin NWR are also adjacent to agricultural lands, in close proximity to the CGS under study. Because the CGS is a foraging granivore, several of these crops (i.e. corn and almonds) may constitute a significant portion of the squirrel's diet while other crops (i.e. cotton or alfalfa) may not. It should be noted that while San Luis NWR has adjacent agriculture, the closest agricultural plot is approximately 985 meters away from the nearest

trapping location, and therefore is not considered to be a significant source of food for the population.

I further subdivided Merced NWR into two separate sites where CGS trapping efforts were concentrated (Fig. 2). These sites are separated by a rural highway. Each is largely surrounded by natural grassland, shrubland, and pastures reserved for cattle grazing (all with same relative caloric output), but the southern site has an area where seasonal vegetable crops are grown (Fig. 2a) as well as another area where corn is grown seasonally to feed migratory fowl (Fig. 2d). A cattle barn is located in the center of the northern site (Fig. 2c) where grain is stored. The northern and southern trapping sites are within 550 meters, and it is possible that squirrels transfer between locations during their lifetime, or even during foraging bouts.

Similarly, I further subdivided San Joaquin River NWR into northern and southern trapping locations, which are also separated by a rural highway (Fig. 3). These two sites are at a greater distance from one another (8,000 meters), thus the probability of individual squirrels transferring from one site to another is very low. The northern site (Fig. 3c) is immediately adjacent to a NWR-managed corn field, as well as privately owned plots where a variety of seasonal vegetables are grown. A portion of the southern site (Fig. 3a) is adjacent to an almond orchard.

### **Data Analysis**

#### ***Morphometric Data Analysis***

I measured body condition using a commonly employed approach, where average hind foot length for an individual is regressed against body mass, for all adult individuals sampled within a population. I excluded juveniles in order to obtain a more accurate population distribution of body condition, not affected by developmental variation. For recaptured squirrels, body condition values were averaged across all capture events.

#### ***Agriculture Crop Data Analysis***

I used ArcGIS(v10.6) to analyze satellite imagery of National Wildlife Refuge lands, to delineate the landscape plots into agriculture or non-agriculture, with pastures/alfalfa categorized as the latter. I used GPS capture location data as a centroid for estimating foraging range for individual CGS. The diameter of the centroid was dependent on the number of distinct GPS locations for an individual. For individuals captured at a location designated by a single GPS point, I created a 50-meter buffer around that point (Fig. 4) as a proxy for the estimated foraging range (Ulm 2019). This resulted in a total square area of 8,804 meters<sup>2</sup>. For squirrels caught 2+ times and with a recapture distance less than or equal to 25 meters, I connected the GPS points with a line and created a 50-meter buffer around the centroid.

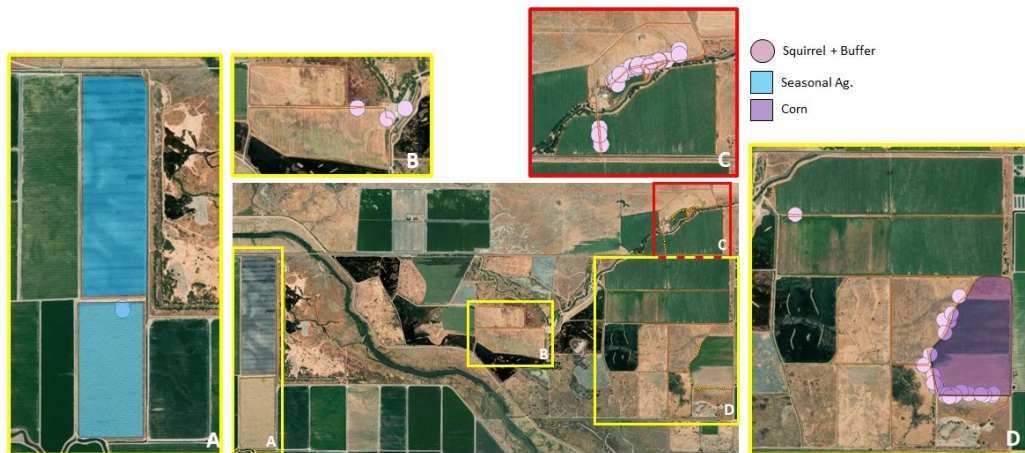


Figure 2: Trapping locations at the Merced NWR. The northern site (highlighted in red) and southern site (highlighted in yellow) are separated by Sandy Mush Road. Each site is surrounded by pastures/alfalfa, natural vegetation and shrubland with accessible food crops highlighted. Imaging shows each capture point including a 50-meter buffer which was used as an estimate for foraging range. For further details, see Agricultural Crop Data Analysis. Imaging obtained using ArcGIS(v10.6).

For squirrels caught 2+ times and whose recapture distance exceeded 25 meters, I connected the GPS points with a line and created a 25-meter buffer around the centroid (Fig. 5). I then calculated the percentage by which the estimated foraging range overlapped agricultural crops and non-crop vegetation (excluding hardscape).

### Statistical Analysis

To address the question of whether individual CGS body condition is influenced by the degree to which estimated foraging range overlaps with agricultural crops, I used a general linear modeling approach. General linear models assume normality for dependent variables, so I performed a Kolmogorov-Smirnov test for normality on the variable body

subsequently conducted a univariate GLM analysis with the full model described as  $body\ condition = \% \text{ agriculture} + sex + site + year$ . Body condition and % agriculture are continuous variables, and sex, site and year are categorical variables. I treated % agriculture, site and year as random variables, and sex as a fixed variable. Preliminary model building tested only for main effects from the four explanatory variables, using a Type III sums of squares approach. I conducted all statistical analyses in SPSS (IBM, v. 26).

### Results

We captured a total of 652 individual California ground squirrels between the three National Wildlife Refuge locations from 2015-2019. Excluding juveniles and individuals with incomplete information,



Figure 3: Trapping locations at the San Joaquin River NWR. The northern site (highlighted in red) and southern site (highlighted in yellow) are separated by Hwy 132. Each site is surrounded by pastures/alfalfa, natural vegetation and shrubland with accessible food crops highlighted. Imaging shows each capture point including a 50-meter buffer which was used as an estimate for foraging range. For further details, see Agricultural Crop Data Analysis. Imaging obtained using ArcGIS(v10.6).

condition, using the pooled data from all three populations sampled. The preliminary test for normality was significant, therefore I performed a log<sub>10</sub> transformation of the body condition data. I

I used 424 adults in this analysis (Table 1). Approximately 55% of the individuals were trapped at



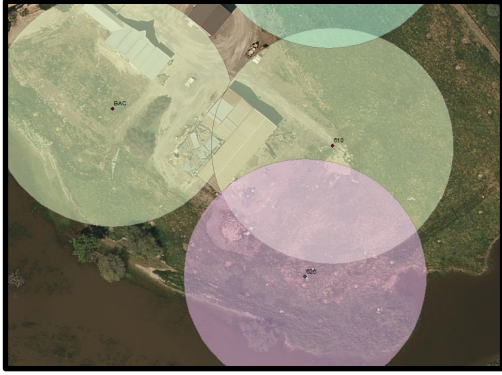


Figure 4: The 50-meter buffer zone of squirrels 626, 610, and BAC (San Joaquin River NWR) based on a single recapture point. Hardscape has not yet been excluded from the total area. Imaging obtained using ArcGIS(v10.6).



Figure 5: The 25-meter buffer zone of squirrel AAL (San Joaquin River NWR) based on two different recapture points. The buffer zone excludes hardscape from the total area. Imaging obtained using ArcGIS(v10.6).

San Luis NWR: while we spent a disproportionate number of trapping days at San Luis NWR to collect data for other purposes, we also experienced the highest rate of trapping success at location (3.33 squirrels per hour of trapping effort, compared to 3.29 squirrels/hour at Merced NWR and 1.43 squirrels/hour at San Joaquin River NWR).

A preliminary Kolmogorov-Smirnov test indicated that pooled body condition did not follow a normal distribution,  $D(424) = 0.049$ ,  $p = 0.018$ ; however, the log10 transformation of pooled body condition data yielded a non-significant test result  $D(424) = 0.027$ ,  $p = 0.200$ , suggesting that the transformation imposed a normal distribution on the data. In the univariate GLM analysis, tests of between-subjects effects revealed three of the four terms in the model were significant contributors to variation in body condition. The power to detect small effect sizes was

substantial for all terms, ranging from 1.000 (sex) to 0.718 (year). Sex was the strongest contributor to variation in body condition ( $F = 60.43$ ,  $df = 1$ ,  $p \leq 0.000$ ), with males exhibiting higher mean body condition (1.237,  $N = 189$ ) than females (1.183,  $N = 235$ ). Site was the next most important contributor to the model ( $F = 13.07$ ,  $df = 2$ ,  $p \leq 0.000$ ), with mean body condition highest in San Joaquin River NWR (1.24,  $N = 102$ ), followed by Merced NWR (1.21,  $N = 92$ ) and San Luis NWR (1.19,  $N = 130$ ). The least important, yet still significant contributor to the model was year ( $F = 3.08$ ,  $df = 3$ ,  $p = 0.028$ ), with mean body condition values following a sequential decline by

year: 2016 (1.26,  $N = 27$ ); 2017 (1.22,  $N = 180$ ); 2018 (1.20,  $N = 103$ ); 2019 (1.19,  $N = 114$ ). The model term % agriculture was not a significant contributor to variation in individual body condition.

## Discussion

A previous study on California ground squirrels (Ulm 2019) found agriculture to be a significant factor influencing variation in juvenile skeletal size and body condition among Central Valley populations. Within these same populations, I was unable to detect a significant relationship between individual body condition and the percentage of overlap of estimated foraging range with agriculture. However, I did find that sex, site, and year were significant factors contributing to variation in body condition.

It is not surprising that sex was the most significant factor given that CGS are a sexually dimorphic species; adult males are consistently larger than adult females in body and cranial morphometrics (Smith et al. 2016) and exhibit higher average muscle mass. In our own populations, the average weight for adult males was 615.4 g, and 522.1 g for adult females. Differences can be attributed to how each sex allocates energy reserves; for example, in Richardson's ground squirrels (*Spermophilus richardsonii*), juvenile males have been shown to allocate more energy to skeletal growth than to fat reserves, in comparison to juvenile females (Michener and Locklear 1990). Notably, however, rodents including CGS are known to deviate from "Rensch's rule" (Matějů & Kratochvíl 2013), which states male-biased sexual size dimorphism (SSD) increases with increasing body size. According to Matějů & Kratochvíl, in CGS specifically, body size and social system could not explain this deviation, which suggests the existence of ecological or other selection factors preventing the evolution of extensive SSD.

Site was the next most important contributor to variation in body condition. This supports Ulm's interpopulation analysis, where she found that the

	Males	Recaptured Males	Recapture Rate (%)	Females	Recaptured Females	Recapture Rate (%)	Total Sample
<b>SJR NWR</b>	36	4	11.1%	66	3	4.5%	102
<b>MC NWR</b>	39	10	25.6%	53	14	26.4%	92
<b>SL NWR</b>	114	46	40.4%	116	35	30.2%	230

Table 1: Captures of adult California ground squirrels from 2015 to 2019 at National Wildlife Refuges within the Central Valley of California: San Joaquin River (SJR), Merced (MC) and San Luis (SL).

average adult body condition for males and females was higher at Merced and San Joaquin River NWR than it was for San Luis NWR. However, she did not find a significant difference between Merced and San Joaquin NWR themselves. In this analysis, site was a significant factor influencing body condition, but percent of home range overlap with agriculture was not a significant factor, which suggests that my current approach for estimating foraging range may be flawed.

Home range size in this species is a highly plastic trait, exhibiting variation with and among populations across a variety of habitats. Estimates range from 626-902 m<sup>2</sup> for adult females and 313-376 m<sup>2</sup> for adult males (Owings et al. 1977), to 4,217 m<sup>2</sup> for adult females to 5,466 m<sup>2</sup> for adult males (Boellstorff and Owings 1995). Our own preliminary, unpublished data fall within these values (575 m<sup>2</sup> to 3436 m<sup>2</sup> for adults of both sexes, Russell 2020). When estimating foraging range, I used buffer sizes of 25 m or 50 m, which produced estimated ranges from 2,426 to 11,859 m<sup>2</sup>. These values may not be an accurate estimate, but because we could only place traps adjacent to private agricultural lands (and not within them), reducing the diameter of the buffer of a trapping location would mean that the individual would exhibit 0% overlap with agricultural crops in the area. This would have underestimated the degree to which individuals exploit crop food resources, based on our own observations of squirrel crop raiding behavior. It is likely that squirrels living near agriculture modify their own ranging behavior to take advantage of these calorie-dense food resources, in ways which have yet to be documented in the literature.

Finally, year was the third most significant contributor to individual body condition within my model. Given the variation in select agricultural plots and annual precipitation, exacerbated by California being in an “exceptional drought” (D4) from 2015-2016 (NIDIS 2020), this statistical result is convincing. Notably, however, the average body condition across all

the populations *declined* each year despite the Central Valley’s improvement to only a “moderate drought” (D1) by 2018 and “abnormally dry” (D0) by 2020. This may be due to a variety of factors, including a transition to a more nutritional but less calorie-rich diet as natural vegetation began to recover. Additionally, as San Luis constituted the largest portion of the sample and did not have any agricultural crops nearby to supplement diet, there may be a delayed effect on body condition seen most prominently in this population that affects the overall analysis.

It is possible that the multi-year drought influenced CGS body condition to such a degree that it influences the evolution of Central Valley populations. In unstable climatic environments, the relative strengths of size-dependent and size-independent mortality can lead to antagonistic selection pressures between early maturation and large body size through delayed maturation (Brown and Sibly 2006). Evidence of trade-offs in post-drought body size are seen in aquatic salamanders with different body sizes and maturation rates (*Siren lacertina* and *Siren intermedia*). Using field data and a discrete-time model, Luhring and Holdo (2015) found under mild conditions, the small-sized, fast-maturing species (*S. intermedia*) outcompeted the large-sized, late-maturing species (*S. lacertina*). However, as drought severity increased, *S. lacertina* experienced less of a decrease in its population and was able to encroach into areas normally dominated by *S. intermedia*. Aquatic and semi-aquatic species are especially adaptable to fluctuating environments given they are constrained by freshwater availability and therefore often unable to disperse into new territories. CGS, on the other hand, exhibit slight male-biased sex dispersal (Ulm 2019) and secondary dispersal has been observed in both sexes. This suggests that CGS may depend on dispersal into new territories to accommodate food shortages and may not prioritize growth rate over fecundity when food resources are scarce. As CGS are listed as a species of “least concern” (Smith et al. 2016),

there is very little information on how this species copes with food shortages, and how variation in body condition directly influences life history strategies and lifetime reproductive success.

In the future, I may reconsider how the data for recaptured squirrels are analyzed. In this analysis, body condition for each adult recapture was averaged across all years, with the most recent year used as a reference. I did this to provide a more accurate estimate of foraging range, as each GPS location per capture event was used to determine the foraging range. However, given my results, this may be an inaccurate representation of accessible food. Limiting recaptures by year or even season would provide better insight and should be considered for future revisions.

### Conclusion

Unlike many other native mammals, CGS have shown themselves to be a resilient species thriving in the modified landscape that makes up California's Central Valley. While CGS are a historically well-documented species, little is known about how this species responds to fluctuations in climate or food availability. While population-level analysis is important for observing general trends, intrapopulation analysis will provide the greatest insight in the long-term impact a high-calorie diet has on individuals, especially in conjunction with individual behavior or genotypic profile. The results presented here provide a more accurate representation of how small mammal populations may be impacted by variation in human agricultural crop availability. Given that agricultural production is expected to rise by 70% in 2050 (FAO 2009), this information is crucial in maintaining local biodiversity.

### Acknowledgements

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# An Update of the Laws, Regulations, and Privacy Concern on Digital Marketing in E-commerce

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## Abstract

Digital marketing is the use of the internet, mobile devices, social media, search engines, and other channels to reach consumers. While these advanced methods of digital target marketing come with distinct advantages for advertisers and consumers alike, they also raise privacy concerns for online shoppers and expose marketers to potential legal risk. The current laws and regulations in regards to online behavioral advertising and consumer privacy have not been effectively able to prevent the ongoing data breaches and malicious use of personal consumer information. The purpose of this article is to explore the lack of policy and regulation in place to efficiently regulate digital marketing as well as the effects that digital marketing and privacy concern may have on e-commerce. Specifically, this article attempts to (1) to provide an overview of Online Behavioral Advertising and Web Cookies, (2) to cover the current and evolving laws and regulations in place with an emphasis on the Federal Trade Commission, (3) analyze the effects of these laws on consumer privacy concern and e-commerce, and finally (4) discuss some recommendations for online marketers. This paper will also explore the principles learned and the connections that can be made between companies, consumer data, data privacy, and web browser cookies that are used in advanced forms of digital marketing.

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## Introduction

The methods of target marketing have changed over the years from traditional to digital. The way we have collected data on consumers and used that data to solicit products to them has caused controversy over the recent decade. Businesses have steered away from traditional methods of marketing such as direct mail, newspaper ads, and billboards, and have adopted advanced methods of marketing and data gathering through use of digital marketing. Some of these methods consist of search engine optimization and online behavioral advertising (OBA), also referred to as Online Behavioral Targeting (OBT). In a simple example of OBA, an advertising network that does marketing for many different companies can track consumers by their web browsers—using cookies—and assume what types of products or services that they would be interested in. For consumers visiting websites about vacation trips, the network will assume that the consumer is interested in going on a vacation. The network can then display ads to consumers that

they think would be interested in purchasing vacation packages.

Web cookies can be described as files that websites store on your computer's hard drive to identify you as a consumer. Greenburg, E. A. (2000) article explains that one of the main uses for cookies is targeted marketing, where web sites will subscribe to media service companies that place advertisements on the sites' pages and keep record of those who view them. Upon browsing such a page, you may not even notice these advertisements. But these advertisements notice you, and they secretly store cookies on your computer that assigns a unique identification number to you. Phelps, Nowak, and Ferrell (2000) conducted a survey to examine relationships among consumer beliefs about direct mail advertising, situational characteristics, and privacy concerns. The results indicated that most of the consumers were worried about the ways companies were using their personal information and this had caused a negative view toward personalized direct mail.

These methods of digital marketing have continuously increased in use throughout recent years. U.S. digital advertising revenues reached \$57.9 billion during the first six months of 2019—the highest spend in history for the first half of the year—according to the latest Internet Advertising Revenue Report prepared by PwC US. The record-breaking total marks a 17 percent year-over-year increase from the first half of 2018. While increased growth is continuing in digital, the report also cautions that resources associated with complying with the California Consumer Privacy Act (CCPA) and the myriad of other data regulations proposed by states will likely have a negative impact on businesses in the digital marketplace (IAB 2019). Specifically, this article attempts to (1) to provide an overview of Online Behavioral Advertising and Web Cookies, (2) to cover the current and evolving laws and regulations in place with an emphasis on the Federal Trade Commission, (3) analyze the effects of these laws on consumer privacy concern and e-commerce, and finally (4) discuss some recommendations for online marketers. This paper will also explore the principles learned and the connections that can be made between companies, consumer data, data privacy, and web browser cookies that are used in advanced forms of digital marketing.

### Literature Review

Do the methods of digital target marketing prevent consumers from engaging in e-commerce? Many consumers view the methods of digital marketing as an invasion of privacy, others find it convenient for their online shopping experience as products are tailored to their liking and solicited to them. But at what point do we draw the line between conscientious soliciting and the breaching of one's privacy? Information sharing may increase productivity for both online consumers and companies. Having products solicited to you based off your personal preferences is more convenient for the consumer and helps companies with their marketing efforts. If consumers are given the option to opt out of the use of cookies—through Adchoices—and don't want their online activity being monitored, then they can do so, right?

AdChoices, which is part of a self-regulatory program that was initiated by the Federal Trade Commission in 2009, was created for companies that use online interest-based advertising in the United

States, Canada and across Europe. The program asks that advertising companies establish and enforce responsible privacy practices for interest-based advertising, and it is focused on giving consumers transparency and control over their information. The American Association of Advertising Agencies, the Association of National Advertisers (ANA), the American Advertising Federation (AAF), the Direct Marketing Association (DMA), the Interactive Advertising Bureau (IAB), the Better Business Bureau (BBB), and the Network Advertising Initiative (NAI) all joined together to create this program. The group overseeing the program was called the Digital Advertising Alliance (DAA), and the DAA's AdChoices program was launched in October 2010. For companies that are part of the self-regulatory program, the Adchoices icon will be displayed on the top right corner of their online advertisements to let consumers know when data is being collected or used on them. Consumers can learn more about the advertisement, what the website is collecting, and have the ability to opt-out of such targeting by clicking on the icon. One opposing view of this option is due to the fact that though consumers may be aware of the Adchoices symbols in the corner of their advertisements, they might not necessarily understand how exactly to use it. Tugend, A. (2015, Dec 21) states, there is a technical hitch. If users decide at any point to delete all their cookies—the small text files used to track web preferences—then the AdChoices opt-out function, which is also a cookie, will be deleted. One way to ensure the opt-out stays on a browser is to click Protect My Choices on the choices page, and for some the process is just too complicated. Parks Associates, (2014) Ur, Leon, Cronor, Shay, and Wang (2012), NAI (2015b), DAA (2016), & McDonald and Cranor (2010) argue that:

Consumer awareness of the DAA's AdChoices icon is low. One study by Parks Associates reported that only 6% of consumers were aware of the AdChoices icon displayed on websites in 2013 (Parks Associate, 2014). Ur, Leon, Cronor, Shay, and Wang (2012) found that among 48 participants surveyed, only 7 participants had seen the icon.

Overall, the public's knowledge of OBA and privacy protection is lacking. The NAI opt-out tool was developed cooperatively by NAI members and the DAA in order to allow

consumers to opt out of OBA which uses cookies (NAI, 2015b). The AdChoices icon informs users that their information may be collected and/or used for advertising purposes and also links them to an opt-out tool that gives them control over how their information is used (DAA, 2016). Parks Associates (2014) found that, of people who had noticed the icon but did not click it, 59% did not know that the icon would allow them to opt out from targeted ads. McDonald and Cranor (2010) reported that only 11% of participants understood the meaning of the explanation of NAI opt-out cookies when they were shown the NAI opt-out page, (as cited in Soontae An (Professor), Hannah Kang & Hyun Seung Jin (Senior Lecturer) 2018 p: 275)

Some argue that the United States is in need of a system similar to the European Union's, where consumers are notified by websites that are tracking them and notified to opt in. Aalberts, R. J., Nill, A., & Poon, P. S. (2016) state that,

For many of the large U.S. online marketers that are also doing business in the European Union, it is important to realize that OBT is regulated more strictly there than in the United States. While the U.S. regulatory system strongly relies on industry-led self-regulation, which pivots around allowing users to take the initiative and "opt out" of behavioral advertising, the European Union's protection of online privacy is considerably greater (Tene 2013). Since the summer of 2011, European Union consumers must explicitly "opt in" to online behavioral tracking according to the "do-not-track" e-privacy directive (Delo 2012). That is, consumers must give their consent by actively opting in. This is quite different from the U.S. practice, where consent is usually given by acknowledging the whole service agreement, which somewhere includes a few paragraphs about privacy and online behavioral tracking. Consent in the European Union (EU) requires overt consumer approval before marketers can track personal data (Lee 2011).

### ***Federal Trade Commission Guidelines, Regulations, and Laws***

There is no single principal data protection legislation in the United States. Instead, the U.S. regulates personal information through many statutes at the state and federal level. These regulations help to protect private information of consumers such as financial information, addresses, and even health records. Depending on the type of information, the laws can consist of the Gramm-Leach-Bliley Act, HIPAA laws, the Cybersecurity Information Sharing Act of 2015, and the basic consumer protection statute enforced by the FTC, Section 5(a) of the Federal Trade Commission Act (FTC Act) (15 USC §45). These laws help to regulate and decrease concerns of information fraud, dissemination, and unethical behavior. Since 2009, the President, Congress, and the FTC have been working on measures to create online privacy laws that would protect consumers that use social networks and participate in e-commerce. Due to an increase in consumer complaints in regards to online identity theft and dissemination of personal information, they have pursued litigation against well-known corporations under the "deceptive practices" section of the FTC Act over recent years. This is ideal for setting an example and deterring future issues in regards to companies failing to secure user information and has been the basis for creating the new California Consumer Privacy Act, AB 375.

The regulation of unfair trade practices under Section 5 of the FTC Act serves as an approach to regulation of online data protection. Once a company breaches the regulations set by the FTC, the FTC can impose hefty fines, mandate programs to ensure information privacy, and monitor corporations to ensure compliance. Failure to prevent data breaches has resulted in a few cases that ended with judicial decisions. This is crucial to ensuring the proper securing of personal information. The methods companies use to increase marketing seem effective for themselves, but when companies fail to secure that information from hackers and malicious intentions of third parties, that's when regulation and penalties must be enforced. There also should be an increase in transparency for consumers of whom obtain the right to know who their data is in the hands of.

Some corporations have been known to violate privacy laws by not being able to prevent security breaches and protect consumer data. This is

where regulation comes into play as a vital part of the online marketplace. As previously mentioned, in January of 2020 the California Consumer Privacy Act, known as AB375, was passed. AB 375 allows any consumer in California to request to see all the data a company has saved on them, as well as a full list of all the third parties that data has been shared with. In addition, the California law allows consumers to sue any companies that have violated the privacy guidelines, even if there is no breach. As Bietti, E. (2020) states, the self-regulating and individual choice-centric approach to consumer data protection remains predominant in the U.S. While legislative progress is being made at the state level, effective federal legislation is yet to be seen. As long as we continue to rely on voluntary disclosures and individual choice, the full scope of deception and malicious use of consumer data will never be addressed. One prime example of this can be seen from the settlement reached between Facebook and the FTC. The fine amounted to \$5 billion for privacy violations. The fine would set an example to big tech companies and be the largest fine to date penalized by the FTC. Previously, “the largest fine ever imposed by the FTC was a \$22.5 million penalty on Google back in 2012 after regulators determined the search giant had tracked users of Apple’s Safari web browser after saying explicitly that it wouldn’t do so” (Kelly, Makena). During that same year, Facebook made an agreement with the FTC, stating that they would no longer lie to its users about their information remaining private. This is a prime example of the need for policy reform and increase in federal legislation. Even the Federal Trade Commission indicated in its 2012 report, *Protecting Consumer Privacy in an Era of Rapid Change: Recommendations for Businesses and Policymakers* page 11, that, to date, self-regulation has not gone far enough. In most areas, with the notable exception of efforts surrounding Do Not Track, there has been little self-regulation. The continuous and widespread cases of unauthorized and improper use and sharing of personal consumer information is evidence that companies that seek to cut corners on consumer privacy do not have adequate legal incentives to curtail such behavior.

### ***Privacy Concern and its Effect on E-commerce***

Research obtained from Sheehan and Kim (1999) states that personalized ads aren’t as effective

if the consumer being targeted feels that their privacy has been invaded. In a study of unsolicited personalized email messages, they found that as consumers’ privacy concerns increased, consumers were more likely to request to be removed from the mailing list or to send a negative message to the online entities in charge. Aguirre et al.’s (2015) article also argues, when firms do not openly notify users that they use personal data and personalized ads, consumers feel more vulnerable. However, when companies are open about data collection, this does not affect the perceived vulnerability. In addition, Miyazaki (2008) found that explicitly disclosing the usage of cookies in a privacy statement and a pop-up can increase consumers’ trust towards the website, their intention to use the website, and to recommend it. Hence, when advertisers are transparent about OBA, this is to their own benefit (as cited by Boerman, S. C., Kruikemeier, S., & Zuiderveen Borgesius, F. J. (2017)). There is no doubt that online behavioral advertising and use of cookies raises privacy concerns for consumers, but the best option for advertisers while doing so is clearly to be transparent with the consumer.

In an article by Jai, T.-M. (Catherine), Burns, L. D., & King, N. J. (2013), research findings suggest that consumers are concerned about their privacy with respect to the level of dissemination of their personal information for secondary uses by affiliates and third-parties, even when the data is shared by their trusted retailers. This could result in a loss in ad spend, a decrease in consumer interaction to a particular brand or website, and ultimately a loss in sales.

### **Methods**

Methods in obtaining this data consists of utilizing the California State University, Stanislaus library databases to conduct secondary research on articles covering privacy laws and regulations on consumer privacy and digital target marketing. Key sources consist of the Federal Trade Commission website, the *Journal of Advertising*, and the *Journal of Promotional Management*. Key terms that were used in accessing this information were: Online Behavioral Advertising, Web Cookies, Digital Marketing, Consumer Privacy, Laws and Regulation. The FTC’s website was used to analyze self-regulatory reports that provide the basis for consumer privacy protection.



## Expected Results

Expected results were as follows: (1) that there are a lack of laws and policies in place to effectively regulate online behavioral advertising and data privacy, and (2) that consumers are discouraged from engaging in e-commerce due to methods of digital target marketing and the raise of privacy concern.

## Significance

This study is significant because previous research articles reviewed indicate that consumers may be discouraged from sharing their personal information and shopping online, even after regulations by the FTC have been created and shown to be enforced. There is also a need for more research in regards to how these consumers react when privacy concern and awareness of digital marketing increases, and what effect that may have on e-commerce and advertisements. Lastly, U.S. Congress has yet to create federal legislation to effectively prevent the ongoing issue of data breach and privacy concern. It is also extremely important that online retailers provide clear and easy to understand explanations about their information practices that are at least accompanied by opt-out choices to allow consumers to knowledgeably participate in managing their online privacy.

## Solutions and Recommendations

Some feasible solutions to this issue would be to follow the “Opt-In” concept used by the European Union, which would be to gain a user’s expressed consent prior to receiving targeted ads. Legislation created to enforce companies to explicitly gain permission to track consumers through use of cookies and other methods should be implemented at each state level as well as the federal. Lastly, more stricter rules for the kind of information companies can track using OBA should be created and made clear.

In conclusion, there needs to be clear laws defined and kept up with technology as it advances in the world of e-commerce and it should continue to be the FTC’s responsibility to fully ensure compliance. Companies should definitely benefit from their ability to target certain demographics and use information that users have granted permission for them to, but as for that information being sold to third parties, or used in a way that violates the rights of those who own that information, that’s not acceptable and penalties shall

follow. The regulations currently in place are ineffective and thus far have not prevented the continuous amount of data breaches from occurring. Therefore, as the online world of retail and information evolves, so should laws for ethical practice, and the enforcing of them.

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# The Effects of Online versus In-Person Psychology Courses on the Students Overall Grade in the Course

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## Abstract

Technology has come to be heavily depended on in terms of communication as it brings ease to many different aspects of our lives, especially in college education. With advancing technology in communication, courses once restricted to be completed in person are now available through fully online settings. Psychology courses specifically make for an easier subject to be transitioned to the online setting as compared to other subjects like biology since there aren't as many labs or group work needed. Regardless of subject, throughout continued research there is a lack of emphasis on the specific academic success achieved by the students taking the different style courses. In-person courses could be beneficial to students due to a set time frame resulting in better time management and better communication opportunities with professors and peers. However, it can also be argued that online courses consist of straightforward assignments and an opportunity to learn at the student's own pace. Technology overall serves as a means to add options beyond the traditional classroom environment to further the education of students who may not be able to physically be present for a course, however, it may also be negatively altering the overall grade a student receives in the online setting compared to the traditional in-person setting. This particular study is an attempt to provide research regarding academic success, through measure of the overall course grade, in online versus in-person psychology college courses while comparing variables such as opportunity for communication, interest in the course, work difficulty, and grade satisfaction.

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## Introduction and Literature Review

Today, online learning consists of students opening any type of computer or even a smartphone at any remote location they may be in order to virtually view a lecture, review PowerPoints, and even take exams without the need to step foot on a college campus to fulfill taking the course. This is a completely different form when compared to the traditional in-person courses in which the student must be physically present in a classroom on a college campus to have access to a lecture, fulfill note taking, and complete assignments/exams all at a designated time while in front of a professor. I had students fill out a questionnaire and gathered data of their overall course grades to test my hypothesis, students who take an in person class will be more likely to receive a higher overall grade in the course as compared to students who take the same course fully online, due to the drawbacks that come with online courses. Not only will this study contribute to research but it can also help make improvements and help students when deciding if they want to commit to a fully online course.

Online courses have increased in both accessibility and popularity since 1989 when the University of Phoenix became the first to offer both a fully online program for undergraduate and graduate

students. In 2003 there were 150,000 courses being taught to more than 6 million students via the web compared to the predictions that almost 19 million students would turn to an online course by 2014. Not only are there universities that are dedicated purely to online education all around but the majority of universities now offer at least a handful of courses in the online format. Perry and Pilati (2011) argue for the success and ease that is brought about by online learning. They emphasize that online learning is not for every student or professor to utilize but that it must be recognized that it can be very effective. The authors argue that an appropriate use of technology is in fact needed for success. They go on to advocate for online instruction as an opportunity for faculty/professors to enhance their teaching (Perry & Pilati, 2011). It is also good to note that there are many resources available online that may not be accessible to an in-person course. Dolan (2008) showed that the resources available to a student in a classroom setting can be offered online as well. This study reveals an important aspect regarding the resources which professors can utilize and the extent which they can go to in ensuring a well-structured course is in place and available.

Online courses tend to be favored in some cases due to the opportunity to go at one's own pace and

its increased resources over in-person courses. In the study by Dolan (2008), the research focused on analyzing the impact of student performance and satisfaction with the course when enrolled in the online versus in-person course. Dolan (2008) ran the research through the setup of teaching an Introduction to American Government and Politics course, which she ran herself, as closely tied to one another as possible while taking advantage of the different online opportunities. Results from the data taken proved to show a higher average in grades from the students in the online course as compared to the students in the face-to-face course. The online opportunities may have been a factor which students were able to look into and take advantage of on their own. This closely relates to Perry and Pilati (2011) who firmly believe technology is an asset and if used properly and to its full potential by students it can be beneficial. Not only that but they make a point to emphasize the freedom which comes from online learning as stepping away from the confinement of a clock in a traditional classroom as the student can make their own schedule. A study which emphasizes this concept as well is how Waschull (2005) replicated a study previously completed by Schrum and Hong (2002) in which organizational, pedagogical, institutional, and student factors were identified as relating to the success of an online course. The results proved to differ from the results found by Schrum and Hong (2002) as Waschull found that six out of the seven factors were not correlated with course performance. The two factors which were found to correlate with test score average, assignment average, final exam score, and final course average were self-discipline and motivation.

While online options do have the potential to be as informative and accessible as in-person courses there is still the question of whether the online courses are as effective for college students in terms of satisfaction. Loveland and Loveland's (2011) study confirmed that enlisting in an online course can cause certain drawbacks, such as having a more negative perception of the course compared to the in-person course. The results indicated that there was an overall higher satisfaction from students enrolled in a traditional classroom setting. What the Lovelands' found was that students evaluated their online course off of different factors than which they would have looked at if the course was face-to-face. The article states that in order for online courses to improve, the professors would need to better adapt to the unique requirements which comes with the environment of a fully online class (Loveland & Loveland, 2011). While it could be true that in some instances the actual work of the students has little differences to it, another study which points out the student's satisfaction is one by Kemp and Grieve (2014) in which two groups were exposed to the

course face to face for the first week and then were switched over to an online section for the second week. After both groups had been exposed to each course option over a period of time, data was collected on the preference and performance (Kemp & Grieve, 2014). Activities, exams, and discussions had been completed both online and in class by the same groups of people simply at different points in time. Kemp and Grieve (2014) found results showing no statistical significance between the scores of the students throughout the two course options. Students themselves, however, showed a strong preference for completing assignments and exams face-to-face as they believed it was a better option and environment than facing a screen.

As far as the factor of communication from either style, there are different perspectives. Take, for example, the study by Perry and Pilati (2011) who even though the researchers themselves argue for technology as being a great use of resources in teaching, they also argue for online settings as having opportunities to still keep communication between peers. For example, they point out that interaction can actually even be increased through student discussion boards which are easily accessible to students enrolled in online courses (Perry & Pilati, 2011). There are resources that can be used to ensure communication as long as the professor is aware and makes use of them. On the other hand, there is the study done by Kemp and Grieve (2014) in which the student showed a preference for the experience of the in-person classroom regardless of their scores on an exam being of no significant difference. Besides the satisfaction of the students themselves there is a point shown of drawbacks of online courses being a sense of deprivation in socialization and communication. Students were able to perform as well but they missed out on the actual face to face interactions not only with a professor but with peers. Even through the resources available to contribute to discussions, it doesn't compare to the good old-fashioned face to face socialization. This concept is further emphasized through a study done by Galyon, Heaton, Best, and Williams (2016) in which the researchers compared the participation available to the students in both style courses. It was found that the live course, when compared to an online-hybrid course, produced significantly higher cohesion scores (Galyon et al., 2016). With an opportunity to be around other students, not just a professor, comes the opportunity to speak out and bounce thoughts and questions off of each other during discussions. A drawback, when we look at online courses, is the deprivation of peers as there is little exposure and no way to physically connect with others in the class who may have similar questions or a better understanding of the material.

Even though there are a handful of studies comparing test scores or achievement, there still exists

a lack of studies on online courses and the effect it has on students' overall academic success in the course compared to an in-person class. This is especially true for psychology courses which are very commonly taken not just as major courses, but a part of general education courses offered to many different students. Once again, Galyon, Heaton, Best, and Williams (2016) evaluated how GPA, critical thinking, and academic classification was affected in online and live sections of a course. Their results, when compared before and after the section was taken, showed no significant differences between sections yet there was no focus on the students' academic performance in the actual course itself. Kemp and Grieve (2014) also conducted a study that looked at how students performed on exams in an online setting and face to face. The researchers separated a group of students into two groups and yet found no significant differences. However, the overall academic success of a student is based on more than just exams.

## **Methods**

### ***Participants***

For this study I recruited participants from the CSU Stanislaus student and faculty population. There was a total of 74 student participants who fully answered the questionnaire while following instructions. From the total, 26 participants reported on behalf of in-person courses and 48 reported on behalf of online courses. Participants were men and women who are at least 18 years of age, 7 male and 67 female, and from different ethnic, socioeconomic, and educational backgrounds. I also attempted to recruit CSU Stanislaus faculty members who had taught at least one fully online or in-person psychology course for participation in this study.

### ***Materials***

Student participants first completed a demographic questionnaire asking what they identify as (Male, Female, or other), their age, and ethnicity. They also answered the main survey I created to assess their satisfaction with their online courses and general experiences in their courses. This survey first asked the student participants for the type of course taken whether online, in-person, or both as well as to specify the class which was taken and the letter grade they received in the course. The surveys consist of a six five-point scale question and three free response questions. The six questions asked are as follows; I felt eager to learn and take notes for this class, I felt comfortable and confident to reach out to the professor with any questions, I found it difficult to complete tasks for this course, I found that this course was taking more time out of my schedule than anticipated, I felt that my earned grade in the course accurately reflects the work that I put in, and I wanted to take this course regardless of the format that it was

offered in. The five-point scale used ranges from strongly agree (1) to strongly disagree (5). The three free response questions were as follows; If you had taken the above course in the opposite format (if online then in-person instead and vice versa) do you believe that you would have received the same course grade? A better or worse grade? Explain, was there anything specific that you believe held you back from receiving a better grade in this course? Explain, and if you have any additional comments regarding your academic success in the course above feel free to note them down. This survey was available both through a paper, if requested, and electronic copy whether a direct link was emailed, or the participant completed the questionnaire through Sona. A questionnaire was also going to be available in both paper and electronic form for professors. Professors were asked for their perspective on teaching their online or in-person courses and how confident they felt to teach their course in the manner which they did.

### **Procedure**

I contacted faculty/professors through email asking for permission to reach out to their students whether through email or in person during a class session to present and ask for volunteers for the study. Participants were able to choose to complete the study either online by giving me their email or in-person. Aside from physically looking for participants, the study was put on Sona. Faculty/professors were also reached out to through email asking for their participation.

For those who completed the study online, they were first provided with an informed consent page and once agreeing to participate, moved on to answer the demographic questionnaire and finally the course questionnaire. The course questionnaire had the option to indicate whether the student was reporting on behalf of their experience in an in-person course or online course. If the student had taken both types of courses, they were asked to indicate so yet go on with the rest of the survey reporting solely on their experience in the online course. Once finished with their survey, participants were shown a debriefing form that provided in depth details about the study and thanked them for their participation. No participants completed the study in person; however, the same procedure would have been applied through paper form. Faculty/instructors were as well reached out to electronically and the same procedure applied.

### **Design and Analysis**

This study was a between-subjects quasi-experimental design with one independent variable with two levels. The independent variable was the course delivery. The two levels were the online course and the in-person course. Both Excel and SPSS were used to run

the test and compare data. The dependent variable was the academic success of the student in the course. The groups of students were in either one group or another without randomization. Students filled out a survey to self-report their own data which was then compared among the two groups.

Three student participant responses were discarded as they either did not apply to the psychology course category or did not fully complete the questionnaire who have had experience taking either fully online courses and/or fully in-person classes. The Faculty/ instructor data was not able to be accounted for as well due to high levels of emails being received and busy schedules, which led to a lack of responses.

### Results

Out of the 74 participants, ~ 10% were male (n= 7) and the rest were female (~ 90%; n = 67). Gender is not thought to be a confounding factor due to the small sample size of males which participated as well as the overall sample size of participants. From the total, ~ 35% (n = 26) reported on behalf of In-person course experience while ~ 65% (n= 48) reported on behalf of an online course experience. I compared the results of the overall online course grades of having passed the class in general with a C or better as well as comparing to see how many students had passed the course with a successful grade measured by earning a B or better. The results I actually received from the overall course grade received in the online class are of a 100% passing rate and a success rate of ~90%, having earned a B or better. On the other hand, students in the in-person course had an overall passing rate of 96% and ~85% success rate of a B or better-earned grade (Fig.1). Through an independent sample t-test (Table 1) between the course type and grade earned, it was concluded that there is no significant evidence to support the research proposal that in-person courses affect a student's grades in a significant manner (p= .161).

There were 6 lower division psychology courses and 18 upper division psychology courses in which students reported on behalf of (Table 2). There was a majority of students who were taking upper division online classes as compared to students taking lower division courses. While most of the courses were scattered there was ~82% of students reporting on lower division courses who specified the PSYC 2010 Intro Class (n= 23). Overall participants presented a sense of indifference as to the actual format of the classroom, ~82% of the total participants were neutral to strongly agreeing on wanting to have taken the course regardless of the format, and were focused more on the content they would be taking in from the course (Fig. 2). Participants reported having had a strong motivation themselves to do well and those who received an A in the online courses expressed believing they would receive the

same grade in an in-person version of the course. The one participant who received a D in the in-person format, along with students who were in the C letter grade expressed having procrastinated in doing their work as a reason for their grade not being higher giving little blame to the format of the course. In both online and in-person courses students generally felt comfortable reaching out to their professors (Figure 3); ~4% (n= 1) of the in-person reporting students and ~6% (n= 3) of the online students expressed not feeling comfortable enough to reach out to professors. Students did not seem to find tasks for their courses to be too difficult either (Table 4); only ~8% (n= 2) from the in-person course and ~15% (n= 7) of the online students agreed that tasks were difficult to complete. From the two in-person course students, one was enrolled in a lower division course and the other was enrolled in an upper division course. Meanwhile, in the online courses both students who reported Strongly Agree to task difficulty were in upper division courses along with 2 out of the 5 total students who had reported Agree, the remaining 3 students were in lower division courses.

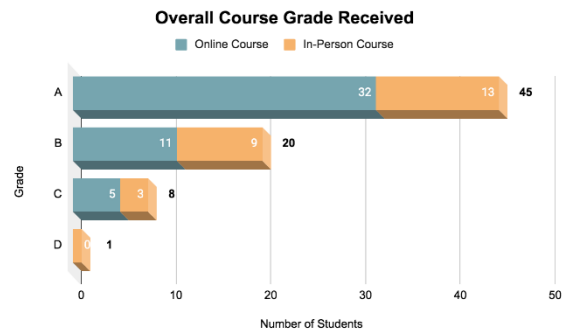


Figure 1: Overall earned grade by either course format

Independent Samples Test										
	Levene's Test for Equality of Variances	t-Test for Equality of Means				Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
	F	Sig.	t	df	Sig. (2-tailed)			Lower	Upper	
Earned overall grade in the course	Equal variances assumed	1.366	0.246	1.415	72	0.161	0.255	0.180	-0.104	0.614
	Equal variances not assumed			1.331	43.178	0.190	0.255	0.191	-0.131	0.641

Table 1: Statistics of Independent Sample t-test

Type of Psychology Course in Which Student is Enrolled			
	In-Person	Online	Total
Lower Division	4 courses; n= 17	3 courses; n= 11	6 courses; n= 28
Upper Division	8 courses; n= 8	16 courses; n= 38	18 courses; n= 46
* Some courses offered in both styles			

Table 2: In-person and online psychology course enrollment statistics

**"I wanted to take this course regardless of the format that it was offered in"**

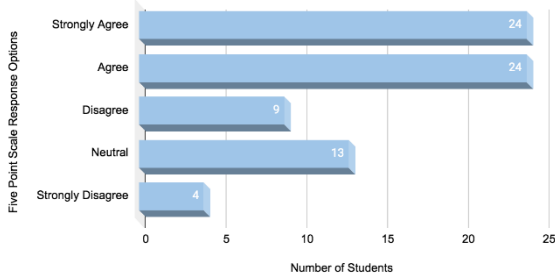


Figure 2: Overall student response to taking a course regardless of format

**"I felt comfortable and confident to reach out to the professor with any questions"**

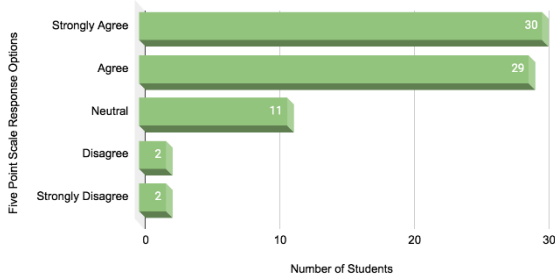


Figure 3: Overall student response to feeling comfortable and confident to reach out to professors

## Discussion

The hypothesis of this study was that students who take psychology courses in-person earn a higher overall grade, a B or better, than students who take psychology courses online. Going into this study, I had expected the results to reflect a higher educational success rating, a more positive experience overall, a better connection with their professor, and fewer instances of feeling as if they were falling behind when enrolled in the in-person course. I expected to find these results as they are more often exhibited by students attending in-person classes (Gibson, 2011). I also kept in mind that results may come to find that there is no significant difference in the performance of the students yet mainly in their personal experience in what they take in learning wise (Cahn, 2017). The results as an overview showed online classes to be pretty common among the participants and did not give very many drawbacks in terms of affecting their overall grades. The more technical results showed that not enough

information was available to come to a set conclusion and the course type could not be correlated to certain grades which again, could be due to a smaller participant size and various variables. The data collected suggests the difference between course type and students taking the course may not have been as big of a challenge for the student in terms of getting their work done and doing what is required of them for the class. Just as well, the majority of online courses were upper division classes which may have to do with students being older and having to juggle tighter schedules in which the online option allowed them to work at their own pace. Psychology courses overall are easier to be taken online even when taking an upper division course as the format is more lecture and note based which can fairly easily be uploaded and made available online. Once again, previous research has pointed out that the actual grades may not differ much between the styles of the course but that satisfaction from the student may vary as far as their experience. Even though there were no significant differences within the data there is a slight curve toward students feeling more comfortable to reach out to professors and having less difficulty with tasks in the in-person courses.

While effort to collect honest data from students was taken there were limitations in terms of who was participating. Many participants seemed to be either psychology majors or were interested in the context of the course regardless of the way it was taught as well as expressing self-motivation to do well in the course. Participants who reported on behalf of the in-person course most likely have not had an experience in the online course and their feelings about trying to earn the same grade in an online format may be biased or inaccurate due to not having the knowledge as to whether or not they do well in that environment. Additionally, it is possible that participants misread a step in the survey and answered for the opposite course style than asked when selecting that they had experienced both in-person and online courses. As far as faculty/professors, a drawback is the limitation of the psychology major in terms of only reaching out to a handful of professors who teach these courses and who on a daily basis receive many emails which could have led to the lack of responses and data from this perspective. Another overall drawback is the fact that as technology advancements are found as a resource for the classroom, not all professors are able to keep up or feel confident enough to truly utilize the most that technology can offer them when teaching a course.

Throughout this study I was most excited to see the perspectives of not only the students but the faculty as well. I was disappointed that I was unable to get the data from the professor perspective and do think that that is a very impactful perspective to take into consideration as well for any future studies. I also looked forward to

comparing my own experience and perspective of online courses to my peers. I had personally struggled a bit when I took online courses for the first time and felt that in-person were a better format for myself. I had also heard many peers around me that felt similar to my thoughts about online courses, so it was interesting to see the end results go against what I had thought. I do believe online courses are helpful and agree that they will only continue to grow in popularity.

### Acknowledgements

I would like to thank the faculty and staff of California State University, Stanislaus Honors Program for the guidance and support throughout my undergraduate career. A special thank you as well to Dr. AnaMarie Guichard and Dr. Jamila Newton for their time and Dedication to my project.

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# The Effects of Past Financial Business Scandals on The Current Business World

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## Abstract

In the early 2000s, many business scandals occurred that led to several changes throughout the business world. These scandals took place particularly in the accounting aspect of businesses. Large corporations such as WorldCom and Enron, began claiming more assets and less liabilities than what they really held. When the truth was revealed, these businesses came to a fall causing many people to lose their jobs and shareholders to lose their money. Due to the catastrophic chain reactions, the government put several new rules and regulations, such as the Sarbanes-Oxley Act, into place to put an end to accounting related business scandals.

This study is an attempt to try to see the connection between past financial fraud and the effect on the current business world by focusing on the financial scandals of Enron and WorldCom. Past research on the effects of financial business scandals on the current business world has been lightly touched upon, but further examination and analyzation can conclude what exact financial scandals created specific negative effects. It is crucial that the cause and effect of financial fraud be clearly seen in order for business leaders to be able to take the proper steps to avoid the same mistakes. It is predicted that the connections between past financial scandals and the present-day business world will show a decrease in financial fraud and an increase in attempts to hold higher reputations of CPAs and publicly traded companies.

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## Introduction

In the early 2000s, many business scandals occurred that led to several changes throughout the business world. These business scandals took place particularly in the accounting aspect of the businesses. According to Petrick and Scherer, large corporations such as WorldCom and Enron, began claiming more assets and less liabilities than what they really held (2003). These false numbers caused many people to lose their jobs and shareholders to lose their money. When the truth was revealed and these businesses came to a fall, the government put several new rules and regulations into place to put an end to accounting related business scandals.

Of all the laws and regulations put into place, the Sarbanes-Oxley Act is the primary law that was enforced and had the largest impact on the accounting profession (International Financial Law Review, 2006). Foote and Neudenberger state that these new laws have an effect all over the world. In addition, new laws and regulations affect multiple relations: business to business, business to employee, and business to customer (2005). Word about these many business scandals spread throughout the media and the effects of these scandals have been stated through established

laws, but the effects of these scandals have not been deeply researched.

This study is an attempt to try to see the connection between past financial scandals and the effect on the current business world. The following literature has been utilized to analyze how past financial business scandals have affected present and future businesses. This study will be based on research previously conducted by reliable intellectuals. Most of the research will be focused on the financial scandals of Enron and WorldCom and the Sarbanes-Oxley Act. Research regarding Enron, WorldCom, and the Sarbanes-Oxley Act is relevant to the effects of past financial business scandals on present and future businesses due to Enron and WorldCom being a part of major financial scandals. These two scandals had major impacts which then led to the announcement of new accounting regulations known as the Sarbanes-Oxley Act. In order to accurately display the effects of past financial business scandals on present and future businesses Enron, WorldCom, and the Sarbanes-Oxley Act must be discussed heavily.

## Literature Review

### Enron and WorldCom

Asthana, Balsam, and Krishnan's study (2010) analyzed one of the many negative effects between one business and another business. During the collapse of a major corporation named Enron, the name of the business that was hired to audit Enron was released to the public. With the announcement of Arthur Andersen's audits adding to the fall of Enron, other businesses scurried to review their own audits. At the time, Arthur Andersen was one of the Big 4 CPA firms, which led them to be popular among numerous businesses (2010). After its linked scandal to Enron, business everywhere began switching auditing firms. Those businesses that switched within the three-day time frame from the scandal being announced received a positive stock price reaction. Eventually, Arthur Andersen was found guilty of obstruction of justice, which led the firm to cease its practice by August 31, 2002. This study further goes on to explain that because of a massive incident such as this, CPA firms now must establish greater credibility today than before in order for their clients to trust in their services (2010). These findings are also promoted by Minitz and Morris (2017) and Petrick and Scherer (2003). Furthermore, this study is an example of research providing evidence for the negative effects between one business and another and between a business and its customers due to a financial business scandal. However, this study is limited since it focuses its research on one major business scandal and one CPA firm that was linked to the scandal.

Williams' (2008) research evaluates the financial scandals of Enron and WorldCom. His study focuses on the effects of white-collar crime. Enron and WorldCom caused two of the world's largest bankruptcies due to the falsity of several financial statements over multiple years. Since Enron and WorldCom effected not only one nation, but multiple nations and embarrassed corporate America, the government wanted to make an example out of them (2008). Although the news regarding the financial scandals spread rapidly throughout the media, the government knew the coverage was not enough to prevent future financial fraud. When Enron and WorldCom went to court regarding the falsity of their financial statements, the judge enforced strict rulings in order to show the rest of corporate America that white-collar crimes would not be tolerated (2008). Williams' study successfully examined the effects of Enron and WorldCom from a different point of view than other research has done in the past. This study proficiently displays a cause and probability for effect on future businesses but lacks examples of true effects on present corporations.

Once Enron's top management began serving their time in prison, some people's sentencing was cut. Although judges originally gave long sentences, prisoners were able to make deals by offering to use their fortunes to pay back people they had stolen from. Hays and Driver (2013) argue that by letting top management use their money, which is originally stolen, to pay back those harmed by the fraud shows others that if they commit fraud, they can serve short sentences if they agree to pay back the money they stole. Although top management was able to reduce their sentences, they still were held to a minimum of 10 years in prison with all of their assets frozen until it was determined which money was legitimately theirs.

Foley's study (2002) confirmed the effects of the various financial business scandals on the general public. He starts off by stating that currently corporate America is an "ongoing PR nightmare" (2002). Since a large number of corporations were involved in some kind of business scandal that become public, it is hard for them to rebuild their credibility. He found that it is even harder for companies to rebuild their credibility now than ever due to new government laws, greater scrutiny, and higher standards that were put in place due to large corporations publicly falling. Due to the biggest scandals being involved with financial statements, the communication between companies and Wall Street and companies and its shareholders is more sensitive and crucial than before (2002). This study displays an attempt to connect how the business environment currently is due to past corporate business scandals. Although, Foley gives examples by stating the different laws put into place, his connection lacks direct examples of corporations that directly caused this environment.

### Sarbanes-Oxley Act

Janney and Gove's (2010) research focuses on the American government's involvement in the corporate world after the disclosure of stock scandals among various corporations. One of the major legislations that was signed into law was the Sarbanes-Oxley, which was signed by President Bush in 2002 (2010). The Sarbanes-Oxley legislation requires CEOs and CFOs to become more involved and take greater accountability for their company by signing all financial statements. This mandatory rule ensures that CEOs and CFOs cannot claim they were unaware of any financial mistakes. Along with the mandatory signature, penalties for financial fraud were toughened to scare corporations and CPA firms from committing the same crimes as past companies (2010). Janney and Gove's findings is further backed by Foote and Neudenberger (2007) and the International Financial Law Review (2006). In addition, Janney and Grove's study deeply and accurately evaluates a major legislation that creates accountability and instills fear in corporations and their leaders. Their

study reveals a strong connection between past financial fraud and laws passed afterwards that affect corporations now and will continue to in the future. Although this study informs of a key legislation, it lacks speaking about other important laws that have been passed along with Sarbanes-Oxley.

Some argue that the Sarbanes-Oxley Act does not fulfill its job. Reutter (2004) references an Illinois accounting law professor that claims that the Sarbanes-Oxley Act addresses important problems but adopts weak solutions. He furthers his argument by stating that the act causes auditors to miss large opportunities with their clients. He even goes on to say that the act's regulations are too lenient and do not provide any beneficial results. Although some intellectuals view the Sarbanes-Oxley Act as taking opportunities away from auditors, this is done to ensure that all auditors remain independent and are not easily persuaded by their clients.

In addition, Chen (2014), a research student looking to see if the Sarbanes-Oxley Act reduces fraudulent financial reporting, came to the conclusion that the post- Sarbanes-Oxley Act probability of fraud falls by 7% to 18%. His findings support the initial purpose of implementing the Sarbanes-Oxley Act. If the act is truly taking opportunities away from accountants, these lost opportunities are being justified by the decrease in fraudulent financial reporting.

Past research on the effects of financial business scandals on the current business world has been lightly touched upon. Most studies give broad generalizations of the overall effects from financial fraud without referencing specific examples that led to specific effects. Other studies examine specific examples and give a new perspective on the causes and effects of business scandals within corporate America but lack a conclusion of an overall effect on the business world. With regards to current studies, further examination and analyzation can conclude what exact financial scandals created specific negative effects. With each individual scandal, an overall impact from financial fraud among corporate America can eventually be seen to prevent future financial scandals. It is crucial that the cause and effect of financial scandals be clearly seen in order for business leaders to be able to take the proper steps to avoid the same mistakes.

## **Method**

*Participants:* Since this research focuses on effects of past events and deals solely with qualitative data, there were no participants required to conduct research. Overall, the research's subjects were limited to two major corporations, WorldCom, and Enron. WorldCom was the United States' second largest long-distance telephone company. For years, they grew by acquiring other telecommunication company, but

eventually fell after fraudulent activity occurring within the accounting sector of the business. Enron was an American energy commodities and services company that was founded by merging two relatively small companies. Combining these two companies resulted in a corporation, but just like WorldCom, Enron ceased operations in 2007 due to financial discrepancies stated on accounting reports. WorldCom and Enron were chosen as the only subjects due to the large impact they had on the accounting profession and their familiarity among business and non-business individuals.

*Design:* This study focuses on past events and their effects on present situations. This results in a non-experimental study in search for qualitative data. This qualitative data was found through archival research. The archival research was done through Stanislaus State University's online library domain and online textbook publisher accounts. Data was collected through observational research by utilizing various scholarly journals, articles, and textbooks to observe the cause and effects of financial fraud.

*Materials:* In order to collect the data needed to analyze cause and effect, no physical materials were needed. All qualitative data was found through archival research done through the Stanislaus State University library domains and online accounting textbooks.

*Procedure:* Access to Stanislaus State University's library resources were needed in order to begin research to access scholarly journals and articles free of charge. As a student, access to library resources was easily accessible with a student login. Once the library's search bar was open, filters were applied to cut down the number of results. Results were limited to only scholarly journals and articles to ensure reliable sources.

A search for an overview and details of the WorldCom scandal was first conducted. Then, the results of the WorldCom scandal were researched. This included the laws and regulations that were passed due to the scandal. Afterwards, the same steps were taken with the search for the Enron accounting scandal. To further establish credibility, WorldCom's and Enron's scandals were researched through online accounting textbooks. This was done by using an online student account to access previously purchased textbooks. Once logged in key words such as WorldCom and Enron were imputed into the search bar to get related data. Lastly, the results from all searches was analyzed and connected to current business conduct.

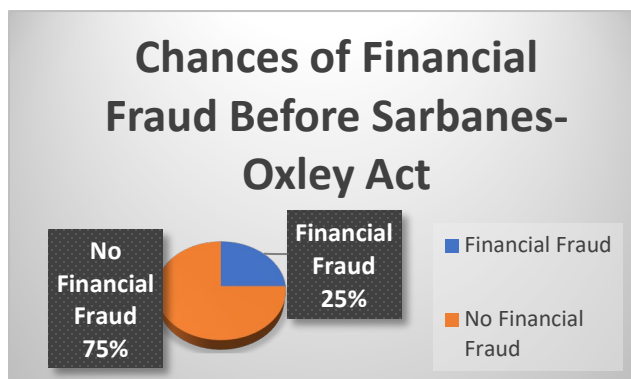
## **Results**

In all the above opinions, articles, and scholarly journals, the review of Enron's financial scandal, WorldCom's financial scandal, and the implementation of the Sarbanes-Oxley Act point to several effects on the current business world. Main effects on businesses today include the following:

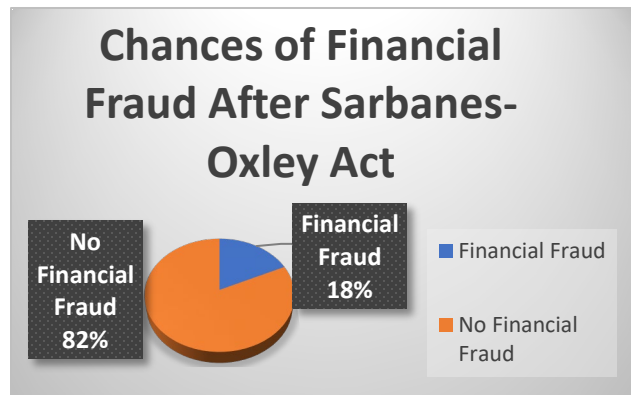
- CPA firms must establish greater credibility with their clients today than before
- If found guilty of false financial reporting, harsh sentences will be enforced to
- demonstrate that white collar crimes will not be tolerated
- Communication between companies and Wall Street and companies and its shareholders is more sensitive and crucial than before
- CEOs, CFOs, and CPAs are held to greater accountability
- The post- Sarbanes-Oxley Act probability of fraud falls by 7% to 18%

These stated effects are found to all share one common goal of reducing financial scandals, like that of Enron and WorldCom. Although there has been financial fraud within the accounting profession since the Sarbanes-Oxley has been implemented, it is apparent that false financial reporting has diminished to a lower rate than before. This claim can be further evaluated below through pie chart 1 and pie chart 2. After reviewing and analyzing all the above data, I conclude that past financial business scandals have positively impacted the current business world by forcing businessmen and women to be proactive and ensure that fraudulent activity does not occur within their company.

**Pie Chart 1**



**Pie Chart 2**



**Discussion**

Overall, this study and its findings contribute to the general field of business, but more specifically to the accounting and financial sections of the business world. The connections made within this study will enhance the reports and research done on WorldCom, Enron, and the Sarbanes-Oxley Act by adding its effects on current corporations, individuals within companies, and layman that invest in corporations. These connections can aid current business students by providing them with knowledge of what has happened in the past in corporate America, what they should expect when they join the work force, and what to look out for during their time in corporate America. These results can also help current business workers by informing them of why they should not be tempted to commit fraudulent activity within their own company and what precautions they should take in order to avoid fraudulent activity within financial sectors.

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#### Appendix A

Data used to create Pie Chart 1 and Pie Chart 2 comes directly from Does the Sarbanes-Oxley Act Reduce Fraudulent Financial Reporting written by Chen, S. A condensed version of his calculations and findings are in the quotation below:

“In other words, suppose the probability of fraud was  $x$  in the pre-SOX period, then my result suggests that the post-SOX probability of fraud became  $(x - 1\%)$ . Dyck, Morse, and Zingales (2013) estimate that the pervasiveness of fraud,  $x$ , is approximately between 5.6% and 14.5%, and hence my finding implies that the post-SOX probability of fraud falls by 7% ( $= 1 \div 14.5$ ) to 18% ( $= 1 \div 5.6$ )” (2014).

# The Relationship between Social Emotional Learning and Teacher Beliefs

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## Abstract

Social Emotional Learning (SEL) has demonstrated to be critical in improving students' skills in social and emotional domains. SEL is the development of skills related to self-control, social awareness, and interpersonal skills. By improving these domains, it can help students manage and recognize emotions, establish positive relationships, and learn how to handle challenging situations. The purpose of this study is to examine the effects of teacher beliefs on the effectiveness of Social Emotional Learning. It is hypothesized that teachers that report a higher confidence in their ability to implement curriculum to reach SEL goals, will report higher levels of social-emotional skills in their classroom. Data was collected using a survey that evaluated teachers' perceptions of SEL and the overall climate of the classroom from credentialed TK-12 teachers in the United States. Findings can help educators and administrators decide what curriculum to implement, as well as decide what future training and support should be included at schools.

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## Introduction

In an ideal world, all children that attend school arrive prepared and ready to learn. This would allow teachers to concentrate on implementing the curriculum and standards set by their state and school districts. Teachers try their best to supplement children's development during the school day. However, students who come from a low socioeconomic background have a more difficult time accessing health resources, participating in extracurricular activities, and they commonly have parents with a lower education level. These different factors put children at risk and at a disadvantage for school when starting school.

The school system in the United States has placed an emphasis on academic learning and getting students into college. Although this prepares students academically, a huge part of life skills was being left out in classrooms. Recently a shift in schools has started to include social-emotional learning (SEL) to ensure that students are building their emotional intelligence. This shift towards a more holistic outlook on the child is new and is being introduced to teachers. Research has proven SEL to be critical in improving students' physical and mental health as well as their academic achievement (McClelland et al., 2017). Social and Emotional skills are vital skills that children need for their adult life. Furthermore, the SEL approach was found to still have a lasting impact on the children until their 20's. Participants in the study reported higher levels of educational and economic attainment, and levels of mental health

(Slavin, 2018). This growth in students is seen across various SEL programs and curriculum in schools.

## Children's Needs

According to Maslow's hierarchy of human needs, students first have basic needs like food, shelter, and the need to feel secure. Then there are psychological needs that are essential before one could achieve a sense of self-worth (Kunc, 1992). Schools take steps to ensure basic needs are met by giving free lunches and maintaining a safe and secure environment. However, there are psychological, and self-fulfillment needs that children have and can reach with support from educators and caregivers. The introduction of Social-Emotional Learning in schools can help students achieve these goals. According to Williams, Lerner et al. (2019) "to focus only on the education of children ... is to ignore the science of early development and to deny the importance of early experiences." Many children enter school with many limitations in physical, social, cognitive, and emotional development that lower their chances for academic success (Williams et al., 2019). The goal of a SEL program is to help students develop skills in the social and emotional domain. By improving these domains, it can help students with decision making, managing emotions, developing empathy and establishing positive relationships (Brackett et al., 2012). It is important to help develop these skills in students, so that as adults they are able to join the workforce, develop meaningful relationships, and have good mental health.

## **Critiques**

In the field, some researchers when studying social-emotional learning (SEL) will use different definitions of what SEL is. So, one of the main critics of SEL is that there is no set definition and it is too loose of a meaning to be accurate. Some believe as Zysberg (2019) explained that SEL is a “fad” and it adds little to the concepts of social and emotional domains. So, critics claim SEL should not be an integral part in school and class planning. The topic of SEL is still a developing topic where more research is being conducted in order to establish best practices and definitions. Although not all literature uses the same SEL definitions and criteria, the finding of those studies does not take away from the importance and found benefits of SEL. Since, it is still a developing theory there is still more research to be done in order to establish and set best practices and definitions for SEL.

Another critique of SEL questions whether it is the school's responsibility to teach students social and emotional skills. Some critics believe that it is the school's sole responsibility to academically prepare students because it could take away from academic teaching. Additionally, it is criticized that certain values or morals should not be taught in a lesson format, but in a natural, realistic way. However, SEL can be integrated into normal class activities and assignments, like through reflective writing.

SEL is a sensitive topic because traditionally parents raise their children according to family values and beliefs. However, school is one of the main places where children are first socialized and introduced to new events. As McCuin et al. (2012) explains, school became more concentrated on academics due to the US policies that were enacted to make the American workforce more globally competitive. Therefore, teachers were more concerned with making sure children were prepared for the content on standardized tests. Now, schools are recognizing the positive impact SEL can have on their students and the overall culture of the school.

## **SEL Implementation**

The school is responsible for deciding what SEL program and intervention plan is best for their school/district. However, an integral part of the SEL curriculum are the teachers themselves. In Schonert-Reichl (2017) research, it was found that when teachers have lower levels of social-emotional competence, this can lead teachers to poorly manage the social and emotional needs of students. As a result, both the students' academic achievement and positive behaviors decreased. It is difficult for a teacher to teach social and emotional competency when they

themselves do not practice it in everyday life. In fact, teaching is one of the most stressful occupations, so in some cases it may be necessary or helpful for teachers to also receive some type of intervention to help them cope with stresses of teaching (Schonert-Reichl, 2017).

In the study by Romasz et al. (2004), they found the qualities that allowed for an SEL program to effectively be introduced to a school district. The staff had an exceptionally positive outlook on the program. The transition was made easier because staff members were familiar with the curriculum, they had received training, and some staff were already knowledgeable in SEL. Additionally, in this district the SEL program was integrated across schools in the district, unlike other schools who use the program in isolation. By integrating a SEL program across the district, it had a more profound effect on students because SEL became the school culture. (Romasz et al., 2004). This collaboration between the district and schools allowed for consistent implementation of SEL and teachers to feel more confident and knowledgeable on SEL goals and practices.

Researchers also found that if there is high engagement and natural integration of SEL, students will still gain the targeted skills; even when teachers do not strictly follow the program (Low et al., 2016). This gives teachers some guidance for when they are preparing a lesson that integrates SEL. With the help of this approach, the true benefits of a SEL program can be seen. However, with the introduction of a new curriculum, some teachers may not feel as prepared or confident to implement SEL in their class. Teachers' beliefs about SEL have an impact on the effectiveness of the curriculum and on the students' social emotional skills. Prior research suggests that teachers who are more familiar and comfortable with SEL will have a more positive effect on their students' social and emotional skills (Romasz et al., 2004). Therefore, we will explore how the differences in beliefs, school support, and training will affect students' social and emotional skills.

Previous research focuses on the overall benefits of SEL across the schools, therefore in this study we will explore the effects that teachers' beliefs have on Social Emotional Learning. Unlike academic subjects, a teacher's background in SEL could be limited because it is not mandatory for teachers to specifically target the social and emotional domains. It is hypothesized teachers that report a higher confidence in their ability to implement curriculum, will also report higher levels of social-emotional skills in their classroom. This information is important to better understand what support and training should be provided to teachers. This will help districts and

schools be able to effectively implement a program or curriculum for the students at all grade levels.

## **Method**

### ***Participants***

Participants in the study were credentialed teachers who taught transitional kindergarten through twelfth grade in the United States. In total 25 responses were collected, and 5 participants responses were deleted for incomplete reporting. Eighteen participants were female and two were male. Additionally, participants were separated into two categories, there were 10 teachers in TK-6th grades and 10 teachers from 7th to 12th grade. There was a total of eight teachers who reported having a SEL program in place at their school. Some examples of SEL programs reported were Toolbox, Restorative Practices, and Character Counts.

### ***Materials***

The first section of the survey recorded preliminary background information like age, grade level, and name of any SEL program set in place (Appendix A). The survey continued with questions about the teachers' own beliefs about SEL and the amount of support/training they receive from their administration. Based on the measure, "Teacher Social Emotional Learning Scale", 12 questions looked at the teacher's comfort, commitment, and culture of SEL at the school. (Brackett et al., 2012) (Appendix B). Participants had five options to answer ranging from Strongly Disagree to Strongly Agree.

Lastly, the final section focused on the teachers' perceptions of their student's social-emotional skills. In order to determine the classroom environment regarding class climate and student relationships, an adapted version of the Classroom Assessment Scoring System (CLASS) was utilized (Pianta et al, 2008) (Appendix C). A total of 9 questions were selected from the following domains: Positive Climate, Negative Climate, Behavior Management, and Teacher Sensitivity. Teachers were able to report from a range of 1 to 7, with seven being in the high range. The study then concluded with the debrief from and information for further research.

### **Procedure**

The researchers posted the survey link to social media with a brief description of the purpose of the study. Participants that were interested were able to complete the survey at a time that was convenient to them. First, Qualtrics presented all participants with the consent form for them to accept. It explained that all data collected will be anonymous and that participants can skip any question that makes them feel uncomfortable. Then background information was

collected, and the survey questions followed. The first question set asked participants about their beliefs on SEL. Then in the last set, the participants rated the climate of their classroom. After the surveys were completed, the debriefing form followed where they were thanked for their participation and references were provided for more information. Exclusions were made for incomplete responses.

### **Results**

For the study, 20 participants' responses about their beliefs of SEL and the climate of the classroom were used. From the Teacher Social Emotional Learning Scale, questions 5,7,8, and 9 were used to calculate the teacher comfort level with SEL in the class. In the last section from the adapted measure, CLASS, questions 1-4 were used to determine the positive interactions and climate of the classroom. A Pearson's  $r$  data analysis revealed a moderate positive correlation  $r=.40$ . Teachers that reported a higher comfort in teaching SEL reported higher levels of positive climate in the classroom.

### **Discussion**

It was expected that teachers who felt more confident in their ability to teach and implement SEL curriculum, also reported higher levels of positive climate in the classroom. Teachers reported higher levels of respect, positive affect, positive communication and positive relationships compared to teachers who reported lower on their comfort in teaching SEL. These interactions signify that students and teachers are demonstrating skills consistent with the goals of SEL. A limitation of the study was that the sample size was small, and majority of responses were female. A more diverse sample would be more representative of the teacher population. Additionally, the measures used required teachers to rate their own classroom based on their view. In the future, children's reports or observations could be used to prevent bias from teachers and to more accurately measure the climate of the classroom.

When a teacher feels more confident in their ability to teach SEL, the more effective instruction will be. Previous research demonstrated that when teachers have high engagement from students and can implement it naturally, students' social emotional skills increase. Additionally, high confidence has been correlated with program buy-in, teachers perceived the program more effectively, and they also enjoyed the program more overall (Brackett et al., 2012). These qualities encourage teachers to be more consistent with their implementation of SEL. Which is essential when implementing across grade levels and years as students continue through the school system. Teachers who are more confident with SEL, were more positive



in their attitudes and commitment to SEL implementation.

Teachers and schools must work together to implement and support SEL to create opportunities for students to grow their social and emotional skills. SEL training can help teachers improve and build upon their own social and emotional skills to better teach their students. Social Emotional Learning can take place in the classroom naturally, without the implementation of a specific program or curriculum. Teachers can receive trainings that help them understand what social and emotional needs students have in the classroom and how to best meet them. Additionally, trainings can be targeted for the different grade levels. Teachers can learn about developmentally appropriate practices for the specific age group they teach. Confident teachers will support the development of positive behaviors and relationships in their students. By creating a positive climate where children feel accepted, they will be more motivated to learn and they will stay engaged in the material (Shechtman & Abu Yaman, 2012). Positive climate in the classroom is essential to keep students involved and part of the community.

The goal should be to help students prepare for the workforce and adulthood. Students will be equipped with the skills to handle difficult situations and be more confident with themselves individually. Future research should focus on the way's teachers can improve their own skills through training, modules and other sources. Additionally, further research should look at ways to integrate SEL into the various standards teachers have to meet. This would give teachers an additional resource they can turn to when planning their lectures and assignments. SEL has proven benefits for the child holistically, so it is vital that teachers learn how to a successfully introduce and implement SEL ideas into the classroom.

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Appendix A

1. Gender:
2. Grade teaching:
3. Number of years teaching:
4. Name of Social & Emotional Program\* used (if any):
  - a. *\*Social and Emotional Learning (SEL) refers to the development of skills related to recognizing and managing emotions, developing care and concern for others, establishing positive relationships, making responsible decisions, and handling challenging situations constructively.*
5. How long has the program been implemented (If no program in place, state N/A)?

Appendix B  
TEACHER SOCIAL EMOTIONAL LEARNING BELIEFS SCALE

Please read the following definition:

***Social and Emotional Learning (SEL)** refers to the development of skills related to recognizing and managing emotions, developing care and concern for others, establishing positive relationships, making responsible decisions, and handling challenging situations constructively.*

With this definition in mind, please read the following statements and think about how true each is for YOU. Rate the extent to which you **agree** or **disagree** with each statement.

YOUR RESPONSES TO THIS SURVEY ARE CONFIDENTIAL

<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
<i>Strongly Disagree</i>	<i>Disagree</i>	<i>Neither Agree or Disagree</i>	<i>Agree</i>	<i>Strongly Disagree</i>

1. My school expects teachers to address children’s social and emotional needs.
2. The culture in my school supports the development of children’s social and emotional skills
3. All teachers should receive training on how to teach social and emotional skills to students.
4. I would like to attend a workshop to develop my own social and emotional skills.
5. Taking care of my students’ social and emotional needs comes naturally to me.
6. My principal creates an environment that promotes social and emotional learning for our students.
7. I am comfortable providing instruction on social and emotional skills to my students.
8. Informal lessons in social and emotional learning are part of my regular teaching practice.
9. I feel confident in my ability to provide instruction on social and emotional learning.
10. My principal does not encourage the teaching of social and emotional skills to students.
11. I want to improve my ability to teach social and emotional skills to students.
12. I would like to attend a workshop to learn how to develop my students’ social and emotional skills.

Appendix C  
ADAPTED: CLASSROOM ASSESSMENT SCORING SYSTEM PRE-K

**Please read the following directions:**

Based on a typical day in your classroom, please read the descriptions below the rating scale and choose a number from 1-7 that best reflects the behavior in your own classroom.

The descriptions are ordered so that they represent a spectrum of possible climates within a classroom. Although there are only 3 descriptions, there are 7 possible options in order for you to best reflect a wider range of classroom climates.

YOUR RESPONSES TO THIS SURVEY ARE CONFIDENTIAL

1. Relationships:

1	2	3	4	5	6	7
There are few, if any, indications that the students enjoy warm, supportive relationships with one another.		There are some indications that the students enjoy warm, supportive relationships with one another.			There are many indications that the students enjoy warm, supportive relationships with one another	

2. Positive Affect:

1	2	3	4	5	6	7
There are no or few displays of positive affect by students.		There are sometimes displays of positive affect by students.			There are frequent displays of positive affect by students.	

3. Positive Communication:

1	2	3	4	5	6	7
There are rarely positive communications, verbal or physical, among students.		There are sometimes positive communications, verbal or physical, among students.			There are frequently positive communications, verbal or physical, among students.	

4. Respect:

1	2	3	4	5	6	7
The students rarely, if ever, demonstrate respect for one another.		The students sometimes demonstrate respect for one another.			The students consistently demonstrate respect for one another.	

5. Severe Negativity:

1	2	3	4	5	6	7
There are no instances of severe negativity between students.					There are instances of severe negativity between students or among the students.	

6. Student Comfort:

1	2	3	4	5	6	7
The students rarely seek support from, share their ideas with, or respond to questions from the teacher.		The students sometimes seek support from, share their ideas with, or respond to questions from the teacher.			The students appear comfortable seeking support from, sharing their ideas with, and responding freely to the teacher.	

7. Student Behavior:

1	2	3	4	5	6	7
There are frequent instances of misbehavior in the classroom.		There are periodic episodes of misbehavior in the classroom.			There are few, if any, instances of student misbehavior in the classroom.	

8. Negative Affect:

1	2	3	4	5	6	7
The students do not display strong negative affect and only rarely, if ever, display mild negativity.		The classroom is characterized by mild displays of irritability, anger, or other negative affect by the students.			The classroom is characterized by consistent irritability, anger, or other negative affect by the students.	

9. Sarcasm/Disrespect:

1	2	3	4	5	6	7
The students are not sarcastic or disrespectful.		The students are occasionally sarcastic or disrespectful.			The students are repeatedly sarcastic or disrespectful.	

# Examining the Relationship between Physical Activity and Cognitive Function in Older Adults

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## Abstract

Cognitive function is comprised of a variety of mental components, including memory, learning, reasoning, and judgement. Cognitive decline is the loss of these skills over time and is a natural result of the aging process. Prior studies have shown that physical activity, such as walking or gardening, slows this age-related cognitive decline. We aimed to explore what specific aspects of cognitive function are related to physical activity. Therefore, we examined 49 participants, from the ages of 65 to 89, from an independent living community of senior citizens who reported their typical frequency, duration, and intensity of physical activity. These responses were then weighted by metabolic equivalents, summed, and scaled to represent overall physical activity. Participants completed the Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV), which is a measure of adult intelligence. We analyzed the relationship between self-reported physical activity and objective data obtained from gym facility key cards, which revealed that participants' self-reports of physical activity were accurate. Next, we examined the relationship between self-reported physical activity and cognitive function. Results indicated a significant positive correlation between physical activity and two WAIS-IV subtests, such that more frequent physical activity was associated with better working memory and better visuospatial skills. These results suggest that engaging in physical activity may be protective against age-related cognitive declines, which may have important implications for maintaining independence and the ability to execute cognitive functions as we age.

*Keywords: physical activity, cognitive function, aging, exercise, WAIS-IV*

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## Introduction

Cognitive decline is a continuous concern among the aging population (Guure, Ibrahim, Adam, & Said, 2017), and measures are being taken towards preserving brain function in older adults (Guure et al., 2017). The prevalence of diseases associated with memory impairment has more than doubled since the early 2000s and is projected to raise an additional 68% by the year 2030 (Guure et al., 2017). Researchers are exploring how much of our brain function can be preserved as we age, and how much of cognitive decline is inevitable (Guure et al., 2017). Nonmodifiable factors such as age and genetics are one reason for onset of Alzheimer's that cannot be controlled (Guure et al., 2017). However, modifiable factors such as diet and exercise can be altered to prevent deterioration of memory and brain function (Guure et al., 2017).

Previous research suggests a correlation between physical activity level and performance on tasks that measure cognitive ability (Wang et al.,

2013). Studies examining the relationships between physical activity and cognition have focused mainly on older adults in an effort to prevent cognitive impairment (Wang et al., 2013). There is a decline in tasks such as memory recall and visuospatial skills as people age (Guure et al., 2017), yet results indicate positive effects of physical activity on cognitive function, dementia risk, and cognitive decline (Guure et al., 2017).

Further research supports the correlation between exercise and protein expression in the brain, which is responsible for learning and memory formation (Sleiman et al., 2016). A protein called brain derived neurotrophic factor increases in the hippocampus after exercise, which is linked to a decrease in anxiety and depression, and an increase in cognitive capabilities (Sleiman et al., 2016). One of the primary functions of the hippocampus is learning and memory formation. Therefore, the increase in neurotrophic factor helps to keep this region of the brain active (Sleiman et al., 2016). This suggests a positive correlation between physical activity and the

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preservation of cognitive skills and function due to enhanced signaling pathways in the hippocampal region of the brain.

Additional research has been conducted to explore the validity and reliability of self-reported measures of physical activity in children (Verstraten et al., 2013) and the workplace (Engbers, Poppel, Mechelen, 2007), but no research has been found regarding senior citizens and self-reported physical activity. For children, self-reports of physical activity were not different from actual physical activity as measured by testing the differences in means between methods (validity) and repeated measures (reliability) (Verstraten et al., 2013). When employees in the workplace were assessed based on the use of stairs, there was no significant difference between what they reported and their actual use of the stairs (Engbers et al., 2007). The findings of this research did indicate variability in activity level influenced by an employee's work environment (Engbers et al., 2007). The concept that an individual's work environment correlates to the amount of activity they engage in can be applied outside of the workplace when examining social communities and residential living facilities. The reliability and validity of self-reported exercise in a senior citizen community can further be explored.

### **Significance**

With the growing prevalence of dementia in geriatric patients, it is important to understand the preventative steps that can be taken to preserve cognitive function in the aging population. Physical activity is one of these modifiable lifestyle factors that can preserve cognitive capabilities. Furthermore, if self-reported measures are found to be a valid measure of physical activity, they could provide simpler methods of evaluating the impact of physical activity than objective measures.

### **Hypotheses**

I hypothesized that individuals who engage in more physical activity will have overall higher cognitive function. I also expected to find a correlation in the amount of physical activity a participant subjectively reports in comparison to the objective amount of exercise recorded by their residential key cards, such that self-reported data is a valid measure of physical activity.

### **Method**

#### ***Participants***

The study was conducted at a retirement community for independently living older adults. Forty-nine participants were recruited, from the ages of 67 to 89 ( $M_{\text{age}} = 79.66$  years,  $SD = 6.30$ ; 67% female). Sixteen of the participants were male, and 33

were female. Of the participants, 32.7% earned a Master's degree or higher, 30.6% earned a Bachelor's degree, 4.1% earned an Associate degree, and 8.2% earned a high school education. The ethnicity of participants was fairly homogenous, as 97.9% of participants identified as Caucasian and the other 2.1% identified as Asian. Participants over the age of 90 were excluded from data collection based on exclusion criteria for cognitive assessments. The group of participants were all members of the same continuing care retirement community, had access to resources that are available to individuals with high socioeconomic status, and affiliated with a religious group.

### **Design**

This is a cross-sectional study derived from a larger longitudinal study that focuses on the correlation between the amount of physical activity (predictor variable) and cognitive functioning (outcome variable) in older adult participants.

### **Measures**

#### ***Self-Reported Physical Activity***

Participants were given a demographics questionnaire that asked questions about their engagement in physical activity. They reported a typical week of physical activities that they participate in, in addition to the intensity of the activities, and the duration of the activity in minutes and days per week. This was then converted to a scale for metabolic equivalence based on intensity and the amount of time engaged in physical activity per week: Level of intensity was given a score (vigorous = 8.0, moderate = 4.0, light = 3.3) and multiplied by minutes per day. The total minutes were summed to create a total physical activity metabolic equivalent, and then divided by 100 to standardize scores, which ranged from .46 to 58.24 ( $M = 11.71$ ,  $SD = 10.82$ ).

#### ***Objective Exercise***

Residents have access to gym facilities where they can record the amount of exercise they engage in. Among the resources available to them is cybercycling, which is a type of exergame which combines a traditional stationary bike with virtual reality tours, competitive avatars, and video game features. In addition to cybercycling, residents can partake in group fitness classes or independent activities such as swimming and walking. Residents also have access to weight machines, and the sets, repetitions, and weights of their resistance exercises are recorded. Raw exercise data collected from participant electronic recordings were converted to a scale for metabolic equivalence based on the total amount of exercise engaged in per week by calculating

the minutes of physical activity per day. Total minutes were summed to create an average weekly total of physical activity, which was then rescaled by dividing by 100.

### **Cognitive Function**

The WAIS-IV consists of a series of 10 subtests which measure crystallized ability, fluid reasoning, visual processing, short-term memory, quantitative reasoning, and processing speed (Benson, Hulac & Kranzler, 2010). The WAIS-IV is an interactive, face-to-face assessment where the administrator sits with the participant as if conducting an interview. The process takes about 45 minutes to an hour to administer.

### **Procedure**

Participants were split into two sessions. During the first session, participants were given an informed consent to complete and demographic questions to answer that asked detailed questions about their demographics, health history, and physical activity. The second session consisted of administration of the WAIS-IV and a debriefing form. Analysis was conducted based on FSIQ scores and a comparison of objective data with subjective reports.

### **Results**

The relationship between physical activity and cognitive ability was analyzed using Pearson correlations. Results indicated a strong significant positive correlation between subjective self-reports of physical activity and objective exercise ( $r = .96, p < .01$ ), (Figure 1). Results also indicated a significant positive correlation between exercise and two WAIS-IV subtests, such that more frequent exercise was associated with better visuospatial skills ( $r = .32, p = .03$ ), (Figure 2), and better working memory skills ( $r = .35, p = .02$ ), (Figure 3). Pearson correlations were conducted for the remaining composite scores of the WAIS-IV and physical activity, but there were no significant correlations (Figure 4). Further analysis was conducted to examine the data in quantiles. Results show a comparison of overall composite scores based on physical activity examining the top 25% of participants and the bottom 25% of participants (Figure 5).

### **Discussion**

These results indicate the positive relationship between physical activity and cognitive ability as we age. They also indicate the validity of self-reported data from the participants. Implications of this research indicate that self-reported physical activity is valid at measuring a participants' level of objective exercise. Additional implications show the

correlation between physical activity and working memory, which shows that as we age, our ability to use short-term memory that is concerned with immediate conscious perceptual and linguistic processing can be positively associated with physical activity. The same is true for our ability to interpret spatial relations as we age.

Further research should explore different types of physical activity, including cardiovascular activity and resistance training, and the impact they have on cognitive ability. Individual exercise programs, group activity exercise, and physical activity combined with mental challenge should also be examined to show the relationship between the various types of physical activity we can engage in, and how this impacts us as we age. The relationship between physical activity and other areas of psychological health such as depression, positive affect, and anxiety should also be explored.

It is important to understand the benefit of physical activity on all age categories, from adolescent to adult and through old age. Further research should be conducted to examine the physiological and psychological effects of physical activity across all age groups to incorporate an active approach to promoting overall health and wellness while preventing disease.

Limitations of the study include a small homogeneous sample of predominantly Christian participants, all residing in the same community with access to gym facilities ( $M_{age} = 79.66$  years,  $SD = 6.30$ ; 67% female). Nevertheless, engaging in physical activity may be protective against working memory decline.

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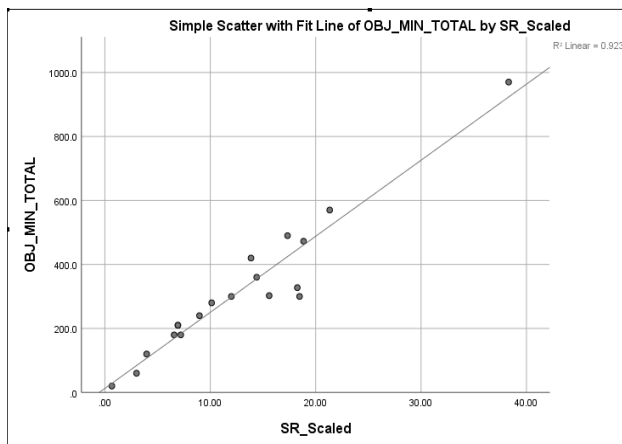


Figure 1: The relationships between self-reported physical activity and objective reports of exercise shows a strong significant positive correlation ( $r = .96$ ,  $p < .001$ ). Results indicate that subjective self-reports of physical activity are valid at estimating objective exercise.

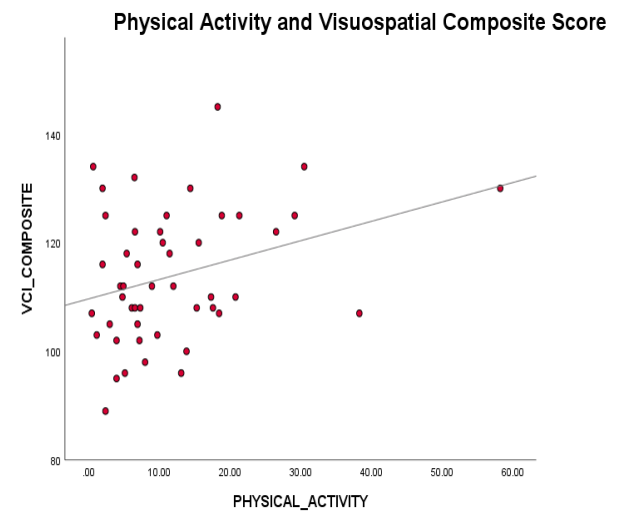


Figure 2: The relationship between physical activity and visuospatial skills shows a significant strong positive correlation ( $r = .32$ ,  $p = .03$ ). Results indicate that individuals who engage in more physical activity will score higher on assessments that measure visuospatial skills. This refers to our ability to perceive space and perform tasks such as drive a car.



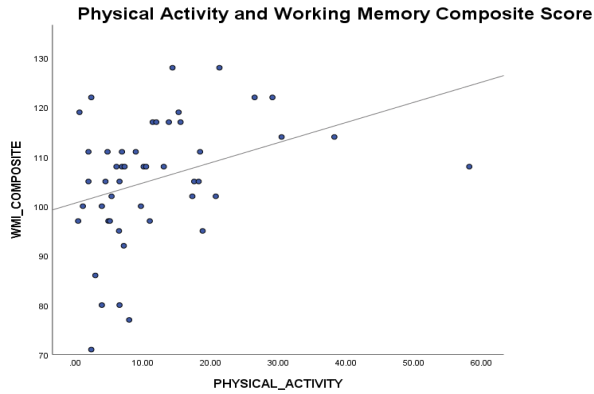


Figure 3: The relationships between physical activity and working memory shows a strong significant positive correlation ( $r = .35, p = .02$ ). Results indicate that individuals who engage in more physical activity will perform better on tasks that measure working memory. This relates to our ability to use memory-related skills such as recall and decision making.

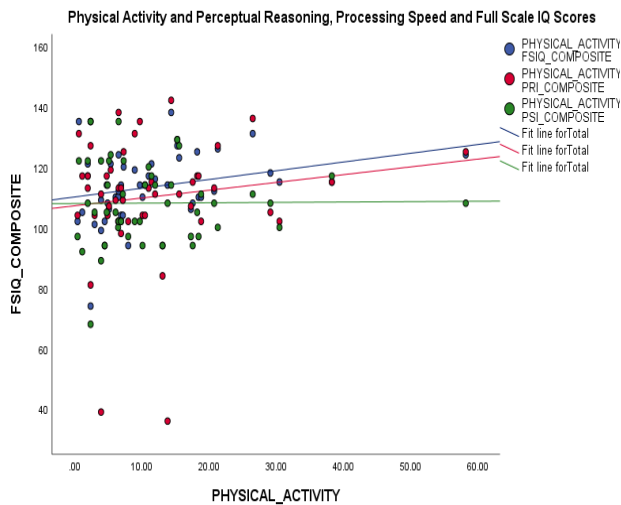


Figure 4: The relationship between physical activity and all composite scores of perceptual reasoning, processing speed, and FSIQ. Perceptual reasoning refers to our ability to think and reason using visual cues and organize our thoughts. Processing speed is how quickly we can accurately solve a problem or answer a question, and FSIQ is the sum of all the composite scores to measure a participant's full-scale IQ.

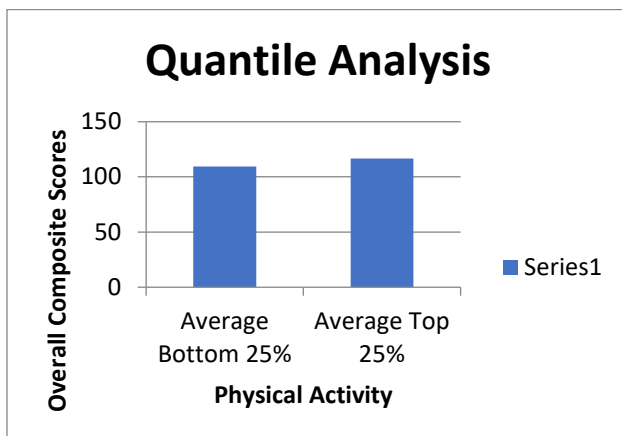


Figure 5: A quantile analysis of overall composite scores based on the top 25% of participants and the bottom 25% of participants categorized by physical activity. Analyzing the data using this graph helps to visualize the difference in overall scores of the participants between the top and bottom quantiles.

# The Relationship Between Incarceration and Recidivism Rates

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## Abstract

In 1960's United States politics crime became a spotlight issue. With growing crime rates the public was looking for a solution to make their communities safer. With the election of Richard Nixon in 1968 the war on crime was in full force and the solution became to convict more people. Later in the 1980's mandatory minimums became commonplace. With California's Three Strikes Law in 1994 the philosophy of solving crime through harsh punishments solidified as the dominant thought among Americans. As a result of this tough on crime initiative we have quadrupled our prison populations and put tremendous strain on our prison infrastructure. Here we explore whether a tough on crime philosophy is effective at reducing crime or if recidivism rates, or re-conviction rates of prisoners, don't support the reduction of crime. Recidivism rates point to the effectiveness of a punishment technique. Preliminary results point to harsher sentencing not necessarily correlated to a reduction in future crime.

*Keywords: Recidivism, Rehabilitation, Retribution, Mandatory Minimums, Tough on Crime*

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## Introduction

### *Modern Punishments and Deterrence*

When viewed from afar criminality seems to be a fairly simple issue to solve, people commit crime, society punishes them and after experiencing the punishment they are less likely to commit crime in the future. However, it is not often this simple. Many have the idea that crime is committed by result of a cost benefit analysis within the mind of a criminal. If the cost (e.g., punishment, severed social ties, less financial stability) outweighs the benefit (e.g., money, status) of a particular crime then laws effectively deter a potential criminal. If the benefit outweighs the cost, then a crime is subsequently committed. Up until this point the main cost associated with committing a crime is jail time, this becomes ineffective if the offender does not view jail as a consequence. The logic dominating public opinion is that prison has a specific deterrent effect which serves to reduce recidivism. On the contrary, scholars have shown that the logic by which prison does, or does not, reduce recidivism may be more complicated (Mears, Cochran, Bales & Bhati, 2016). Many suggested alternatives to jail time are probation, limited opportunities for workers unions, fines, etc. These alternatives become more relevant when considering different sanctions for low level offenders vs. time served in jail.

Most modern punishments rely on the logic that severe and certain punishment will have a deterrent effect on crime. However, severity does not always deter. When the costs associated with

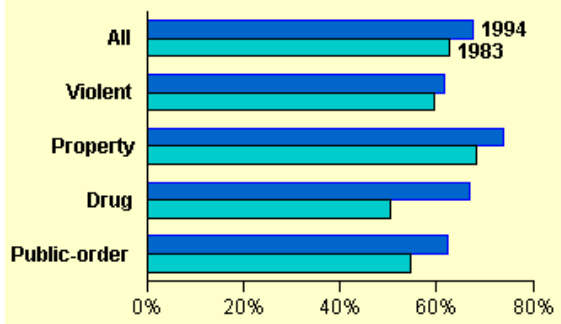
incarceration, such as reduced employability and access to public housing, decrease the benefits of non-offending recidivism upon release may become the more rational option. (Mears et al.,2016). In this way by incarcerating a low-level offender we could be inadvertently making crime a more appealing alternative when they get released. One example of this is the strain we've put upon the parole system by overcrowding prisons. In an effort to reduce overcrowding, parole officers have had to take on more people which has resulted in less oversight, and more parolees violating the rules and subsequently being sent back to jail. The Bureau of Justice Statistics has shown a considerable growth in probation and parole numbers since the 1980's, with this comes an increased caseload for officers (DeMichele, 2007).

### **Determinate Sentencing and Recidivism**

Within the field of criminal justice recidivism is the rate at which convicted criminals reoffend. A study from the Bureau of Justice Statistics which compared recidivism data collected in 1983 and 1994 showed a 5% increase in rearrests rates as well as a fairly stable rate of reconviction. Overall, the 1994 study showed that 51.8% of prisoners that year returned to prison within three years from a separate conviction or a technical violation of their parole (Bureau of Justice Statistics, 2002).

### Percent of released prisoners rearrested within 3 years, by offense, 1983 and 1994

Offense of prisoners released



If the ultimate goal of a prison system is to make society a safer place, then the primary goal would be to deter crime and the secondary goal should be to reduce recidivism rates among people who have already committed crimes. If jail doesn't serve as an effective deterrent to future crime, then more effort needs to be put into making crime a less desirable option after prison time is served. A rehabilitative model of punishment is one in which criminals are "fixed" and made more fit for society; in theory this model should be more effective at reducing recidivism rates than our current retributive model.

The goal of a law is to deter a crime but a law on its own is not an effective deterrent. A sign on the side of the street that shows a maximum \$1,000 fine for littering deters crime only if the punishment for breaking it is severe, swift, and certain. In this case the \$1,000 fine would be effective because it is a severe monetary inconvenience to someone, the ticket would come immediately after the offense, and you can be sure that if a police officer witnesses you littering you will get a ticket. If a law is lacking either severity, swiftness, or certainty then there is little deterrent effect. In many ways the Three Strikes law in California was made in an effort to increase the deterrent powers of criminal law and to make crime less desirable. Consequently, the California Three Strikes Law has been called a policy born of "rage, pain, and fear" (Giovanni, 2012). Created as a reaction to the murders of Kimber Reynolds and Polly Klaas which were both committed by repeat offenders. Under the law someone could be committed to life without the possibility of parole if they had two prior serious convictions, even if the third offense was nonviolent and not serious (Giovanni, 2012). As a result, prison overcrowding has become an epidemic severely straining the state's prison systems. California's prison expenditures have risen from 1 percent of the state budget to 8 percent, increasing as

the prisons filled to capacity. Needless to say, we are now feeling the effects of the Three Strikes Law.

### Effects of legislation: The Three Strikes Law

Recently, habitual offender legislation in New Zealand has shown to have the same unfortunate consequence as the California Three Strikes Law. No tolerance legislation within an area serves as an indicator that the populace believes incapacitation is a more appropriate response to crime than rehabilitation. Ultimately no tolerance legislation also results in the weakening of judicial discretion, disproportionate law implementation, and an increase in prison population. The three strikes laws are created to, "criminalize criminality itself and ... to make sentencing harsher" (Oleson, 2014). Implementation of the three strikes law in California served as a fairly regressive move across the board, however some claim a 20% reduction in crime due to the law's deterrent effects, however this is a hard figure to estimate. Three strikes laws also heavily favor determinate sentencing over judicial discretion. This is all relevant to the article because as a new adopter it is interesting to see whether New Zealand will fall into the same rut. The researcher looked at data from convictions and three strikes warnings from California and then compared them to early statistics from New Zealand. The study concludes that even though New Zealand's three strikes laws are much more lax in terms of sentence length it will still produce a lot of the same consequences (Oleson, 2014). It will lead to a reduction of judicial discretion (transfers discretion away from judges to legislators and prosecutors) which makes a more one-sided judicial system with less adaptation.

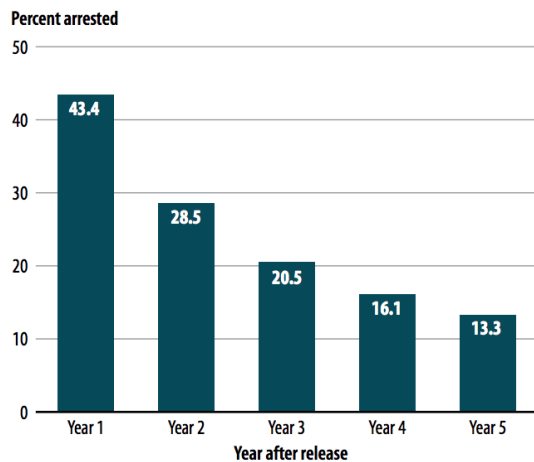
Violent crime rose sharply in the United States from the 1960's to the late 1980's peaking in 1991. This was justification for many to enact tough on crime laws such as the violent crime control and law enforcement act of 1994 which provided for mandatory life without parole sentences after three serious violent felonies. It also greatly increased government spending on law enforcement and prisons. With this greater spending on prisons it would be more likely that people would be caught and sent to prisons. In an effort to speed up this process courts also began to remove safeguards that excluded certain types of illegally obtained evidence from trials, making it easier to convict. The efficacy of increasing incarceration efforts in order to incapacitate the most criminals possible is still disputed. Scholars still argue on whether an increase of incarceration has a notable effect on crime rates (Mears et al., 2016). In spite of drastically increased incarceration rates, there is no evidence that recidivism rates have improved. "A 2005 Bureau of Justice Statistics (BJS) national assessment of recidivism rates among prisoners released from thirty states in 2005 found that, within five years of release, 77% of prisoners were rearrested for a felony or serious misdemeanor, 55% were reconvicted of a new crime, and 28% were sent to prison for

a new crime”(Mears et al., 2016). This data seems to suggest that even though being sent to prison serves as a deterrent, it doesn’t necessarily reduce reoffending after release. How do we reconcile this difference with the goal of making society safer from repeat offenders?

**Does incarcerating people reduce recidivism?**

Mass incarceration was mainly a response by legislators to the massive crime growth in the 1970’s to the 1980’s. Even though the United States is home to 5% of the world’s population it is home to 25% of its prison population. There are five times as many people incarcerated today than there were in 1970. This is not to mention that most of these prisoners are disproportionately people of color. What has been the shift then? Has our society really become five times more likely to commit crime? Financially, \$80 billion a year in the U.S. is allocated to prisons and jails, nearly what the Department of Education gets (Roeder et al., 2015). In the state of affairs today we have the highest per capita prison population in the world and half the violent crime we witnessed at the peak of crime rates in 1991. While this may sound as if incarcerating more people leads to lower crime, many studies point to an aging population, an overall drop in alcohol consumption per capita, and less crack use in the inner cities to explain the decline (Roeder et al., 2015). In many ways the tough-on-crime movement has become a case of diminishing returns. At first the more people we imprisoned the lower crime rates fell; now, with an all-time high of incarcerated people, we don’t see as big of a return. Does it then become counterproductive to incarcerate people with harsh sentences only to expose them further to the world of crime and criminal techniques, and thereby increasing recidivism?

**Percent of prisoners arrested during the year who had not been arrested since release in 30 states in 2005**



A big problem in our modern-day prisons is that they operate almost exclusively upon a model of retribution. This model, while useful, focuses on giving the criminal what they deserve. When the United States experienced its tough on crime movement, one consequence of this was mandatory minimums. Mandatory minimums acted as a way to level the playing field and make punishments for certain categories of crimes roughly equal across the board. While they did make headway in standardizing punishments, the downside to this is that it didn’t leave much room for judicial discretion or mitigating factors. There were set time sentences across the board and the burden was placed upon the parole board to release convicts upon good behavior and other qualifications. Mandatory minimums served a big part in prison overcrowding, but through research have not been shown to have a big effect upon recidivism. One study suggests that time served in prison may exert mixed effects on recidivism, though more recent work suggests that the effect may be minimal (Mears et al., 2016). More research is needed, but what is clear from multiple studies is that a lengthier prison stay does not necessarily mean a lower rate of recidivism. One study even suggests that in communities which are disproportionately affected by imprisonment, and especially longer prison stays, people have a higher chance of imprisonment from the very start (Hatzenbuehler, Keyes, Hamilton, Uddin, & Galea., 2015). A 2014 study looked at the differences between six states that used indeterminate and determinate sentencing models and compared recidivism in each. It found that mandatory parole release was likely to have a deterrent effect in Maryland and Virginia and discretionary release tended to be more effective in New York and North Carolina. States like Oregon and Texas with a mixed release program showed no meaningful difference between the two styles (Zhang, Zhang, & Vaughn, 2014). What this study concluded is that it matters more on how a system is implemented than WHICH system is implemented that makes the difference in recidivism.

Studies have shown that those who didn’t finish high school are more likely to be arrested again than those who graduated and those who finished college were less likely to reoffend than either of the groups (Keller 2016). This is important for those who advocate for education behind bars. Even more important is the idea of introducing rehabilitative techniques into the incarceration processes.

If a shift is made towards effective rehabilitation, we can invest in giving criminals the means to reintegrate back into society. This would mean not only a lower rate of recidivism, but also a lower incarceration rate down the line. Examples of this reduction in recidivism rates can be observed in more liberal states like Norway. Many re offenders do so because of factors such as socioeconomic status, interpersonal issues, or the inability to find employment, helping to remedy these problems would likely lower recidivism.

## **Critiques**

While making an argument for rehabilitation and indeterminate sentencing, some may argue that this defeats the purpose of a prison system. If we as a society do not punish crime “harshly” then how is this fair to the victim? The point of retribution is to give the criminal what’s coming to them, if we don’t do this as effectively then it defeats the point of a prison system.

Others would say that by investing in rehabilitative programs we are wasting money on the lowest common denominator in our society. Why invest money in these people when we can invest more in people who aren’t criminals? However, when evaluating levels of recidivism, it is a long-term game. Through the implementation of rehabilitation programs more money will be spent in the short term, but in the long term the benefits of a more productive work force and less of a strain on police resources outweighs those costs.

## **Method**

### ***Participants***

What I hope to find with this study is a correlation or lack thereof between harsher sentencing techniques and a reduction in crime. In order to do this, I will focus on three different studies which collected data on recidivism and compare their findings. The three studies I am referring to were conducted by the Bureau of Justice Statistics (BJS) in 1983, 1994, and 2005. Recidivism was shown to be higher progressively with each subsequent study conducted. However, the 2005 study collected data on twice the amount of states and analyzed for three times longer than the previous two studies. Using only the 2005 study as my main data pool I will compare recidivism rates to states with different sentencing policies. What I expect to find is less recidivism in states with more rehabilitative sentencing. Ultimately, the key in reducing crime is to punish people effectively. By doing this we can reduce the effects of crime on our society in the long term. I will also compare how other countries implement rehabilitative techniques into their sentencing practices. By doing this I feel I can make a well-rounded analysis of recidivism and determine whether rehabilitation would be better at reducing long term crime.

### ***Materials***

My only materials will be reports from the BJS. In these reports they break down offenses by the type of crime, demographic, location, etc. The type of crimes evaluated will be felony offenses at the state level. BJS reports only account for formal police

contacts and convictions. This may constitute a shortcoming when accounting for unknown crime.

## **Procedure**

Within the BJS I will compare recidivism data for felony offenses for different states with different sentencing laws in regard to determinant or indeterminate sentencing practices and legislation. I will then compare these offense rates with the level of recidivism in each category. I will try to take into account third variable situations and will address conflicting factors such as socioeconomic class and race when possible.

## **Results**

I expect to see a noticeable difference in recidivism rates between states with different sentencing legislation. In states where this legislation provides more rehabilitation, I expect to find lower recidivism rates. States which provide more retribution than rehabilitation are expected to have higher recidivism rates. What was made clear by analysis of the BJS data is that what matters most is the socio-economic conditions that the felon is returning to. In regard to reducing recidivism more of a focus should be put on rehabilitation efforts within prison, but oversight and resources also need to be made available once felons are released.

## **Discussion**

I believe that the subject I am studying should be of paramount importance within the criminal justice community. The goal of a police force and a judiciary system should be to reduce crime at its source to a point where there is less crime to chase and more time to foster growth within communities. A very important aspect of this is whether our punishments are actually effective. This can have fiscal impacts because of the fact that so much of our national and state budgets go towards housing prisoners. Ideally, we could find a better way to punish criminals with the ultimate goal being to make them more fit to return to society and give them less motivation to commit future crime. This would in turn reduce the number of people in prisons and relieve strain on our resources. The impact of information of this sort would be holistic because it would affect countless fields and determine whether our modern methods of creating and enforcing laws is effective in the modern world.

## **Acknowledgements**

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# Melatonin and its Effects: The Truth Behind this Popular Supplement

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## Abstract

Melatonin is a significant hormone secreted in the pineal gland of the brain that is primarily known for regulating the sleep-wake cycle. This sleep-wake cycle is affected by two processes known as process C for circadian and process S for sleep. Process C work as an endogenous clock driving the cycle's rhythm, and process S functions through a homeostatic sleep behavior that keeps up with the sleep and wakefulness acquired. The short-term consumption of melatonin as a supplement has been successful in treating sleep-related disorders of many kinds such as jet lag and delayed sleep phase syndrome. It is worth noting, there are many after-effects that can occur with melatonin consumption, such as short-term depression, dizziness, headaches, and irritability. Easy accessibility to melatonin supplementation can lead to *habit-forming side effects*, resulting in dependency. While there is a lack of information and studies on dependency, it can be underestimated, leading to complications in the side effects correlating with substance abuse. There is a lack of knowledge in users who do not have a general understanding on the exact duration of treatment. This can be uncertainty on whether supplements should be taken once for minor cases such as jet lag, or consistently for a period of time for major sleeping disorders. The goal of this study is to inform users of the possible effects that can come with taking melatonin supplements, because although already a naturally produced hormone, melatonin can alter users' body cycles in the long run.

*Keywords: sleep-wake cycle, short-term consumption, lack of information*

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## Methods

The initial interest for this study came from the constant misinterpretation of melatonin constantly being considered a drug, and not a hormone. As a hormone, melatonin is in charge of sending chemical messengers throughout the body in order to regulate the sleep-wake cycle. The sleep-wake cycle is a daily pattern responsible for determining the appropriate sleep and wake times, affected by physical, mental, and behavioral changes known as the circadian rhythms.

For this research, my information was found through a systematic review. This method allowed me to select and evaluate evidence in order to assess the results and derive conclusions. Specific keywords that were used included the following: "melatonin FDA banned," "melatonin supplementation dependency," "melatonin overdose case," among others. Regardless of searching through primary, secondary, academic, and medical sources, there was not enough research on melatonin supplementation as whole to find many results on these searches. "Melatonin FDA banned" was possibly one of the easier searches within Google Scholar, with a few switches in wording to "melatonin legality" or "melatonin illegal" and a few article searches. "Melatonin supplementation dependency" on the other hand, was quite difficult to

come across. Medical sources such as *BioMed Central* and *PubMed Central* hardly offered, if any, information on the specific correlation between melatonin and dependency. It rather cited about the relationship of melatonin to other sources such as tobacco, insomnia, and therapy, with information citing centralized around 2010 for *BioMed Central* and around 2015 for *PubMed Central*. "Melatonin overdose case" was also among the easier searches to find, with many records showing cases of users overdosing on melatonin supplements. *EBSCOhost* was among one of the sources used, but with only three databases, my information was retrieved from *PubMed*, which offered more articles on this topic. On both sites, information was cited back to 1997. This was something interesting to note due to the lack of released information on melatonin supplements.

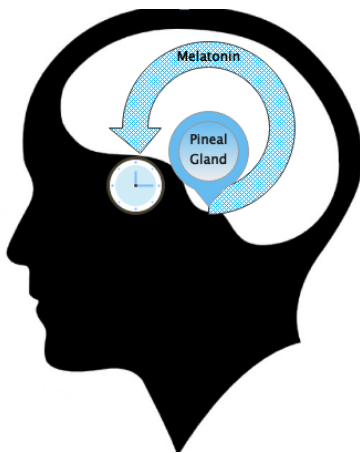
Looking for specific data, it could be said that 150 databases could have been looked through, but only about 20 were kept for potential information on the findings of melatonin and its effects. 150 databases were looked through for keywords, but not many actually contained information specific to melatonin, but rather the mention of the hormone.

## Introduction

*[Melatonin's anatomy and physiology]* To understand the effects of melatonin, it is necessary to first understand what melatonin is and its significance. Melatonin is a naturally produced hormone in the body, which is responsible for sending chemical messengers throughout the body to coordinate specific functions. In melatonin's case, specific functions would be regulating the sleep-wake cycle. Melatonin is produced right above the center of the brain, in an area called the pineal gland, which is about the size of a pea. In order for melatonin to be able to carry out its functions, there is a process to the way it works. Melatonin works through the influence of light and dark detection with the eye retina. Light detection helps regulate the body's energy levels produced by serotonin—a neurotransmitter produced in the intestines and the brain that contributes to feelings of well-being and happiness. The circadian rhythm works as an internal clock scheduling the release of melatonin, releasing higher levels during dark detection and lower levels during light detection.

*[The sleep-wake cycle]* While melatonin has many functions, one of its most important contributions is helping regulate the sleep-wake cycle. This sleep-wake cycle is affected by two processes known as process C for circadian, working as an endogenous clock driving the cycle's rhythm, and process S for sleep, functioning through a homeostatic sleep behavior that keeps up with the sleep and wakefulness acquired. The sleep-wake cycle is responsible for producing and releasing melatonin at different rates throughout the day. Melatonin production tends to increase during the dark, but it is known to decrease when it is light.

## Melatonin and the Sleep-Wake Cycle



*[Supplementation]* Melatonin has been studied since the 1950's, but it did not become a nutritional supplement until the 1990's. In 1958, Aaron B. Learner and his colleagues from Yale University first isolated this hormone. Melatonin obtained its name due to their studies in which the substance had the ability to lighten a frog's color. With easier accessibility to melatonin supplements within the United States than other countries, this supplement became popularized due to its effects on sleep, cancer, and other hormones. Melatonin's availability in supplement form allows users to treat short-term disorders. These short-term disorders can include jetlag and delayed sleep phase syndrome—a condition where delayed sleep causes difficulty in being able to wake up at the desired time. Consuming excessive melatonin can impact the natural circadian rhythm over time. One should keep in mind that dependency can arise not from consuming melatonin supplements itself, but from the side-effects of melatonin supplements that can be habit-forming. Dependency varies in definition and is often misinterpreted with addiction. The difference between them is that dependency is characterized by symptoms of tolerance and withdrawal, addiction is the change in behavior caused by brain biochemical changes due to substance abuse.

By researching the relationship of melatonin to its effects, impactful results were found both mentally and physically. Studies demonstrated that there is not more than two years' worth of collected innovative research. Not finding long-term research made it harder to identify melatonin's long-term impact on users, whether it be beneficial or detrimental.

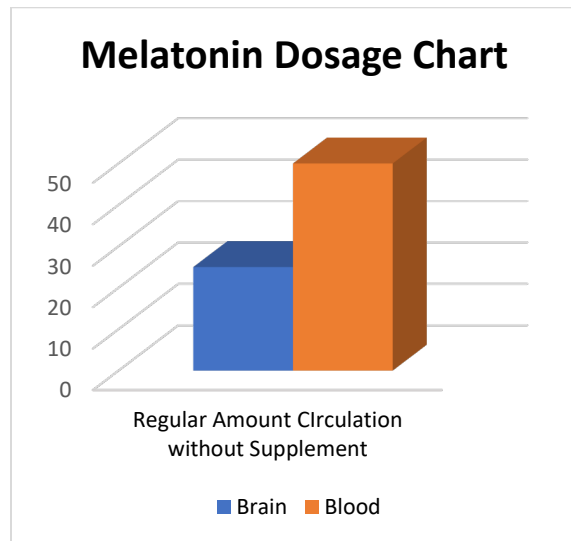
## Results

### Melatonin Availability Chart

United States	United Kingdom	Germany
<ul style="list-style-type: none"><li>•accessibility: over-the-counter</li><li>•legality: legal</li><li>•form: liquid, spray, chewables and tablets</li></ul>	<ul style="list-style-type: none"><li>•accessibility: prescription needed</li><li>•legality: known as <i>Circadin</i>, legal but with age and health requirements</li><li>•form: tablets</li></ul>	<ul style="list-style-type: none"><li>•accessibility: prescription needed</li><li>•legality: known as <i>Circadin</i>, legal but must be over 55 years old</li><li>•form: typically tablet, but form can change</li></ul>



Melatonin supplements are available in different forms including liquid, spray, chewable and tablets. Supplementation availability does vary, and while there is easy access to melatonin supplements in the United States such as an over-the-counter option found at local drug stores, there are other countries that limit it (as seen on the Melatonin Availability Chart above). Melatonin supplements are classified as dietary and therefore not FDA approved under the Dietary Supplementation Health and Education Act of 1994. As mentioned, because of the easy access to melatonin in some countries, it is necessary to keep in mind the recommended dosages versus actual dosages.



While studies show that recommended dosages vary from 0.1 to 5 milligrams, recorded dosages have shown to greatly exceed this amount. A case recorded a 66-year old man consuming melatonin supplements the night before his prostate surgery in hopes of aiding him in relaxation and a proper night's sleep. This case is significant because the user ran the possibility of affecting or postponing his surgery the following day due to upping the average dosage of 5mg, to 24mg for relaxation. Another case indicated that a 4-year old girl accidentally swallowed 39 milligrams of melatonin in liquid form, greatly surpassing the recommended amount. Sleep routines are recommended for children as melatonin supplements are not exactly sleeping pills, but children with neurodevelopmental disorders among other children are often found consuming melatonin supplements. If melatonin supplementation is used, it is recommended to be taken at extremely low dosages with the consultation of a pediatrician, for a very short period of time. While this case resulted in no symptoms shown on the patient, there are a variety of

factors that may have affected these results, such as age and lack of brain development.

There were notable differences in both the brain and blood before melatonin supplementation consumption. According to "Melatonin the "light of night" in human biology," the average melatonin in the brain varies from 10 to 60 pg/ml. It is shown that melatonin peaks in early childhood but decreases in older people producing a negligible amount of melatonin. Due to these statistics, the average melatonin in the brain for childhood to older people was considered at 25 pg/ml (as seen on the Melatonin Dosage Chart above). While studies show that different tissues or body fluids contain a range of melatonin concentrations, according to "Significance of High Levels of Endogenous Melatonin," the average melatonin in the blood is about 50pg/ml.

Because of a lack of studies, and an unknown amount of melatonin supplementation users, there was an inability in calculating the exact amount of melatonin circulating in the brain and blood once the supplement was consumed. Results did show that serum melatonin concentrations in the body were 10 to 100 times higher than the usual nighttime peak.

#### Melatonin Side Effects Table

Short-term side effects	Long-term side effects
<input type="checkbox"/> dizziness	<input type="checkbox"/> depression
<input type="checkbox"/> headaches	<input type="checkbox"/> nightmares
<input type="checkbox"/> nausea	<input type="checkbox"/> low blood pressure

While melatonin is a natural compound that circulates in the body, like a drug, studies show that it is dependent. Dependency does not arise from the consumption of melatonin but rather from the habit-forming side effects of melatonin consumption, which are viewed as addictive. Melatonin is often considered a drug, and this is related to the constant misunderstanding of the differences between dependency and addiction. Dependency is characterized by symptoms of tolerance and withdrawal, but addiction is characterized by changes in behavior caused by biochemical changes in the brain due to constant substance abuse. Because dependency is underestimated, it can result in complications correlating to melatonin supplementation due to over-dosage or inability to correctly measure the body-to-supplement dosage ratio. It is difficult to calculate the necessary dosage according to each body type, and it is especially difficult to self-change the dosage increments throughout time as the user's body becomes familiar

with the supplement. This often leads to dependency due to the easy accessibility of melatonin supplements, at least all over the United States, and in other countries. It is recommended that melatonin dosages start out small, and as the body becomes more familiar with it, one can slowly increase the supplement intake. This will help the body familiarize with the supplement and help a user rest without obtaining full side effects. The recommended melatonin dose lasts about 5 hours in the body, but overuse of this supplement can cause a disruption in the circadian rhythm. By disrupting the circadian rhythm, this can lead to daytime sleeping.

Dose-dependent effects have not been completely evaluated in users consuming large doses of melatonin supplementation over long periods of time, therefore, they cannot be accounted for due to lack of research. Hypotheses are based on short-term side effects, which include dizziness, headaches, and nausea. There is a higher possibility of experiencing less common side effects if more melatonin supplementation than recommended is consumed during a longer period of time. While there is no specific time frame to define long term, there are only up to two years' worth of research in this topic, displaying the differences between short term and long-term side effects during this time gap (as seen on the Melatonin Side Effects chart). The more intense side effects that can occur during a long-term consumption include nightmares, depression, and low blood pressure.

## Discussion

When considering taking melatonin as a supplement, it is important to keep in mind both the positive and negative effects that could arise. Doctors are so quick to recommend or prescribe melatonin supplements for mild uses, compared to other aids. Other prescribed sleeping aids can be more dependent and even harmful. Temazepam, for example, is a sedative treating insomnia, but the user does run the risk of suffering paranoid or suicidal ideation, and impaired memory, judgement and coordination, all effects far more harmful than melatonin supplementation.

Melatonin supplementation has the possibility of helping with cell protection. This includes the involvement of modifying the immune response and blood cell formation. Melatonin also has a lot of therapeutic potential. While there are not many studies to confirm this and it is just a mere possibility, melatonin supplements are being reinforced into cancer therapies for therapeutic effects to reduce the side effects of chemotherapy especially or radiation. Melatonin supplements are not just used for sleeping, but also for migraines, attention deficit hyperactivity

disorder known as (ADHD), and irritable bowel syndrome (IBS).

The lack of long-term research with melatonin supplementation limits not only researchers' advances but also users' knowledge. Less research leading to unknown effects in the long run makes it more difficult to identify on whether effects will be beneficial or detrimental, among other factors. Supplementation can also lead to habit forming side effects that result in dependency. Considering the short-term effects of melatonin, it leads to consider the detrimental effects of using melatonin supplements long-term wise.

Concentration from natural foods and varying dosages are important factors when considering melatonin supplements. This uneven concentration leads to an uneven distribution and a difference in the biophysical dynamic features of the foods. Because melatonin concentration varies in plants and animal foods, this leads to unknown amounts circulating in the body after melatonin consumption. There is not easy access or enough proven data calculating how much melatonin is appropriate to take when considering all health factors. It is necessary to calculate self-changing dosages as the body becomes familiar with the supplement.

The main purpose of learning about the uses of melatonin along with the possible side effects that can be either beneficial or detrimental in the long run is for the reader or user to gain awareness when it comes to consuming melatonin supplementation. There is very little information and studies, with so many possible unknown risks that can come with melatonin consumption if consumed long-term. While there is not a lot of long-term research to consider, it is necessary to keep in mind both the positive and negative side effects that can be found affecting users both physically and mentally.

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# The Relationship between Childhood Poverty and Academic Success, Parental Influence, and Health

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## Abstract

Living in poverty for a large portion of development results in an overall lower quality of life. This paper gives an introduction to the long-term effects of living in poverty as a child. After setting parameters that detail what poverty is, it will explore the relationship between poverty and several different factors that a child cannot control. The three specific factors it will examine are academic success, parental influence, and health. It is not until we understand the information presented that we may be able to identify, label, and recognize this problem in our own lives. Once we are knowledgeable about the effects of poverty we must design, create, and produce solutions. This knowledge also gives us the ability to categorize, prioritize, and criticize present suggestions for diminishing the effects of poverty.

*Keywords:* poverty, children, parental influence, academics, health

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## Introduction

Socioeconomic status influences all elements that contribute to your personal identity. This includes, but is not limited to, a person's productive capacity, skills, ingenuity, and imagination (Boran, 2010). A person living in poverty is often so consumed by the desire to escape poverty that it encapsulates their entire being. This makes poverty an enemy to a prosperous development. According to the U.S. Census Bureau, "If a family's total income is less than the family's threshold, then that family and every individual in it is considered in poverty." In 2017 over 40 million Americans lived in poverty according to this definition. More importantly, poverty has remained a consistent problem in the United States for an extended period of time, and the United States poverty rate shows very little improvement in the last five years (U.S. Census Bureau, 2018). If there is no current solution to solving the poverty epidemic that has erupted in the United States, it is important to realize its effects on children. Hence, early intervention has recently been proven crucial to successfully keeping a child on track in the course of their development, especially in an academic setting (Slavin, 2012). Those working with these families, and children specifically, need to understand the effects of the relationship being discussed in order to be able to provide the necessary support and resources. The current lack of solution has also exposed a divide between the upper and lower class. As a result of the differing beliefs of policy makers, a void of action that has the possibility to lower poverty rates continues to

persist. Thus, the controversy between policy makers over how to combat this epidemic continues to render all poverty reduction efforts ineffective. The modernist approach is to advocate that "the poor" have the right to be left alone (Boran, 2010). However, this flawed line of reasoning ignores the viewpoint of a person living in poverty. Additionally, poverty affects millions of people every day, yet it is not something typically given a lot of media attention. Similarly, the little attention that it is given, is not specified enough to highlight the actual magnitude of this problem.

For these reasons, in combination with lack of sympathy or knowledge of these effects, the simple solutions to this problem are ignored. Furthermore, these effects are typically outside of a child's control, and hard for their parents to overcome. For many families, these problems will persist for many generations. This research paper is a tool that can help improve their quality of life, and lessen or eliminate some of the challenges that they face.

The following research demonstrates the effect of living in poverty as a child on various specific factors. These factors include achievement in an academic setting in relation to: parenting style, parent expectations, parent education, school readiness, physical and mental health, and adult salary / overall wellbeing as an adult. Achievement in an academic setting refers to grades, standardized test results, their ability to follow school/classroom instructions and rules, their highest level of school completion, and their I.Q.

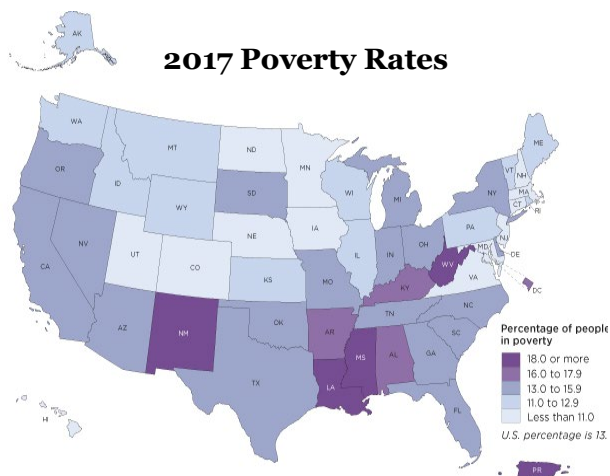


Figure 1. Percentage of children living in poverty in the U.S. and Puerto Rico, 2017. Taken from the U.S. Census Bureau.

### Thesis

Based on previous studies, I predict that an economically disadvantaged child is vulnerable to many negative factors that derive from living in poverty. The specific factors that I will analyze are parental influence, academic success, and health.

### Method

This paper follows a qualitative textual analysis design in which I closely examined, described, and interpreted a plethora of previously collected data relating to my research and analyzed it. This research data was gathered using a variety of different outlets such as: educational literature books, company websites, psychology textbooks, and statistics of government, state, county, and worldwide data. Meanwhile my recommendations are based on information from peer-reviewed journal articles about poverty. Once I had gathered and analyzed research on each specific factor (academic success, parental influence, and health), I completed a comprehensive analysis that related these three topics to my hypothesis. Additionally, I analyzed my research in the fashion that *The Craft of Research* describes as “appealing to the general reader who wants to expand their current understanding of a subject.” This process eliminated bias and resulted in a logically organized body of work.

### Literature Analysis

#### *Home environment*

According to John Bowlby, there is a positive correlation between an adult’s ability to form strong positive relationships and their childhood home environment (Bowlby, 1969). In fact, the quality of home environment, including child rearing practices, directly affects a child’s willingness to strive to succeed at a challenging task and meet standards of accomplishment.

The core propositions of this research are generally unopposed. However, prominent theorists disagree about the degree of importance of a child’s environment and the role a child’s educational setting plays in their development. For example, perhaps one of the most significant contributors to the field of child development, Jean Piaget, asserts that the sociocultural context of development is not of great importance, and education merely refines the child’s cognitive skills that have already emerged (Guthrie, 2003). Similarly, he theorizes that children’s thought process and concept of reality are neither learned from, or influenced by adults. However, his work remains controversial in its validity, as a result of the varying success rates of those who incorporate his concepts into their work with children.

A study done by Greg J. Duncan, Ariel Kalil, and Kathleen M. Ziol-Guest titled “Early-Childhood Poverty and Adult Attainment, Behavior, and Health” found that living in poverty as early as prenatal care will have a later effect on academic success and adult achievement. In this study, participants were studied for a total of 13 years as they transitioned into adulthood. Because the results were consistent throughout the entirety of the study, the researchers were able to confidently conclude that there is a strong correlation between early childhood poverty and adult earnings (Duncan, Kalil, & Ziol-Guest, 2010). This particular study reaffirms the importance of resources, home environment, and parental expectations to a child’s academic and adult success.

#### *Parent education and schooling experience*

Educators teaching in low income areas have also noticed a trend among parents: they do not want to come to their child’s school. Whether it be for student intervention, classroom volunteering, or parent teacher conferences, there is a large number of children who are left without help from their parents.



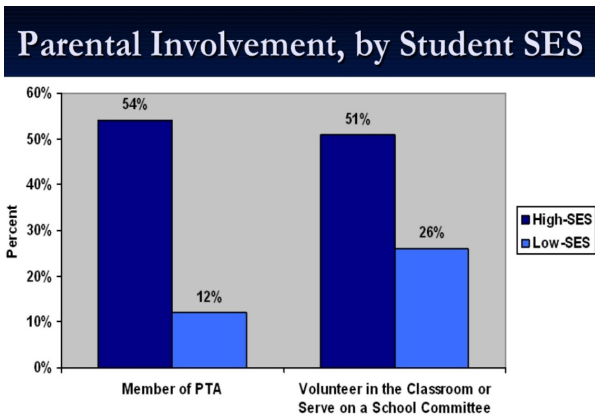


Figure 2. Parental involvement, by student SES, 2011. Taken from The Century Foundation.

There are several different barriers that can prevent a parent from “coming to school.” An article by Margaret Finders and Cynthia Lewis titled, “Why Some Parents Don’t Come to School” categorizes these reasons into three different categories: “school experiences, economic and time constraints, and linguistic and cultural practices” (Finders & Lewis, 1994). The most common reason for this lack of involvement is the parent’s own negative schooling experiences. For example, Martha Mendoza notes in her article titled, “Latino Academic Achievement Gap Persists” that it has become common for parents to be apprehensive towards education due to a lack of confidence or an insecurity about their own intelligence (Mendoza, 2013). This can be specifically linked to either their completed level of education, or linguistic barriers. Most often, parents avoid “coming to school” for a combination of these reasons.

Contrastingly, parents with high academic expectations of their child are more likely to take an active role in their child’s education, and therefore offer more support. This means that the more school they have completed, the higher expectations they have. Consequently, a parent’s level of education is a strong predictor of a child’s academic achievement. Pamela E. Davis-Kean completed a study at the University of Michigan’s titled “The Influence of Parent Education and Family Income on Child Achievement: The Indirect Role of Parental Expectations and the Home Environment.” This was a cross sectional study that involved 8,000, lower socioeconomic status (S.E.S.) participants. A cross sectional study is an observational study of a wide population at one point in time. This allows researchers to collect large amounts of data without bias or outside influence. Participants of this study were families chosen based on the parent’s education success, parent’s income, and the size of the family.

The resulting data concluded that parents with a degree from an institution of higher education held stronger expectations of academic success in comparison to parents with little to no completed schooling. As a result, children with parents who had higher education scored higher on reading and math tests in comparison than those who have parents with less education. Additionally, over 49% of the higher education parents interviewed said they expect their child to graduate from a four-year college with a diploma. These parents also had high expectations of their child’s home behaviors that can be linked to higher academic achievement. Examples of such behaviors include voluntary reading for enjoyment and active participation in sports. These homes are considered to be a “cognitively stimulating environment.” A cognitively stimulating environment is a home in which the child’s learning and academic engagement is continually stimulated. Based on these results Davis-Kean concluded that a parent’s education is a moderate-strong indicator of their child’s academic achievement.

According to the National Center for Children in Poverty, only 36% of children in poverty have parents who have a high school degree. This means that children with lower a S.E.S. are less likely to do well in an academic setting because of the expectations their parents have placed on them. Low S.E.S. parents are also not capable of providing them with a cognitively stimulating environment. For example, parents with a lower education level do not have the same vocabulary and grammar skills and literacy competency of a college educated parent (Davis-Kean, Pamela, 2010). Therefore, they cannot offer the same level of language stimulation and corrective feedback. This level of stimulation plays a significant role in a child’s academic success as exemplified in the study done by Davis- Kean.

#### Parental influence on child health

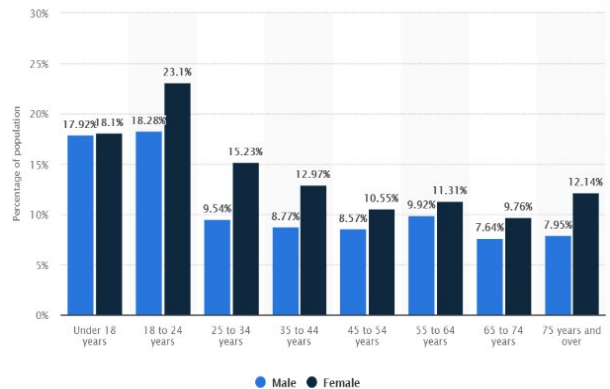


Figure 3. Poverty rate in the United States by age and gender, 2018. Taken from Stastica.

In correspondence to the research done by Pamela E. Davis-Kean, Catherine E. Ross and Chia-ling Wu found that there is also a strong correlation between a parent's education and the health of a child. In their study, Rose and Wu concluded that the link between poor health and education can be classified into three categories: (1) work and economic conditions, (2) social-psychological resources, and (3) health lifestyle. People with a higher level of education are more likely to be employed full time and not suffer from economic hardships (Ross & Wu, 2009). In addition, more educated people are more likely to have a greater amount of social support and sense of self-control among other beneficial resources in comparison to those without this level of education (Ross & Wu, 2009). Less educated people also tend to follow an unhealthy lifestyle that includes excessive drinking, smoking, less to no exercise, and little to no involvement in preventative medical care (Ross & Wu, 2009). A child's physical and psychological health are greatly affected by their environment and the resources they are given. For a child living in poverty, this means that level of academic success will reflect their poor health.

## Discussion

The overarching goal of this analytical approach is to help readers who are interested in improving the quality of life of children in poverty expand their current knowledge in a way that is accessible and appealing. This also includes gaining an understanding of terms and concepts such as *poverty* and the *achievement gap*. Moreover, readers will understand that it is in the best interest of the child for a parent to be actively involved and interested in the development of their child. Additionally, the information presented in this paper can be easily correlated to other significant issues many children face. For example, a child who lives in poverty is more susceptible to problems with abuse, drug usage, dropping out of high school, gang membership, and adult homelessness (Boran, 2010).

Improving the home environment is the first step in diminishing the negative effects of poverty. Furthermore, parental influence is the easiest environmental factor to control and maintain (Boran, 2010). There are several easy, free, and impactful tasks and ideals that parents can incorporate into their daily routine that can improve their child's quality of life. For example, they can establish and maintain a sleep schedule and routine. According to *The US National Sleep Foundation* school-aged children should sleep at least 10 hours a day. Therefore, parents should enforce a daily bed-time routine that optimizes their child's sleep duration. Similarly, parents should encourage their children to participate in cognitively

and/or physically stimulating activities. For example, daily reading is the best way to stimulate intellectual development in children (McIntyre, 2017). Simple environmental adjustments such as these allow parents to positively impact their child's academic performance regardless of their own capabilities and resources.

School is also a great place for application of intervention. All schools have room for improvement and growth, and this information presents an opportunity for educators to potentially do a better job at catering to the needs of economically disadvantaged children. These children have a specific need to feel safe, respected, and valued. Teachers have a unique opportunity for impact because there are many simple and realistic applications to minimize these negative effects inside their classroom. The easiest way to help these children is to be a positive role model for them, teaching them that anything is possible. Additionally, teachers should offer these children the support they cannot receive at home. This can include offering emotional support, teaching them life skills, and supporting their goals. Lastly, teachers have the opportunity to educate parents with this information, encourage them, and offer them support.

Living in poverty has the power to impact academic success in a negative way. From their very first breath, the odds are stacked high against children facing this problem. However, with intervention, determination, and ambition, you can lessen the obstacles they face. Then, only two questions remain: What will you do to educate those around you about the relationship between poverty childhood poverty and academic success, parental influence, and health? and How will you inspire them to make a change?

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# Writing My Own Poetry Book

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## Abstract

What is the difference between poetry and any other string of words? Poetry has the power to change the meaning of words, of sentences, to change the way someone feels. Poetry brings something out of people that is hard to get out using other forms of writing. Poetry tugs at your heartstrings, opens your mind, shows you new worlds, and helps you understand your own. This is why I write. **I want to write and reach as many people as I can so the ones who think like me can see that they are not alone in all of this, and so the ones that don't can hopefully understand my point of view and perspective, as well as of someone they may be close to, to connect to people.** This is why I am writing and publishing a poetry book. My working title is *Drowning in My Own Thoughts*, and it will have about 150-200 poems and 50+ illustrations. I will separate the poems into chapters with themes. The current themes are Depression, Love, Suicide, and Rejection. Each chapter will have an introduction to help the reader better understand what was going on in my life and my point of view when I was writing those specific poems. The final product will be a book in print, copyrighted and able to sell in stores, and on my Instagram.

*Keywords:* social media, fake news, information dissemination

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## Introduction

### Meaning

You know, when I do what I do, I do not always think of the meaning. In fact, I very rarely think about the meaning as I work. I do things out of emotion; whichever emotion is driving at the time. There isn't always a purpose to it or a meaningful reason. I write what I write, I draw what I draw, and I do what I do because it is how I feel. It often isn't till much later in the process or when I finished the piece, that an actual meaning shows itself in my work. So why do I draw and write? Most days, I don't know, and even if I did, I am not sure I would be able to tell you a reason because I don't understand it myself. So, why am I writing a book? I don't know, maybe this has no meaning, it is just something to do, an extension of my emotions that drive me. Perhaps I do it, just because I can. Or maybe, if I just do it, if I write that poem, if I draw that picture, put them on the same page, design a cover, format it, and print it, maybe, just maybe, then it will have meaning. Maybe you, the reader, give it meaning. You give it life.

### Background

In *Abstract Heart* by J. Iron Wood, he has his poems separated into chapters, and has each poem titled, dated, and signed. I liked that each one has a title because it helps the reader get a sense of the topic

from the get-go. The chapters help give a context of the author's inspiration, so with the title, it helps give the reader a more profound understanding of the poem. I still haven't decided on whether or not I want to title the individual poems, but they will be dated and separated into chapters. I liked the sketches in *I Find You in the Darkness* by Alfa because they were simple line drawings, but they were always in context with the poem. The illustrations helped the mind relax with visuals and not have the entire book only be poems. They also helped give a better sense of imagery to the poems they were paired with. In other books, I did not like a chronological order to the poems. In one example, the author made it so that it appeared to all have been written in one night, and you're following his thoughts throughout his sleepless night. You were able to see the flow, and while I do think this worked for him and his purposes, I do not think it will work for mine. For him, you can see the progression of his thoughts flowing from one into the next throughout the night. However, my thoughts are more erratic and chaotic in a short timespan to benefit from a chronological timeline. For me, one poem written two seconds after another is very different, which makes this style less effective and why I will not be using a

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chronological approach but rather organizing the book into themed chapters.

*Spaceship* by Robert M. Drake is another good book, although he did not name or date any of his poems, and I do not like his style for my purposes. His poems were able to flow from one to the other by not using titles and dates, but it turned the whole book into more of a single pathed story, which is not my intention. He also had drawings, more of doodles all over the pages, which were fine. For me, however, they overcrowded the work or even was trying to compensate for the work, and I found it too distracting and not adding to the meaning, so I will not be using that technique in mine. In *Good Poems* selected by Garrison Keillor, he did something similar to what I want to do, he collected a number of poems and grouped them by theme into named chapters. The difference is that the poems in his book are all by different authors while in mine will all be my work, and he did not include intros to the chapters where I will be. I feel that introductions will help the reader get a better sense of the theme and viewpoint from when the poems were written rather than just a single worded title to lead into the segment.

Andy Warhol said that art is whatever you can get away with. This is what art means to me; art gives me freedom that I have never had before; I can do what I want and get away with it. I try to create whenever I can, but it mostly just happens when I least expect it. I will get inspired, and then I will go from there. I often get inspired by something that happened to me that day and how it made me feel, and other times I just see something and try to draw it myself or write about it. However, art does not reach its full potential unless it is shared; my work has been sitting in a dark corner of my room, collecting dust for years. This would not fair to my work, myself, or anyone I can connect with. It's not fair to keep it hidden, that is no way to treat art, and that is not how you grow. The definition of art is something that stirs a feeling or sends a message to someone, but if I keep my work hidden and not share it, then it is only work, work with no meaning. It will only be work with no purpose, and it cannot be considered art until it reaches someone else. This is why I share my art, so that I can call it art, and give it life, so you can give it life.

## Methods

The experts that I will be collaborating with are my on-campus advisor Professor Schmidt, and author Caytona Ryan. Professor Schmidt will be helping me with mostly logistical things, like applications and grants, as I often need a faculty signature to complete a

lot of these applications. Caytona is a published writer and will be helping me by reading my poetry and giving me tips and pointers on my poems, and on formatting my book.

I have collected most of my poems; I need to finish organizing them into the chapters that I want and then put them in order. I chose to go with chapters rather than a chronological order because I wanted the reader to get a sense of what I was feeling when I was writing that specific poem. I need to write the intros to each chapter and start pairing artwork together with poems. Then I need to start editing the poems individually and also getting critical feedback from my peers and advisors. I have the idea and concept sketch for the cover design, but I need to actually bring it to life and have it in the proper format for printing using the program Infinity Publisher. Then after I spend copious hours editing, I need to put all of the pieces together, the books intro, chapters, poems, art, cover and send it to the printer at 48 Hour Books. There they will print a copy and send it back to me for inspection. If I approve it, I purchase an ISBN number, which makes it a published book, and buy more copies of the book to sell. I want to sell on my Instagram page, and if things are looking good, I want to try to get my book in local bookstores, and hopefully, in the future, I can get it sold online.

Throughout the process, I am advertising my book by word of mouth and on my Instagram by posting information and sneak peeks. I am also fundraising to help cover the cost of printing, editing, and purchasing the software. I am doing this by selling art and stickers, I also set up a Go Fund Me page. While most people often go through a branded publisher or self-publish through someone like Amazon, I chose to go with 48 Hour books, for a couple of reasons. I did not want to spend the time to wait to get my book published with a big publisher, as I want to start selling it right away, so I will publish it myself, then I will try to work with publishers to help alleviate the costs and be able to sell nationally. I will not be using Amazon for publishing, because anything that they publish the author gives up the right to use, edit and resell. It becomes Amazon's property to use as they see fit, and the original author is not allowed to sell it anywhere else, and will only get a portion of the money made from the sales. This does not mean that I will not sell on Amazon, I am just not going through them to publish, because I want to own my art.

## Results

Do you ever whisper something,

In the silence of the night,

Then you hear it again,  
Like a distant echo  
In the back of your head,  
Repeating itself over  
And over and over  
And over  
Until.....  
Its isn't even your  
Voice anymore?  
12-17-17

You smiled,  
In a way that hid your fangs,  
As I came closer,  
I was lost in your lips,  
Too lost to look deeper,  
It wasn't until it was too late,  
When you had done your worst  
That I knew,  
  
You were poison.  
11-13-17

I sexually identify as a corpse,  
(Cold,) no heart,  
Too dead to care,  
And done with this world.  
12-24-17

Oh to compare thee to a summer's day,  
I hate summer,  
I hate the day.  
Enough said.  
12-24-17

If the moon was a flower,  
I would plant you a meadow,  
Where we could spend our hours,  
In the night of the moonlight glow,  
Where we can spend our time,  
In the peace and light,  
Where it wouldn't be a crime,  
If we spent the night.  
12-26-17

I'm in the back seat to the car that drives my life.  
7-19-17

### **Discussion**

My best-case scenario for a result by the end of May 2021 is a printed, published book that can be sold in local bookstores, on my Instagram and website. I will be publishing through 48Hourbooks where the upside is that I will have complete copyright and ownership of my poems and book, but the downside is that I will have to pay for every book printed. If my poems are received well by my critics and readers, the book will have just over 150 individual poems of varying lengths, including the single-lined poems and deep thoughts. I will be going with a soft paperback binding, and generally, I am going to have one poem per page. This will include a chapter of one to two-line poems. In this chapter, I will have multiple poems per page, which will cut down the length of the book, as I do want to try to keep it below 200 pages. The worst case would be that I have all of

the poems compiled and some edited but no final format. I hope to at least make it to the point where I have the book's contents completed. The final product will mostly be in black and white, with the cover and some select images in color to help try and keep the cost down. For the most part, I have finished collecting my poems and have decided which ones I want to include. I have decided that I want to group the poems into chapter like groups based on themes and subjects of the poems themselves. Current working themes are Depression, Love, or the lack thereof, Suicide, Identity, Rejection, and a chapter of single-line poems and deep thoughts. I am also going to include intros to each chapter to help the reader understand my motivation for these specifically themed poems. So, the reader can understand where I was coming from and get a better understanding and connection to my work. I need to design the cover art and layout, as well as go through old art and make some new pieces to be included in conjunction with some of the poems. I still need to do some heavy editing and organizing what I already have collected. Then I need to put it all together; I need to put the poems in their chapters with their intros. I need to create the cover art and create a pdf layout of the complete cover backing. Then after editing, I need to submit the book to 48hour books where they will print me a test copy. Then I can approve it and have the book finally printed, and when I do so, I will purchase an ISBN and have it copyrighted, as it is easier and cheaper to copyright an entire piece of work than all the poems individually. My goal is to print around 125 books. My onsite faculty advisor for this project is Professor Arnold Schmidt in the English Department. I will be going to him for verbal and written feedback on grammar, organization, and layout. I am also working with him to get grants like the SERCSA grant. I will also be getting feedback on the poems themselves from a writer I know, Caytona Ryan, as well as some other friends for tips, suggestions, and general advice.



# The Relationship Between Sleep and False Memory

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## Abstract

Memories are not exact copies of reality. Instead, memories are reconstructions of reality that are influenced by many factors, such as prior knowledge, perceptions, and feelings. False memories are distorted memories or recollections of information and events that did not actually happen. Sleep plays an important role in memory due to its influences on how the brain functions. Furthermore, sleep deprivation reduces the amount of information we can store in our working memory, impairs our ability to learn, and hinders our executive function. Many studies have shown that sleep deprivation negatively affects cognition. However, the research on sleep deprivation affecting false memories is inconsistent. Therefore, I examined the relationship between sleep and false memories with a sample of 149 participants recruited from Amazon's Mechanical Turk. I predicted that less sleep, measured as the amount of time spent sleeping the night before ( $M = 6.53$  hours,  $SD = 1.33$ ) and on average ( $M = 6.79$  hours,  $SD = 1.09$ ), would be associated with more false memories, measured with the Deese-Roediger-McDermott (DRM) Task. The possible range of false memories was 0 to 30. The range of false memories from the present sample was 0 to 25 ( $M = 10.28$ ,  $SD = 4.39$ ). Consistent with predictions, there was a significant negative correlation between the amount of time spent sleeping the night before and the number of false memories calculated from the DRM Task,  $r(149) = -.23$ ,  $p = .01$ , 95%CI [-.38, -.07]. There was also a marginally significant negative correlation between participants' average amount of time spent sleeping and the number of false memories,  $r(149) = -.15$ ,  $p = .07$ , 95%CI [-.30, .01]. These results potentially have important implications. For example, a witness must immediately give their statement to a police officer. Furthermore, eyewitness accounts are often used in court decisions. If the eyewitness of a crime is incorrect (i.e., relying upon a false memory), it could lead to the wrong person getting convicted of a crime. Gaining a better understanding of false memories will aid in determining our memory's susceptibility to false information and reliability in court cases.

*Keywords: sleep deprivation, false memories*

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## Introduction

How accurate or inaccurate are our memories? This is a very complicated question to answer as memories are not exact copies of reality. Instead, memories are reconstructions of reality that are influenced by many factors, such as prior knowledge, perceptions, feelings, and sleep (Straube, 2012). Memories are an essential part of our lives that allow us to remember information, routines, and experiences. It allows us to learn, plan for the future, and build connections with people. Sleep is another essential component that influences how our body and brain function in our day to day life. This includes how our memory operates. Sleep allows our body and mind to recover from a long day in order to function optimally. In this study, the focus will be on the relationship between false memory and sleep.

## Literature Review

Sleep plays an important role in memory due to the fact that it influences how the brain functions (Frenda, Patihis, Loftus, Lewis, & Fenn, 2014). Furthermore, sleep deprivation reduces the amount of information we can store in our working memory, impairs our ability to learn, and hinders our executive function (Frenda et al., 2014). Additionally, sleep aids us in the consolidation of memories. Consolidation of memories means that when we sleep, the brain is integrating the newly learned information with the already existing information. This process also leads to the creation of false memories (Straube, 2012). To sum up, whether there is a lack of or an adequate amount of it, sleep is a factor in the creation of false memories.

Memories can be distorted at any and every phase of the memory process: encoding, consolidation, and retrieval (Straube, 2012). False memories are distorted memories or recollections of information and events that did not actually happen (van Rijn, Carter,

McMurtrie, Willner, & Blagrove, 2017). An example of false memory is having a memory of bringing your keys into your house and hanging them up, when in fact they are still in your car (Cherry, 2019).

False memories are particularly important in eyewitness accounts of a crime. If the eyewitness of a crime is certain of their judgment but they are incorrect it could lead to the wrong person getting convicted of a crime. That being said, the real criminal would be running free and possibly committing more crimes without punishment (Frenda et al., 2014). Memory is an essential part of life. Therefore, it is important to gain a better understanding of memory and the influencing factors, such as the hours of sleep.

One common way to measure false memories is to administer the Deese-Roediger-McDermott (DRM) Task. The DRM Task was constructed to produce false memories. The task requires participants to read a list of words that are systematically related to a word that does not appear on the list (Frenda et al., 2014). For example, the words on the list would read; “desk”, “classroom”, “pencils”, “students”, and “curriculum”. This list would prompt the participant to think of the word “teacher,” even though the word does not appear on the list. After a waiting period, the participants are shown another list of words and asked to identify which words appeared on the first list shown. The second list contains both the words from the first list, as well as new words. The participants are more likely than not to recall the words that did not appear but were related, i.e. the word “teacher” (Frenda et al., 2014).

Administering the DRM Task to test for false memories is controversial as some do not believe it can replicate a real-life scenario (Frenda et al., 2014). However, this task does follow the misinformation procedure which includes: an encoding phase, a waiting period, a misinformation phase, and a retrieval phase (Frenda et al., 2014). This is a similar pattern eyewitnesses undergo and the three phases can be applied to witnessing a crime. When witnessing a crime, an individual is taking in information, which is the encoding phase. Then there is a waiting period before seeing a lineup of suspects, which is representative of the misinformation phase. Lastly, identifying the criminal is referred to as the retrieval phase (Frenda et al., 2014).

According to Chatburn, Kohler, Payne, and Drummond (2017), sleep deprivation increased both true and false memories. In their study, the researchers had three sleep conditions: rested, partially sleep deprived (four hours of sleep), and completely sleep deprived (no sleep). The participants were placed into one of these sleep conditions prior to completing the DRM task. These researchers found that after sleep deprivation, participants performed worse on the true and false recognition task. Chatburn et al. (2017) also

found that sleep-deprived participants, compared to well rested participants, performed worse only on the true memory free recall task but not the false memory task. Furthermore, the researchers have found that there was no difference between the participants who were completely sleep deprived and partially sleep deprived (Chatburn et al., 2017).

Frenda et al. (2014) drew similar conclusions, although the two studies had different methods. The independent variable in this study was sleep which had two levels: rested and sleep-deprived. The participants were placed into sleep conditions prior to completing the misinformation task. The misinformation task consisted of two sets of event images followed by two narratives that contained statements that contradict the situation in the images. Then, participants answered questions regarding the information they were shown and specified where they retrieved that information from either the images or the narratives. Frenda et al. (2014) found an increase in false memories when participants were sleep deprived before encoding information. They also found that sleep deprivation after encoding did not significantly increase false memories. Both Chatburn et al. (2017) and Frenda et al. (2014) have demonstrated that sleep deprivation prior to encoding increases false memories.

On the contrary, van Rijn et al. (2017) did not find that sleep deprivation increased the number of false memories. In their study, participants completed the Gudjonsson Suggestibility Scale, in which participants listen to a short story about an accident and later answer 20 questions about the story (only 5 of the questions can be answered given the information). After being given the Gudjonsson Suggestibility Scale, the participants gave immediate free recall. Then, they were either sleep deprived or allowed to sleep. The next day, the participants performed the delayed free recall and answered the 20 questions. The researchers found that the sleep conditions, rested and sleep deprived, did not affect false memories (van Rijn et al., 2017). However, these researchers did find that both sleep conditions performed better on the immediate free recall task compared to the 12 hours delayed free recall task (van Rijn et al., 2017).

I believe that the studies reached contradicting findings due to when the sleep deprivation took place and the retrieval method used (i.e., recognition or free recall). Researchers found an increase in false memories in participants who were sleep deprived before encoding information compared to participants who slept (Chatburn et al., 2017; Frenda et al., 2014). Participants that encoded information and then were sleep deprived or allowed to sleep failed to find an increase in false memories (van Rijn et al., 2017). Also, when participants completed a free recall task, sleep conditions had no significant effect on false memories

(Chatburn et al., 2017; van Rijn et al., 2017). This may be to the recognition tasks being suggestive and may prompt a false memory.

Many studies have shown that sleep deprivation negatively affects cognition. However, the research on sleep deprivation affecting false memories is limited. Therefore, further research needs to be conducted in order to expand the understanding of the topic. The present study, which used the DRM Task, was concerned with the relationship between the amount of sleep and false memories. In this study, the participant variable was the amount of sleep, operationalized as the number of hours slept at night (on average and the night before the task). The dependent variable in the study was false memories, operationalized as a count of the number of times a recollection of a word which was not shown previously is recalled. I hypothesize that participants who report less sleep will develop more false memories compared to participants that report more sleep. In other words, I predict a negative correlation between the two variables. As the amount of time slept is shorter, the number of false memories will be higher and vice versa.

## Methods

### Participants

A total of 149 participants (107 females and 42 males) were recruited from Amazon's Mechanical Turk in the United States. The participants' ages ranged from 18 to 88, ( $M = 41.84$ ,  $SD = 13.41$ ). The participants self-reported their education level which showed that 10.7% had a high school diploma or equivalent, 20.8% had some college education, 8.7% had an associate's degree, 40.9% had a bachelor's degree, 18.1% had a master's degree, and 0.7% had a doctoral degree. The participants' ethnicity consisted of 75.4% White or Caucasian, 10.1% Black or African American, 5.4% Asian, 4.7% Hispanic or Latinx, 4.7% from multiple races, and 0.7% preferred not to say. Participants received 10 cents for their efforts. Participants were treated in accordance with the "Ethical Principles of Psychologists and Code of Conduct" (Ethical Principles of Psychologists and Code of Conduct, 2019).

### Materials

A consent form that included a brief summary of the study, right to withdraw without penalty, benefits, time commitment, guaranteed confidentiality, risks, and contact information of the researchers and chair of the Psychology Institutional Review Board was used. The demographic survey used asked for gender, age, ethnicity, and education. A Sleep Questionnaire was also administered which asked about the number of hours of sleep (on average and the night before) as well as the quality of sleep. The hours spent sleeping the night before the memory task ranged from 3 hours to 12

hours 40 minutes ( $M = 6.53$ ,  $SD = 1.33$ ). The average hours spent sleeping ranged from 2 hours 40 minutes to 9 hours ( $M = 6.79$ ,  $SD = 1.09$ ). The DRM Task, which was created to cause false memories, was used to measure false memories (Frenda et al., 2014). This task requires participants to be shown 6 lists of words that are systematically related, such as, "night", "relaxed", "bed", and "tired". Next, as a distraction, a short 3-minute video about the importance of sleep was shown. Then, the participants were given a new word list containing 42 words that were on the previous list as well as new words, such as, the critical word "sleep." The second list of words asked participants to recognize which words did or did not appear on the first list (Frenda et al., 2014). The DRM was calculated by summing up the false positives. The possible range of false memories was 0 to 30. The range of false memories from the sample was 0 to 25 ( $M = 10.28$ ,  $SD = 4.39$ ). Although there were 42 words on the second list, the range does not include the 12 words that were on the first list as the focus is only on false memories. The debriefing form provided a more detailed summary of the research, guaranteed confidentiality, and contact information to learn more about the study's results.

### Procedure

Participants accessed Amazon's Mechanical Turk (MTurk), which contained a direct link that led them to the survey on Qualtrics. The participants were initially presented with a consent form to read and sign. After the participants agreed to the terms of the consent form, they were given a demographic survey. Next, they were presented with the Sleep Questionnaire and instructed to answer the questions to the best of their abilities. Following the questionnaire, the participants were instructed to complete the DRM Task. The task instructed the participants to read and remember 6 lists of systematically related words. Then, as a distraction, participants watched a short three-minute video about the importance of sleep. After the distraction, participants were shown a list of more words, both that appeared on the original list and did not appear, and asked to identify which words they have and have not been shown previously. When the task was completed, the participants were given a debriefing statement to read. After the participants were thanked for participating, they were given a completion code which they plugged into MTurk. This was done to ensure they completed the survey before being paid. Once the participants submitted the completion code on MTurk, they were compensated for participating.

## Results

Pearson's  $r$  was used to analyze the data. We reject the null hypothesis which states that there is no relationship between the reported amount of time spent sleeping and false memories. There was a significant



negative correlation between the amount of time spent sleeping the night before and the number of false memories calculated from the DRM Task ( $r(149) = -.23, p < .01, 95\%CI [-.38, -.07]$ ), (Figure 1). Although there was a significant correlation between the amount of time spent sleeping the night before and the average amount of time spent sleeping ( $r(149) = -.58, p < .01, 95\%CI [.46, .68]$ ), there was no significant correlation between participants' average amount of time spent sleeping and the number of false memories ( $r(149) = -.15, p < .07, 95\%CI [-.30, .01]$ ).

## Discussion

The findings of this study do support the hypothesis. Participants who self-reported less time sleeping had more false memories than those who slept for a longer period of time. My research supports the previous research which found that participants who are sleep deprived the night before encoding information have more false memories than the rested participants (Chatburn et al., 2017; Frenda et al., 2014). Interestingly enough, I found that the relationship between the average amount of sleep participants reported and the number of false memories was not significant but the trend was headed in the right direction. Previous research has not directly examined the relationship or effects that the average amount of sleep has on false memories. Furthermore, participants were getting sufficient sleep time the week before the experiment and were only sleep deprived the night prior to the encoding phase (Chatburn et al., 2017, Frenda et al., 2014). This implies that one night's sleep has a direct impact on our memories. Specifically, sleep deprivation influences the suggestibility of our memories (Frenda et al., 2014). It also suggests that an adequate night's rest may aid in recalling memories more accurately when faced with misinformation (Frenda et al., 2014).

Further research on this topic is needed. The current study was a correlational design, however, an experimental design could give us more insight as to the direct effect that sleep deprivation has on memories. Specifically, future research can examine the effects on adequate sleep and sleep deprivation both before and after encoding information in order to clear up the inconsistencies in the literature as some research has found that sleep deprivation does effect false memories (Chatburn et al., 2017; Frenda et al., 2014) and other researchers found that sleep deprivation does not affect false memories (van Rijn et al., 2017).

Despite the fact that memories are not perfect replicas of reality and its reliability may be detrimental in court cases, our imperfect ever-changing memories are also beneficial. Our memory's ability to eliminate the less significant information is a way it is able to strengthen the critical information in our memory

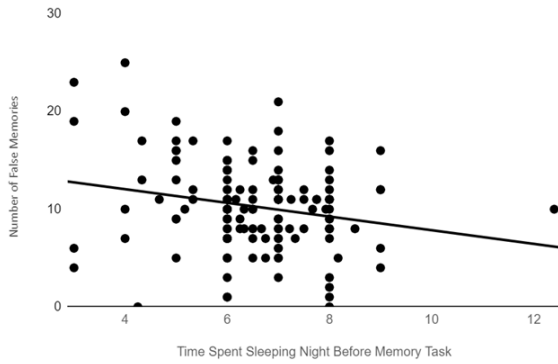
(Frenda et al., 2014). This allows us to apply critical information to other situations.

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*Figure 1:* There was a significant negative correlation between the amount of time spent sleeping the night before and the number of false memories ( $r(149) = -.23, p < .01, 95\%CI [-.38, -.07]$ ).

# Supporting Creative Lesson Planning through Database Design

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## Abstract

Planning and preparing for lessons is a very time consuming task for teachers, especially for new teachers. My project focuses on making lesson planning and coordination between teachers easier and more consistent by enabling teachers to review lesson plans and materials from past years, along with being able to share lesson plans with other teachers. I have created a database in MySQL, a database management system that stores and sorts data based on its relationships to other data, to store lesson plans and any information related to them, along with a web-based front end to interact with and view the data contained within the database via a secure, user friendly interface. This web-based front end has taken the form of a website that allows teachers and other verified users to search and filter the data from the database. By being able to share ideas in person and through the review of others' lesson plans, both new teachers and experienced teachers will be able to implement new ideas into their lessons and coordinate better with other classes. This database will be created with a small user base in mind and will be kept small in its first version, as I believe that this database will function best when used only by one school. However, feedback and future goals could lead to this database being applicable in a larger scope.

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## Introduction

Planning and preparing for lessons are essential tasks for teachers. For new teachers or teachers who are starting to teach a new class, planning can be a very time consuming task. Some schools hold meetings that allow for teachers who teach similar classes to coordinate lessons and collaborate. However, not all schools organize meetings such as these, and some teachers can't coordinate with other sections of their classes due to having less opportunities to coordinate and collaborate with their fellow teachers. Not all schools have an established way for teachers to share their lesson plans, so coordination and the sharing of lesson plans can sometimes be difficult to achieve. In order to aid in the lesson planning for teachers, I am planning on creating a MySQL database that allows for the review of lesson plans and materials from past years, as well as allowing the sharing of lesson plans from other sections of classes. I believe that a way to share lesson materials can not only help with lesson planning, but also encourage conversation about lesson plans, ultimately leading to the improvement of all lesson plans through collaboration. Not only can this project potentially help new teachers plan, it can also help teachers with materials from previous years improve them in future years. Along with the database that will hold the lesson plans and information about lesson

plans, I am also planning on creating a web based interface to the database so teachers can effectively find information in the database. This project will be created with a small amount of users in mind, as many schools have different ways they organize their classes, and a larger database could run into problems with how data would be stored.

## Background Information

I think some of the main uses for my database outside of helping to plan lessons can be helping teachers understand how to integrate technology into the classroom and help teachers understand how a classroom technology works. Not all technologies are fit for every classroom setting, so having advice on how to use technology that has already been shown to be a good fit for the subject can be very helpful in fostering the creation of good lessons, as poor adoptions of technology can actually make the learning environment less effective overall. (Hora et al, 2010) However, having solely good lessons is only temporarily beneficial, as a thorough understanding of how the technology functions is essential in using technology to its fullest potential and being able to effectively plan for technology use in future lessons. (Krauskopf, Hesse, 2011) While a teacher should eventually strive to have a deep understanding of how to use technologies, supporting teachers with

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practices, principles, and advice on how to use technology is the best first step in being able to effectively use technology in the classroom. (Dimitrias et al, 2013) Though technology can be extremely helpful in strengthening the students' understanding of the topics, technology use in the classroom should only be used as a supplement to the teacher's lessons, not as the primary way of learning information. (Drijvers, Weigand, 2010) I have also researched some past work with a similar idea in the form of a website called Cloudworks, which was made with the intent of having a social media website dedicated to the sharing of lesson planning ideas. (Conole, Culver, 2010) While Cloudworks is similar to my idea, I think that having the lesson plans only visible to a smaller group of people may reduce the hesitation people have when sharing their lesson plans, while still encouraging overall discussion.

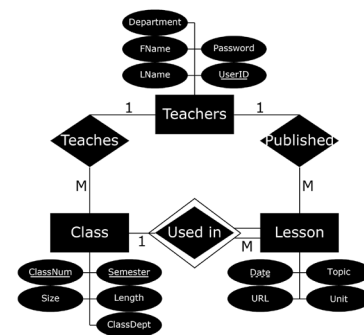
### Methods

My project consists of the creation of a MySQL database and a web-based interface that is used to access the database, as well as the development of further improved versions of both the database and interface after the initial creation. As such, most of my work that will need to be done before the creation of these components will be planning the structure of the database and planning for all of the functionalities in the front end. The structure of the database so far will consist of a table of the teachers using the database, a table containing the classes that these teachers are teaching, and a table containing all of the uploaded lesson plans. These tables will be organized in such a way that each data entry will be uniquely identifiable and each instance of data will have ample enough data to be useful in the functioning of the application. The front end interface will mainly be used as an interface between the user and the database, allowing the user to see the entries in the lesson table based on what they search. The web-based interface was created with a combination of HTML, which was used to create the structure of the website, and PHP, which was used to add functionality to the website. This project didn't result in a gathering of data that I have collected, as it instead took the form of a complete and functional database and interface application made for the goal of sharing lesson plans.

### Procedures

For this project, I focused on the creation and development of the functional parts required for the full operation of the website. During the creation of this project, I first focused on the planning and creation of the MySQL database before focusing on the creation of the website that would serve as a way to

interact with the data contained in the database. MySQL is a relational database management system, so I started the process of creating the database with the creation of an entity-relation diagram, or ER diagram for short. This ER diagram aids in the planning and creation of the database by showing all of the data entities, relations, and attributes that will be recorded in the database and how they are related to each other in the database. The ER diagram can be directly converted into the Create Table statements in mySQL code, which will be entered into the database management software in order to create the physical database. During the early stages of this project, I planned on hosting the database and website online in order to be able to easily access it from anywhere, but due to the timing of when I started development of the database itself, I decided to create the project locally instead. The database has the same structure as the ER diagram due to the main focus of the queries that will be run from the website being on the data contained in the Lesson table.



*Figure 1: Version 1 of the ER Diagram*

After the creation of the database, the only part of the project that needed development was the web front end that interacts with the database. For this part, the interactive portion was the aspect that I focused on most during creation. The interactive portion of the website is two fields that correspond to two entries in the lesson table: the unit and topic.

*Figure 2: The main interface of the Lesson table query*

The query that uses the entry of these search boxes is made such that any text entered on each of the search boxes has to only be contained in the corresponding data, not exactly match it. This means that related lessons can appear in the search, but also that both of the search areas don't have to be filled, allowing searches of any combination of the two boxes. After submitting the search, the website redirects the user to a simple page that displays the basic information of the lesson along with a link to the lesson itself. In the current state of the project, the link to the lesson itself only redirects to a simple page of text.

## Results

While the website is in a working state with the main functionality implemented, there are still many aspects that I plan on improving in the future. Aside from visual improvements to the website, there are a few functions I was unable to get functioning in this first iteration of the project. The most useful function that I was unable to implement is a pdf viewer for the lesson plans instead of showing them as a simple html page. This would be extremely helpful because not only can the lesson plans can be organized by pages, allowing the original teacher to have both the lesson plan and lesson materials in one document, but the lesson plans could also be downloaded from the page itself rather than only being able to be accessed through the internet. Another feature that I was not able to get functional was another query for seeing all of the classes a teacher has taught. This would be filtered by the ID of the teacher, which is the primary key of the teacher table, and it also displayed in the lesson query. The largest feature that I was unable to get functioning is the user system, which is very important for security. The user system would give access to the website to users with accounts, which can be linked to a teacher id. However, one way I was considering making the user system would be to use another table in the database to store the user information and using a query to verify that the user exists with the entered password. However, this approach would need to analyze user input somewhat to protect the user logins from SQL injection attacks, which are attacks that use the structure of queries to edit the queries in unintended ways or create new queries. By not allowing certain special characters, like the semicolon, the threat of SQL injections would be lessened.

## Discussion

Prior to the creation of this project, I had multiple potential endpoints for the website portion. Currently, the website is at the most minimal of the endpoints I had thought of. As I have already detailed in the previous section, there were many features that I wanted to implement, but was unable to fully. However, while they are not complete at the time of writing this article, I still plan on adding these features to the project in the future. While I was still able to get the project functioning, there were many more features that I really wanted to get functioning, as I felt they were essential for the full website. While this endpoint was one that I thought of, I feel that I should have made more realistic endpoints that required more of the features that would be essential in the full website. I think the endpoint that I ended at is unrealistic, considering that I would not have considered this endpoint as an endpoint if I was working to develop this for a client.

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# Informing the Need for Critical Thinking in Mathematics

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## Abstract

The purpose of this research is to examine if word choice and situational context affects students' perception of nonsensical word problems. The research question guiding this research is; do students perceive nonsensical mathematical word problems differently, based on vocabulary and context? A nonsensical mathematics word problem occurs when the information given in the problem cannot lead to a numerical answer. This research analyzes the performance of sixth grade students solving five mathematics word problems in a primary school setting. During the research, each participant was given a worksheet with five problems, four of the five problems were traditional word problems with numerical solutions. The fifth problem was either the famous nonsensical shepherd problem, or a different nonsensical problem with an updated context specifically created for this research. The idea for this research stems from Kurt Reusser's research conducted 1986. A similar research was conducted in 2013 by Robert Kaplinsky. The importance of this research has to do with word choice and context in mathematics problems, it's purpose is to shed some light on if word choice and the context of mathematics problems affects students' ability to solve them.

*Keywords: Anticipatory Set, Nonsensical, Critical Thinking, Nonsensical Question*

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## Introduction

Many students, when introduced to a mathematical word problem are nervous to solve it. Students can pick out the numbers in the problem and try to produce an answer. Many students try to understand what the problem is asking for, and students who reach an answer rarely take a second to think if their answer makes sense according to what the problem is asking. Sometimes students cannot relate to the context of the problem, or are unable to understand the vocabulary used, making them unable to answer the question. According to Kurt Reusser and Robert Kaplinsky's research, it indicates that if students are provided a mathematical problem that cannot be solved, then students will answer with a numerical answer.

## Background

In 1986, Kurt Reusser asked students to answer the following question: "there are 120 sheep and 5 dogs in a flock. How old is the shepherd?" This problem does not have enough information to determine how old the shepherd is, which may confuse students. However, the numbers are relatively simple to manipulate and an answer can be produced by adding, subtracting, multiplying or dividing the numbers. In an article by Katherine K. Merseth in 1993 (Merseth 1993), she talks about Reusser's research and explains how three out of four children gave a numerical answer to the question about the shepherd's age. This same research indicated

that in a student's world, mathematics is seen as a set of rules and procedures, which they have to memorize in order to produce an answer the teacher deems as correct (Merseth 1993).

## 90's School System

When Merseth published her article, she explained how the United States public education system had produced an entire generation of students who engaged in mathematical problem solving without considering the context of the questions they sought to answer. In her article she stated that a total of 40% of 8th and 12th grade students agreed with the statement of mathematics being a set of rules, "while 50% of the eighth-graders and 25% of the 12th-graders stated that mathematics involves mostly memorizing" (Merseth 1993). She mentions, in the classroom, students are sat in assembly lines where the teacher is lecturing and the students are listening. When the teacher is not talking, the students are working independently and silently on worksheets with no interaction with their classmates. Additionally, there may be an issue with the curriculum that is being taught. Merseth claims that many teachers are used to utilizing the textbook, making it such that the textbook determines what is taught in the classroom. Textbooks present material in a certain way; "the dominance of the textbook is illustrated by the finding that more than 95% of 12th-grade teachers indicated that the textbook was their most commonly used resource" (Merseth 1993).

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Moreover, the repetitiousness of mathematics material and content at different grade levels overlap, leading to needless time spent on topics already learned. According to Merseth, the implementation of the spiral curriculum has been less than ideal. The spiral curriculum reuses the old material from the previous grade level into a new form without significant improvement, which breaks off a chance to deepen a student's understanding. "As one teacher wryly noted, 'if Johnny doesn't get multiplication in third grade, he'll have another chance in fourth, fifth, sixth, seventh, and eighth grades'" (Merseth 1993). Furthermore, the lack of teacher's preparation is a concern. "If teachers prepare students poorly, it is due in large part to deficiencies in their own training" (Merseth 1993). One out of two mathematics and science teachers lack their subject-matter training. Therefore the way they were taught is the way they teach their students. This might play a factor for the lack of allowance for students to perform deductive reasoning.

### ***Previous Research***

Robert Kaplinsky took Reusser's shepherd problem and presented it to thirty-two 8th grade students. Twenty-seven years later the results were still the same; a majority of the students gave a numerical answer to the question (Kaplinsky 2013). The two values provided in the problem are natural numbers that are easy to manipulate with the basic operation of mathematics. Most students went through the process of adding 125 and 5 to receive an answer of, 'the shepherd was 130 years old'. When 130 years old was too large of an age, they then began to subtract 125 from 5 to receive an answer of '120 years old', also a large number for an age. These answers students provided are considered unrealistic answers. This is because it is impractical for a human being to live up to an age of 120 or 130 years. If students realized their answers were too large for an age, then they might have begun to perform an alternate operation. Students then divided 125 and 5 to receive an answer of 25 years old, which was a reasonable age for their final answer. According to the context of the problem, they are dividing the number of sheep by the number of dogs to determine how old the shepherd is. Students who decided to take this process of adding, subtracting, and dividing seemed to lack critical thinking skills when it came to the numbers and the context of the problem. To perform critical thinking skills, a student would need to be able to make reasoned decisions, consider the criteria for a thoughtful decision, and not simply apply a rule without assessing its relevance (2013 The Critical Thinking Consortium [www.tc2.ca](http://www.tc2.ca)).

The research on nonsensical mathematics problems originated forty years ago. French researchers in 1979 asked first and second graders the question; "on the

boat, there are 26 sheep and 10 goats. What is the age of the captain?" (Talwalker 2018). More than 75% of students gave a numerical age by manipulating the numbers. Most students added 26 and 10 to receive an answer of 'the captain is 36 years old'. Very few students questioned if the problem was solvable. The researchers expected that most students would answer "there is not enough information". Their research received attention from around the world, for example, from The South China Morning Post, RT, BBC, Washington Post, and Newsweek (Talwalker 2018). All of the media coverage focused on the numerical values, and students' low critical thinking skills. When the news spread, the study was replicated in France again, and in Germany and Switzerland, because many were skeptical that so many students would produce numbers to answer the question. Unfortunately, their results were similar to the original one, making it clear that primary school students lacked critical thinking skills.

The origin of these types of questions traces back to 1841, when Gutave Flaubert wrote a letter to his sister with the question; "a ship sails the ocean. It left Boston with a cargo of wool. It grosses 200 tons. It is bound for Le Havre. The mainmast is broken, the cabin boy is on deck, there are 12 passengers aboard, the wind is blowing East-North-East, the clock points to a quarter past three in the afternoon. It is the month of May. How old is the captain?" This question provides more information, however none of it is necessary to answer the question, which still revolves around students' deductive reasoning skills. It does not provide any information of the captain, what year it is, nor the birth year of the captain. This question can confuse students, however they should still be able to determine that there is insufficient information to solve the problem.

### ***Our Current School System***

For years now, there has been a push for school districts to take action on the standards of mathematical practice in schools. The standards for mathematical practice now are: make sense of problems and persevere in solving them, reason abstractly and quantitatively, construct viable arguments and critique the reasoning of others, and model with mathematics. We also must use appropriate tools strategically, attend to precision, look for, and make use of structure, and look for and express regularity in repeated reasoning (Common Core State Standards Mathematics). These standards were launched in 2009, until they were implemented in the classroom it took time and development for teachers to get into the process of using them. These standards should train students in thinking critically about the question they are being asked. This research will not determine whether the common core standards are working or not. Students who utilize their mathematical practice standards should be able to easily explain why

there is no answer to the problem we are focusing on. Helping students gain understanding of mathematical concepts through improved standards of teaching is important.

As a mathematics major pursuing to be a future educator, I have observed a variety of classrooms with different classroom arrangements, cultures, teaching methods, and strategies. With a new push of technology in the classroom and its standards, teachers are expected to have lessons that focus on student interaction with little help from the instructor. According to Merserth research in 1993, the seating arrangement of students has slightly changed since she mentioned assembly lines seating in classrooms. Teachers have now learned, and have the option of seating their classroom desks in groups or clusters, so they can interact with one another. Teachers use four instructional approaches: Explicit Direct Instruction, Cooperative Learning, Experimental-Based Instruction and Inquiry-Based Instruction. These instructional approaches are required for student interaction. Within these instructional approaches, there are anticipatory sets that students participate in the beginning of the lesson for the day. An anticipatory set is an activity that is given in the beginning class to hook students, activate prior knowledge and prepare them for the day's lesson (Gonzalez 2014). Strategies used in the classroom can include; clusters, divide and conquer, assigned discussion leaders, group surveys, learning cells, turn to a partner, jigsaw and think-pair-share. This allows students to interact with each other, to help each other with the content they are learning. The process of teaching and repetition can help longtime clarity and memory on a subject. Having classrooms seated in groups, according to a 7th grade teacher "makes the classroom spacious and allows me to walk around easier to check on students and answer their questions". I see teachers implementing the 'I Do, We Do, and You Do' model. The 'I Do, We Do, You Do' model is based on teaching and supporting students before expecting them to complete a task on their own. It was popularized by educators such as Anita Archer, John Hollingsworth and John Fleming" (Killian). I have been speaking to some of these teachers on how they move away from traditional ways of teaching, and use of technology is one of the main changes in education. Many districts near Stanislaus county like Manteca, Modesto, Ceres and Turlock are One-to-One. This means that each student in their district receives a laptop to use for their class assignments. In a district that is One-to-One, each student has a Google Classroom user provided with an email for them. Each folder in Google Classroom represents a course. This allows students to view their assignments, quizzes, PowerPoints, videos, and anything the instructor would find useful for the students learning. Teachers that teach these courses

have the ability to add/take away materials at any time. In a Math 7 and US History course I observed, both teachers used quizzes as an opener everyday so the class could review prior lesson lectures. This is considered an anticipatory set. Afterwards the class would review the answers together. This allows for students to see what they need to practice on more. The teachers later told me that the quizzes the students take in the beginning of class are really for them to see what they need to re-teach or move onto a new lesson. Other strategies used with the help of technology are Kahoot, Jeopardy, Desmos math, and other interactive online activities while in the classroom. These quizzes usually only take a total of 10-15 minutes of class time, so it does not get in the way of the remainder of the class period. Since many districts are becoming One-to-One, students are allowed to take these laptops home and most teachers like this idea because it enables students to further their education while at home. The use of technology is a faster way to grade assignments as well as exams. Students can access their assignments and receive a response at a faster rate than waiting for the next day in class to receive their assignment back in paper. The integration of technology into primary schools has led to new forms of teaching that benefit both educators and students.

### ***SBAC Scores***

While schools continue to move to One-to-One, this research decided to look at the overall Smarter Balanced Assessment Consortium (SBAC) test scores for math from grades 3rd-8th and 11th grade in California to determine students current performance level. In 2015, 38% of students did not meet the standards, with only 33% meeting the standards. In 2016, 35% of students did not meet the standards, with only 37% meeting them. In 2017, 36% of students did not meet the standards, and 36% met the standards. In 2018, 35% of students did not meet the standards, and 38% met the standards (Test Results for English Language Arts/Literacy and Mathematics).

Looking at these percentages, there is a slight change in scores but they remain in the 35% range throughout 3 years, there is an insignificant change from one year to another. Taking a look specifically at the percentages in the Stanislaus county and District A for all grades, 42.22% of students have not met the standards, 28.17% nearly met the standards, 17.64% met the standards and 11.96% exceeded standards. These percentages are from the year of 2018 (Test Results for English Language Arts/Literacy and Mathematics). The results are low and can definitely be improved.

With the adoption and implementation of the Common Core State Standards for Mathematics, there is a question of whether students still face the same difficulty with nonsensical math problems. Is it



possible, from the data gathered in the past years from Reusser, Merseeth and Kaplinsky, that students' responses have changed to the questions? Is there a significant difference in student responses to these nonsensical problems? In addition to this comparison, there is a statistical analysis to identify whether there are significant differences in responses due to gender.

## Methods

The last study of this type of research was conducted in 2013. This research was replicated from the previous study, and considered similar aspects for the year of 2019. For this current research, a total of 100 students were surveyed. However, only 98 participants were analyzed because 2 students left the nonsensical question blank. Participants were 6th graders from one local school district. The researcher reached out to over ten school sites. When positive feedback from two school administrators was received, the researcher visited the school sites, introduced the survey to students, and distributed informed consent/assent forms. The researcher returned to the school sites a few days later and administered the survey to students that brought back their signed consent/assent forms. The sample in this study was a convenient sample, because the school district is near California State University, Stanislaus, and the researcher had connections to some of the schools. Each participant in the survey was given a worksheet with five mathematical word problems. Four out of the five problems were traditional solvable word problems. The fifth problem was either the Reusser's "how old is the shepherd?" problem, or a different nonsensical problem specifically created for this research called the Pokemon Go problem.

The nonsensical mathematics problem created for this study reads; 'James is playing Pokémon GO, and catches 125 Pokemon in 5 hours. How old is James?' The purpose of the research is to see if there is a significant difference in student responses to the nonsensical problems, based on word choice and context. The hypothesis being that students should be able to recognize that the question is unanswerable if the context of the problem is more familiar to them. For the nonsensical problem not to stand out, it was surrounded by four additional mathematics word problems taken from the Smarter Balanced Assessment Consortium (SBAC) 2018 test questions.

These are examples of questions used from the SBAC:

- A rectangular prism has a volume of 42 cubic units. The length is 3 units. The width is 2 units. What is the height of the prism?
- Justin is making snowballs to build a fort on the winter break. Justin can build 15 snowballs in an hour but 2 snowballs melt every 15

minutes. How long will it take him to build 210 snowballs?

The data collected from each student was confidential. Only age, gender and grade level was asked from students. After running a chi-square test with the p-value equaling 0.721573, the lower probabilities provide stronger evidence against the null hypothesis. The correlation between performance on the nonsensical questions and the SBAC questions indicated a moderate positive relationship ( $r=0.5$ ) between the two.

## Results

These results indicate that students still try to give a numerical answer to the nonsensical questions, however the results are not as shocking as the previous ones. The wording and context of the problem does not seem to play too big of a part in the lack of understanding of the problem. There was also insignificant difference between the performance of the genders.

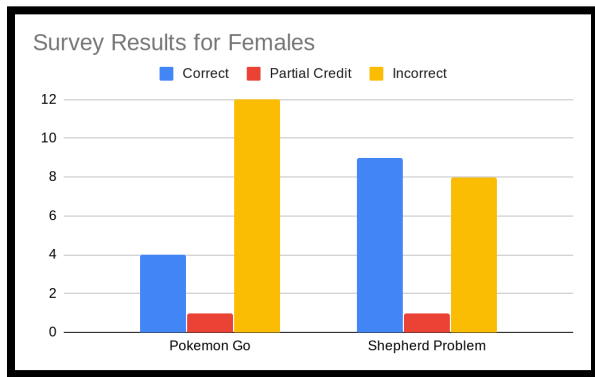
Before looking at the data gathered, the research decided to look at both schools public demographic on the School Dashboard. The first school, School A performed better than the second school, School B. School A had 499 students take the Smarter Balanced Summative Assessment or the California Alternate Assessment and showed 6.1 points above standard level (California School Dashboard). The standard level is zero. School B had 305 students take the Smarter Balanced Summative Assessment or the California Alternate Assessment to show 92.1 points below standard. School B's Suspension Rate, Chronic Absenteeism and English Language Arts are mainly in the low performance area (red and orange). School A's Suspension Rate, Chronic Absenteeism and English Language Arts mainly in the high performance area (green and blue).

After observing the results between School A and School B, this prompted me to further look at results of the SBAC scores for both schools. As mentioned before, the research survey had 4 SBAC questions. I began to look at a comparison of the school's English and Mathematics performance. Provided below are the scores for standard Met or Exceeded for SBAC Scores of 2019.

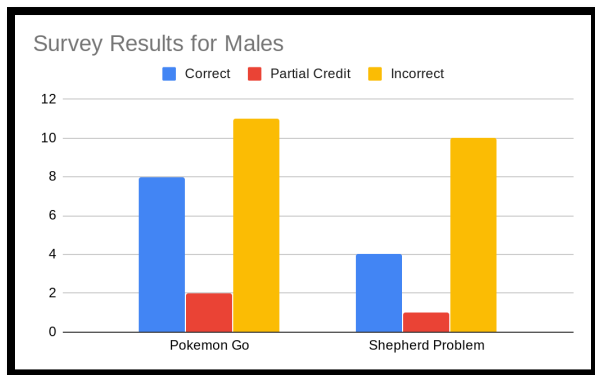
For School B, 21.81% of students met or exceeded the standard for English and 22.08% was for 6th grade. In mathematics, 11.22% of students met or exceeded the standard and 0% was for 6th grade. I decided to look at the differences between females and males for these percentages according to the SBAC. Females performed higher in English whereas males performed higher in Mathematics. Females received 24% in English, whereas males received 19.60%. In mathematics, females received 13.91% and males received 8.56%.

For School A, 63.98% of students met or exceeded the standard for English 58.40% of which was for 6th Grade. In mathematics, 55.12% of students met or exceeded the standard, 52.80% were for 6th Grade. Again, females performed higher in English, with males performing higher in mathematics. Females received 66.66% in English, whereas males received 61.33%. In mathematics, female students received 52.78% and male students received 57.42% (California Smarter Balanced Test Results: 2019).

From the results of students answering the shepherd problem and the nonsensical problem, there was a noticeable difference between the female and male students. We can see this in Figure 1 and Figure 2.



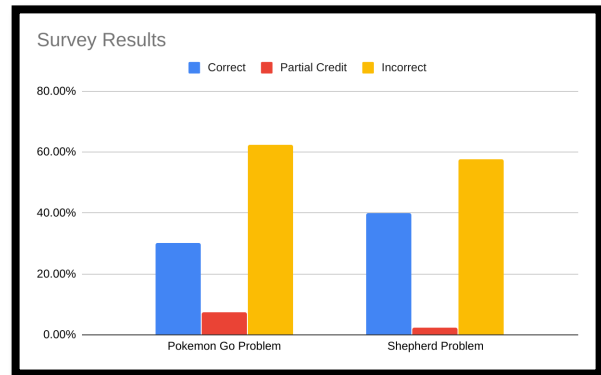
**Figure 1:** The figure above represents the survey results for females in comparison of the Pokemon Go and the shepherd problem.



**Figure 2:** The figure above represents the survey results for males in comparison of the Pokemon Go problem and the shepherd problem.

Female students from both schools did better at answering the shepherd problem correctly than the nonsensical problem, whereas males from both schools performed higher at answering the Pokemon Go problem. Since the nonsensical problem had to deal with Pokemon Go, we can make the assumption that male

students who are exposed to video games like Pokemon Go would relate more to the problem. This correlation does not imply causation. As seen in the Figure 3, a total of 75 6th grade participants participated from School A, and 28.21% on average were able to answer the Pokemon Go problem correctly, whereas the shepherd problem averaged 30.56% receiving it correctly. 12.82% managed to receive half credit for the nonsensical problem and 13.89% received half credit for the shepherd problem. To receive partial credit, students must show they were unsure how to answer the problem given the information, but could not identify why. 58.97% averaged to receive it incorrectly for the nonsensical problem, and 55.56% averaged incorrect for the Shepherd problem. There were a total of 25 6th grade participants from School B. 20% were able to get the nonsensical problem and the shepherd problem correct. 6.67% managed to receive half credit on the nonsensical problem, and none received any half credit for the shepherd problem. For incorrect, 73.33% on average for the nonsensical problem and 80% on average for the shepherd problem.



**Figure 3:** The figure above represents the survey results for all 6<sup>th</sup> grade participants in comparison of the Pokemon Go problem and the shepherd problem.

After gathering the results, 60% of the students surveyed provided a numerical answer to the nonsensical questions. 11% of the students gave unrealistic answers and the most popular answer was 25 years old. Some of the answers for ages according to the problem ranged from 3 years old for James to 680 years old for the Shepherd. These answers were marked incorrect and were considered as unrealistic answers. Meaning, it is impractical for a human to be playing Pokemon Go at the age of 3 and for a shepherd to live up to an age of 680 years.

## Discussion

The significance of this research lies in the importance of developing critical thinking skills and understanding in mathematics education. Using words and context that applies to the student's world is especially important for younger students, since complex vocabulary and abstract thinking has yet to develop. These results should be of interest to teachers, curriculum designers, and everyone involved in teaching students. Sometimes, all it takes for students to understand mathematics is to change the scenery. Connecting complex problems to students' hobbies and pop culture can and will help students learn and use their critical thinking skills. Like Polya, the father of Problem Solving emphasized, the first step of solving a problem is making sure you understand the problem.

## Influences to Consider

Some shortcomings of the research deal with voluntary participation, and common in-school distractions. The research being voluntary may have led to students who are more competent in mathematics to participate. Students were asking questions and talking during their participation, though I tried to minimize conversation and distraction. Not all students in the classroom were taking the survey, and they might have distracted the survey takers. The survey takers did periodically ask the researcher for assistance on some of the questions and tried to determine what the answers were or how to approach the problems. These contributed to the setting not being the most optimal test setting. Then we realized Pokemon Go is not as familiar to all 6th grade students as I thought. There might be a gender bias, this meaning boys might be more familiar with the game.

## Conclusion

When faced with a difficult problem, students easily stray away from deductive reasoning and rely on simple mathematics to give them a completely wrong answer. In my research I use two forms of nonsensical questions, one with relevance to students and one without, to research the problem solving techniques that primary school students employ. Results show word choice does not play a significant role in students' performance on nonsensical mathematics word problems. Students need opportunities to develop their critical thinking skills. For future improvement, this research can be applied to a secondary school setting with a different nonsensical question written with vocabulary that is most known to students. The context of the problem could be created that is best fit for the current generation of students. An example question can be, "Michael was scrolling on instagram and liked 125 pictures in 5 hours. How old is Michael?". The word 'instagram' would be assumed that students are familiar with.

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# Biophilia and Ecowellness: Examining Nature Connectedness

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## Abstract

This study explores the cognitive, affective, and evolutionary spheres that are found in the sub-field of Ecopsychology. Scientific evidence shows that nature can affect humans in these three spheres. This study also suggests that those that come from urban, suburban, and rural backgrounds score the same on average for their nature connectedness scores. Biologist E.O. Wilson said biophilia is present in humans because it stems from an evolutionary need. Looking at nature connectedness at an individual level affirms the importance of nature in our lives, even if nature is not valued aesthetically, cognitively, or through an evolutionary sphere. Humans feel connected to nature in times of personal and global crises (e.g. pandemics or poor mental health). A connection with nature helps us adapt physically and cognitively.

*Keywords: Biophilia, ecowellness, ecopsychology, environmental psychology, microbiome, deep ecology, biophobia, design, environmental ethics*

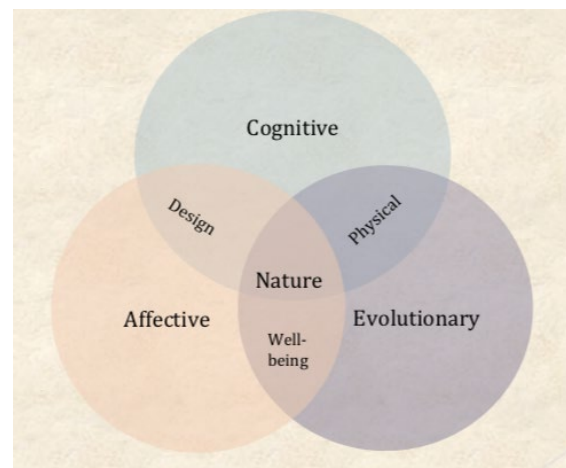
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## Introduction

This study aims to explore how nature connectedness relates to Ecopsychology. The literature on the perspectives of Native American's connection to natural environments illustrates the significance of how one's relationship with nature can impact the psyche. Wildcat (2000) argues that the community aspect of plants, landscapes, and animals does exist; though western paradigms often assert otherwise. Myers and Reese (2012) state that connecting with nature can lead to a sense of communion with the natural world. Maslow mentions that peak experiences are what we strive to achieve in our lifetime (Myers and Reese cited as Maslow 1973). In this research study, "nature" and the "natural environment" are the foundations of the natural world (Myers and Reese, 2012). For instance, nature includes all aspects of nature and human-built environments that express natural elements.

More often than not, traditional psychology research does not explore environmental ethics and disregards the importance of the connection between humans and nature (Perkins, 2010). The work of Harvard biologist, E.O. Wilson indicates a psychological blindspot when nature's role in psychology is discounted. Wilson reasoned that humans have a natural tendency to feel connected to natural elements, which protect the environments we humans have evolved in (Wilson, 1984). He called this connection to nature the "biophilia hypothesis." Humanistic psychoanalyst, Eric Fromm, used the

term biophilia in 1973 and defined biophilia as the "love of life" (Gunderson, 2014). This study will focus on Wilson's perspective on biophilia. This paper indicates that nature connectedness is not dependent on the individual's background i.e. rural, urban, or cultural variables. The biophilia hypothesis is what guides humans to feel connected to nature. Three perspectives can help us search for how we connect with natural environments (See Figure 1). There are imbalances that may be addressed by a nature prescription.



**Figure 1.** Nature is the middle ground

## Biophilia Meets Green Design

Sustainable behavior can be taught and explored in various ways. For instance, let us begin with the visual arts. Evolutionary psychologists and biologists have accepted the pleasure effect that comes from observing the visual arts (Hickman 2016). Within this evolutionary perspective, what does it mean to have a sensory experience when we look at nature? Do humans interact with natural elements in the same way that they appreciate art? Alexandria Rupert (2018) studied the emotional responses that individuals experience at Brooklyn's Botanical garden and why humans are affected by nature. One of her approaches was to inform the reader of relating to nature and how it can be measured at the urban botanical garden. As a designer, she explored how the botanical garden and its architecture are designed to evoke psychological and emotional reactions from the viewers. Rupert supports that affective, cognitive, and physical responses exist between humans and nature.

Designers in the art industry have their own representations of what nature means to them. Scientists discovered that humans are attracted to all fractals no matter what medium they appear in such as in math, art, or nature (Rupert 2018). The structure is organized, surreal, precise, and they are found in the entire natural world. Designers (artists or architects) can design fractals for the emotional, cognitive, and physical effects of the user's experienced environment (Rupert 2018). Also, "nature relatedness" ties in the importance of nature even if it is not valued aesthetically (Rupert 2018). See **fig. 2** and **fig. 3** for examples of green design.



**Figure 2.** Biophilia Design



**Figure 3.** Earth Abides II

## Environmental Ethics, Biophobia, and Considerations

Comparing multiple disciplines reveals some points of contention. Becoming familiar with a parallel field such as environmental ethics is a good start. Arne Naess has contributed by defining the terms "shallow" and "deep" ecology (Sessions, 1995). Connectedness towards nature being considered valuable to humans would affirm his point of shallow ecology. He posited that there needs to be a critical shift to move away from "shallow environmentalism" (1995). However, Naess admits that his movement is a "radical ethic" that may not be wholly understood. Fritjof Capra, the physicist, and deep ecology contributor recognized the application of ecopsychology in developing the ecological self (Capra 1996).

Moreover, Santostefano (2008) stated that ecopsychologists need to consider a dialectical-relational model. This approach is beneficial to facilitate healing from all environments, not just from interactions that intersect with the natural world. A study of the environmental psychology of aging has proven that a community garden in a nursing home resulted in improved communication and socialization for 60% of the residents (Youdin 2016). The elderly were often isolated from their family members; gardening was a nature-based intervention that facilitated healing. Furthermore, there are scenarios when people do not feel safe around their natural environment, and this is called biophobia. E.O. Wilson and social ecologist, Stephen Kellert, described the fear that one may feel from animals and wildlife (Callow cited as Wilson and Kellert 1998). Becher and Richey cited as Kellert (2008) described that a central issue is a lack of environmental education. Feeling out of touch with nature can pose



great psychological danger. Thus, it is essential to understand biophilia and its relation to longevity. The

### Cognition, Evolution, and Neuroscience

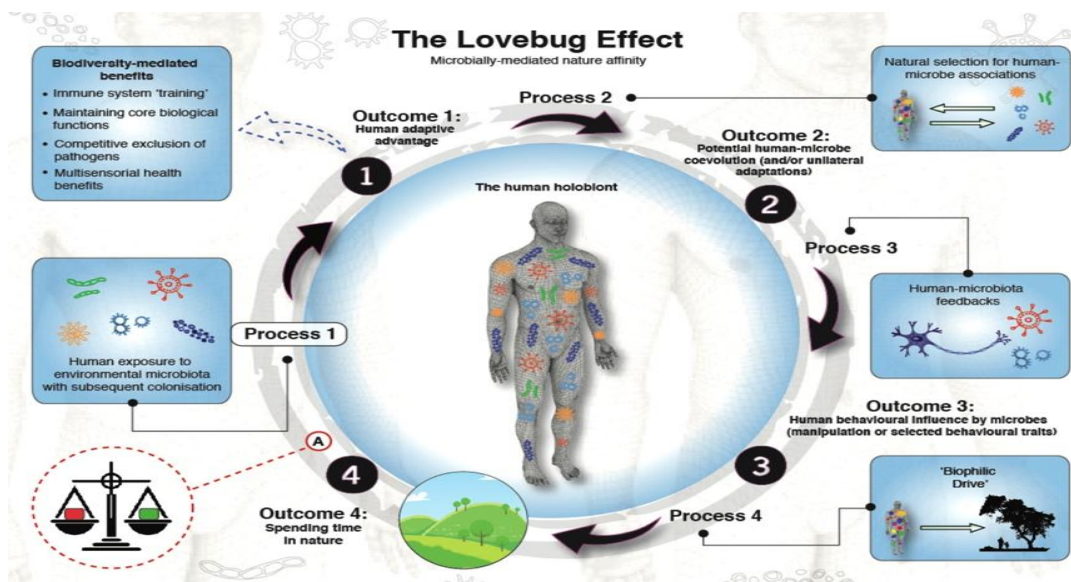
Feeling optimistic and less anxious generally leads to feeling happy. Happiness has similarities with nature connectedness that depends on personal experiences and characteristics for each individual (Capaldi, et. al 2014). According to Gifford (cited as Felston 2014), people who take walks in nature are aware of the hedonic affect afterward. Considering subjective well-being is a vital asset in environmental psychology because it supports that an environment has a therapeutic role (2014). Psychologists in this subfield will be aware of how to advocate for safe, natural living

evolutionary stance on biophilia can be reviewed with the three perspective model described earlier.

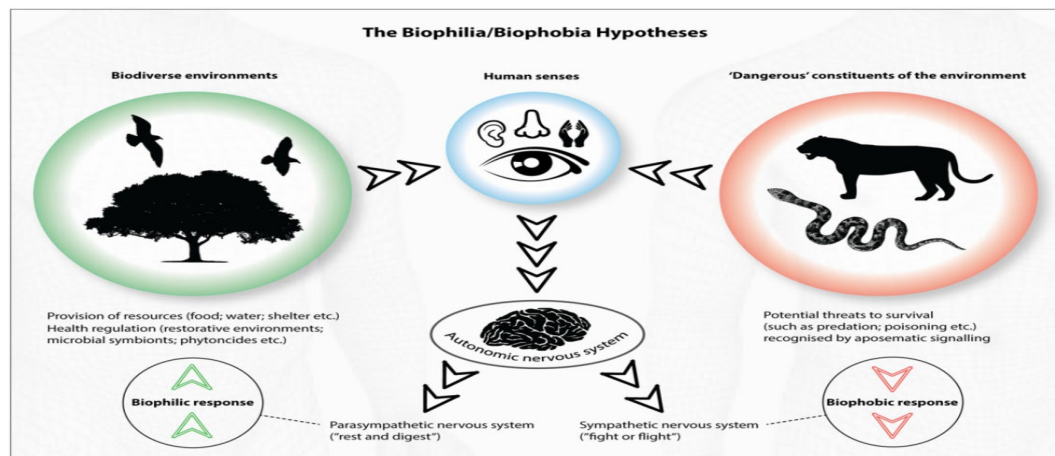
environments. There is also the neuroscientist approach to the biophilia hypothesis and why coevolution leads us to interact with nature. Our gut-brain axis drives us to quality spaces in nature to keep our immune systems healthy. In addition, the parasympathetic and the sympathetic nervous systems are responding to the experiences we have with nature to help us

rest or respond to dangerous natural environment situations. See **fig. 4** and **fig.**

**5** to see how biophilic drive relates to us in areas of coevolution and the nervous system (Breed and Robinson 2020).



**Figure 4.** The abiotic and biotic features, the internal and external microbial communities give feedback to the host. The biophilic drive is influenced by the microbiome. The host can select for natural environments that are helping them stay healthy.



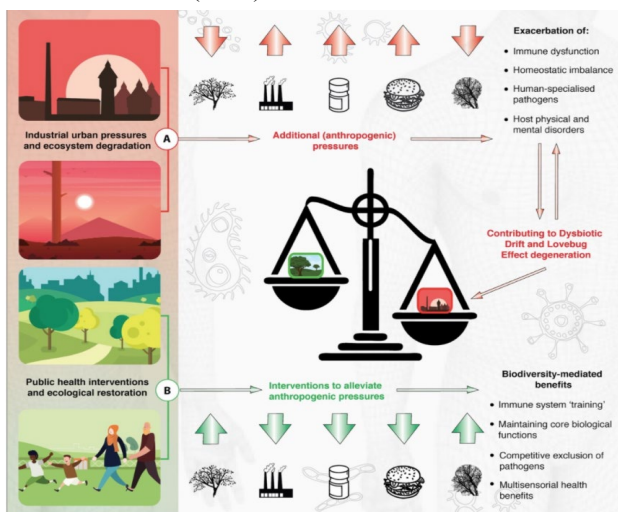
**Figure 5.** The nervous system

## Defining the EcoWellness Model

Counseling professionals can approach clients with new modalities to activate healing by using natural environments as a tool. Myers and Reese (2012) mentioned that EcoWellness counseling expands the therapist’s toolkit. Researchers break this model down into three dimensions: Access to nature, environmental identity, and transcendence. The quality and accessibility of green spaces are considered by Ecopsychologists when they invite their clients to the natural world.

Negative and positive environments are easier to discern depending on the depth of ecological identity. This identity helps one establish their relationship with cities or areas with minimal industrialization (Myers and Reese 2012). This holistic toolkit can potentially bring new beliefs and connections to natural life. Another role of nature is to enhance a feeling of transcendence. Myers and Reese’s implementation of the EcoWellness model with a boy named Kaleef was proven to be successful in adjusting his behavior and overall well-being (2012).

The phenomenon of “nature deficit disorder” results in various diseases from a lack of quality natural elements. There has been a recent trend with public health issues such as depression, anxiety, asthma, diabetes, and inflammatory bowel disease, which intersect with the lack of quality, natural, green spaces. There is research asserting that this trend comes from industrialized areas with dense populations (Breed and Robinson 2020). Urban environments lack biome diversity, which leads to microbiome dysbiosis and stunts the overall immune system function on the host. Breed and Robinson’s model helps policymakers to understand that quality natural environments are essential to keep public health stable over time. See Fig. 6 made by Breed and Robinson (2020).



**Figure 6.** Increasing quality green spaces is important to address public health

## Conclusion

Further research is strongly recommended to expand the literature review in ecopsychology. Overall, biophilia stems from psychological, biological, and effective efforts to help humanity survive and adapt to the uncertainty of various crises. Researching biophobia may also help the field understand how this unbalance is found within environmental demographics (urban, suburban, and rural). Nature is a stepping-stone to our affective, cognitive, and evolutionary perspectives

## Methods

**Participants:** 151 valid participant responses were scored on SPSS. Participants were recruited from Amazon’s Mechanical Turk (Mturk). Their responses were recorded by the format given on Qualtrics. Participants used a computer or intelligent device to begin the External Human Intelligence task. They are asked to state whether they come from urban, suburban, or rural backgrounds. Everyone is a U.S resident and at least 18 years of age.

**Procedure:** Participants who agreed to the consent form are asked by the survey to answer a few demographic questions and look at photos of nature before they take the Connectedness to Nature Survey (See fig.

7 and fig. 8). After submitting, a text box will appear to describe what they observed with a few words or sentences. There are 14 items on the survey that is scored by a 6-point Likert-scale (1=strongly disagree, 2, 3=Neutral, 4, 5=strongly agree, 6=prefer not to answer) that will ask about their behaviors, attitudes, and values about the natural world. Participants will have to answer each question in the way that they generally feel. There will be no identifiers in this study. After the survey was submitted participants were given an incentive of \$1.00 for providing a completion code. This is the the typical amount is given for taking a 10-minute survey on Mturk via Qualtrics.



1	2	3	4	5
Strongly disagree		Neutral		Strongly agree
___1.	I often feel a sense of oneness with the natural world around me.			
___2.	I think of the natural world as a community to which I belong.			
___3.	I recognize and appreciate the intelligence of other living organisms.			
___4.	I often feel disconnected from nature.			
___5.	When I think of my life, I imagine myself to be part of a larger cyclical process of living.			
___6.	I often feel a kinship with animals and plants.			
___7.	I feel as though I belong to the Earth as equally as it belongs to me.			
___8.	I have a deep understanding of how my actions affect the natural world.			
___9.	I often feel part of the web of life.			
___10.	I feel that all inhabitants of Earth, human, and nonhuman, share a common 'life force'.			
___11.	Like a tree can be part of a forest, I feel embedded within the broader natural world.			
___12.	When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature.			
___13.	I often feel like I am only a small part of the natural world around me, and that I am no more important than the grass on the ground or the birds in the trees.			
___14.	My personal welfare is independent of the welfare of the natural world.			

**Figure 7.** Connectedness to Nature Survey

*Results:* The data were analyzed to determine if there were no differences in attitudes, values, and beliefs on nature connection based on demographic backgrounds. The assumption of Homogeneity was met Levene's  $F(2, 151) = .673, n.s.$  A between-subjects ANOVA was conducted and found no significant differences amongst demographic backgrounds (urban, suburban, rural),  $F(2, 151) = 1.732, MSe = .691, p > .05$  (See Table 1).

Table 1					
ANOVA Summary Table for Nature Connectedness and Demographics					
Source	DF	SS	MS	F	Sig.
Nature Connection	2	2.395	1.197	1.732	.180
Error	148	102.296	.691		
Total	150	104.691			

**Table 1.** ANOVA Summary Table

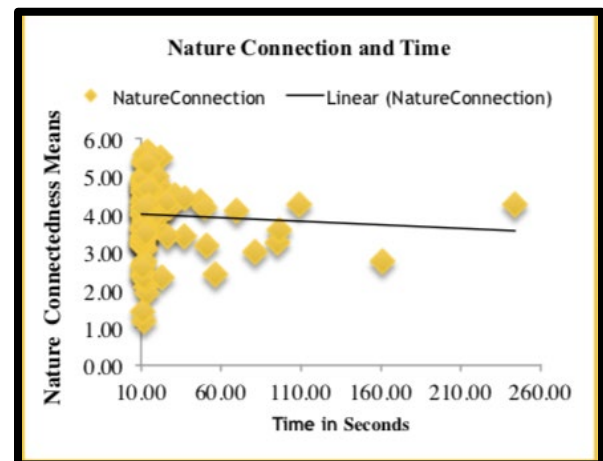
Another variable was analyzed to determine if there were no significant differences in demographics and the time spent looking at the nature images that the participants looked at before taking the Connectedness to Nature Survey. The assumption of Homogeneity was met Levene's  $F(2, 151) = .140, n.s.$  A between-subjects ANOVA test also determined no significant differences amongst time spent looking at photos and whether people came from urban,

suburban, and rural backgrounds,  $F(2, 151) = .518, MSe = 724.548, p > .05$  (See Table 2).

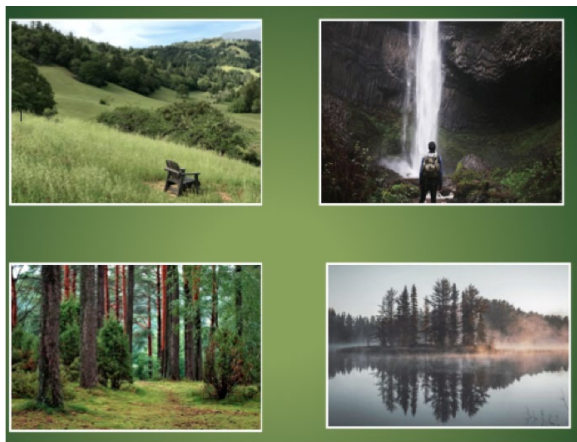
Table 2					
ANOVA Summary Table for Time Spent on Photos and Demographics					
Source	DF	SS	MS	F	Sig.
Time Spent	2	751.33	375.666	.518	.597
Error	148	107233.07	724.548		
Total	150	107984.40			

**Table 2.** ANOVA Summary Table with Time

The time spent looking at nature photos and nature connection scores were analyzed to see if time spent looking at natural elements is related to nature connectedness. The variables show no linear relationship with a Pearson's value of  $-.084$ . As shown in Figure 7, there is no linear relationship with Nature connectedness scores and time spent in seconds looking at four photos of nature (See figure 8).



**Figure 8.** Means and time in seconds



**Figure 9.** Ten seconds with nature

### Discussion and Limitations

As humans, we're called to employ quality and safe natural elements to adapt in times of personal or global crisis. Whether it's hiking for depression or the "green" design of a high-rise. Through our cognitive, affective, or evolutionary spheres, nature creates a middle ground among these aspects that reminds us to adapt and stay healthy with new interventions. Limitations in correlational studies should be considered for future research. The sample size of this study was not sufficient to represent the general public in the United States.

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