The Penn State McNair Journal

Summer 2020 - 2022, Volume 25

THE PENN STATE MCNAIR JOURNAL – SUMMER 2020-2022, Vol. 25

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Scholar Research

About The Penn State McNair Journal

The twenty-fifth volume of the Penn State McNair Journal showcases undergraduate research conducted by scholars of The Pennsylvania State University Ronald E. McNair Post-Baccalaureate Achievement Program during the COVID years between 2020-2022. McNair sponsored research was conducted under the guidance and supervision of Penn State faculty members with experience in the relevant disciplines. The intensive work and persistence required for producing new knowledge is evident within each research article featured in this volume.

The Pennsylvania State University Ronald E. McNair Post-Baccalaureate Achievement Program

A longstanding undergraduate program at the University Park campus since 1991, The Pennsylvania State University Ronald E. McNair Post-Baccalaureate Achievement Program is a five-year TRIO grant program administered by the U.S. Department of Education, designed to provide effective preparation to eligible low-income students who are also first generation and underrepresented students who have a strong desire to enroll into graduate school upon earning the bachelor's degree and to achieve the Ph.D. that are more rigorous than is typically available to undergraduates in a classroom setting.

The Pennsylvania State University Ronald E. McNair Post-Baccalaureate Achievement Program is housed in the Penn State Graduate School. Its administrative home is the Office of Graduate Educational Equity Programs. Established in 1987, the mission of the office is to promote the recruitment, retention, and professional development of a diverse graduate student population.

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About Dr. Ronald E. McNair

"Whether or not you reach your goals in life depends entirely on how well you prepare for them and how badly you want them." -Ronald E. McNair

 Ronald Erwin McNair was born on October 21, 1950, in Lake City, South Carolina. His interest in space was piqued by the launch of the Russian satellite Sputnik in 1957, and boosted by the appearance of *Star Trek* on TV years later, its multi-ethnic cast pushing the boundaries of what was possible for a small-town African-American boy. An outstanding student at Carver High School, McNair starred in baseball, basketball and football and played saxophone for the school band. He graduated as valedictorian of the class of 1967, earning a scholarship to attend North Carolina Agricultural and Technical State University. After initially considering majoring in music at NC A&T, McNair eventually came back around to his love for science, graduating magna cum laude in 1971 with a B.S. in physics. From there, it was on to the Massachusetts Institute of Technology as a Ford Foundation fellow. He later faced a potentially career-altering obstacle when two years of specialized laser physics research for his doctorate was stolen, but he managed to produce a second set of data in a year, and earned his Ph.D. in physics in 1976. During his NASA career, McNair was assigned to the STS-51L mission in January 1985. The primary goal of the mission was to launch the second Tracking and Data Relay Satellite (TDRS-B). It also carried the Spartan Halley spacecraft, a small satellite that McNair, along with mission specialist Judith Resnik, was to release and pick up two days later using *Challenger*'s robotic arm after Spartan observed Halley's Comet during its closest approach to the Sun. Tragically, *Challenger* launched from Cape Canaveral on January 28, 1986, but the orbiter *disappeared in an explosion just 73 seconds after liftoff.* McNair and the six other astronauts in the crew did not survive. Shortly after his death, the Ronald E. McNair Post-Baccalaureate Achievement Program was created through an act of Congress.

Our Acknowledgements

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Our faculty partners are an invaluable resource to the Pennsylvania State University Ronald E. McNair Post-Baccalaureate Achievement Program. They give their time, energy, and expertise in guiding and supervising McNair Scholars on their research during the McNair Summer Research Internship. Faculty Research Advisers also provide mentoring and advice to their McNair Scholar in preparation for success in graduate education.

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Rescuing the Fertility of adsl-1 Mutant C. elegans

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Abstract

Inborn errors of purine metabolism are a group of rare disorders that effect the way the body is able to synthesize purines and break them down into uric acid, one such disorder is adenylosuccinate lyase deficiency (ASLD), a metabolic disorder affecting humans. We use *C. elegans* as a model to study the mechanisms of the infertility seen in ADSL mutants. In this study I aim to investigate the reason for defects in fertility. We are going to do this by constructing a plasmid aimed at restoring *adsl-1* expression to its native location by using the lin-61/adsl-1 promoter in order to create transgenic animals whose progeny display the desired extrachromosomal array. The results show that the lin-61/adsl-1 promoter was able to rescue fertility 17.3% indicating that the low efficacy could be due to incomplete rescue. This means that further action can be taken to determine if the incomplete rescue is due to the animal not having a gonad or not having viable ovum. This experiment lays down the groundwork for future experiments like this using different promoters.

Introduction

Inborn errors of purine metabolism are a group of rare disorders that affect the way the body synthesizes purines and breaks them down into uric acid (1). These disorders present in a broad way that involves deterioration in neuromuscular, reproductive, and cognitive function. Disorders within the category of inborn errors of purine metabolism are the result of mutation leading to enzyme disfunction (2). The enzymes responsible are necessary for synthesis of nucleotides in RNA and DNA. Lower levels of these nucleotides or an increase in intermediates ultimately leads to the development of these disorders (3). The disorders often have immense negative effects on health, with there being few treatments available.

One such disorder is adenylosuccinate lyase deficiency (ASLD), a metabolic disorder affecting humans. In general, inborn errors of purine metabolism often go understudied and for ASLD this remains true with very few cases studied. This is partially due to the lack of awareness of the disorder. There are potentially more cases than reported because of the disorder's ability to disguise itself as other illnesses since its symptoms can mimic other disorders, such as autism spectrum disorder. The symptoms of ASLD include epilepsy, muscle ataxia, delays in development, and other autistic-like symptoms. Although the symptoms of ASLD are well documented, the biological mechanisms responsible for the phenotypes are still being discovered (2). Dysfunction in the adenylosuccinate lyase (ADSL) gene is to blame for

ASLD. ADSL is a gene that encodes for an enzyme of the same name. The enzyme ADSL plays a crucial role in as the catalyst for two steps in the *de novo* purine biosynthetic pathway, shown below in Figure 1.
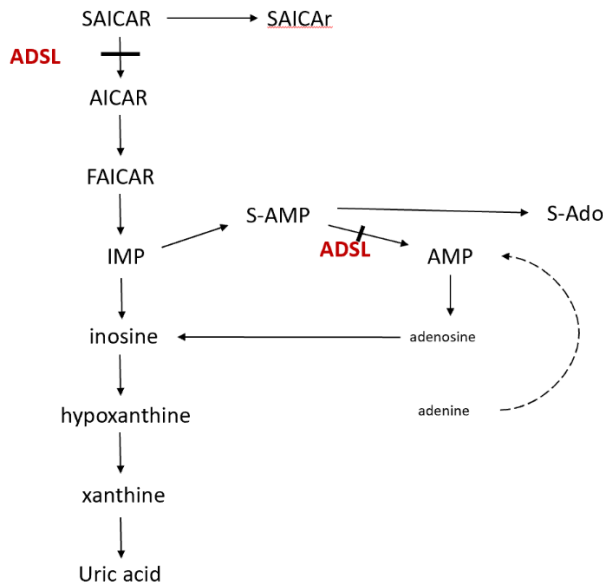
Figure 1: ADSL within the Purine Metabolism. ADSL is first used int eh conversion of SAICAR to AICAR. SAICAr would accumulate without the function of ADSL. The conversion of S-AMP to AMP also requires ADSL. Without this conversion, S-Ado would accumulate.

Abbreviations: R5P, ribose-5-phospate; SAICAR, succinylaminoimidazole carboxamide ribotide; SAICAr, succinylaminoimidazole carboxamide riboside; ADSL, adenylosuccinate lyase; AICAR, aminoimidazole carboxamide ribotide; IMP, inosine monophosphate; S-AMP, adenylosuccinate; S-Ado, succinyladenosine AMP, adenosine monophosphate; XMP, xanthine monophosphate; GMP, guanosine monophosphate.

When the model organism *C. elegans* has ADSL knocked out it displays delays in cognitive development learning, neuromuscular dysfunction, as well as infertility. Here we will investigate the phenotype of fertility within our *C. elegans*. Our goal is to rescue fertility and our hypothesis is that if we restore ADSL to its native location in an ADSL mutant using the adsl-1 promoter, then there will be a rescue of fertility within these ADSL mutants. We used a constructed plasmid that includes the adsl-1 promoter , the ADSL gene, and GFP as a reporter, and injected it into the animals with the goal being to create a transgenic animal that will produce progeny with the extrachromosomal array that we will study.

Methods

***C. elegans* strains and maintenance**

Strains were maintained under standard conditions at 20 °C (4). The strains used were tm3328/h2t (control), HV855, HV856, and HV873 (Table 1). To create the extrachromosomal arrays, hermaphrodites were injected with plasmid DNA at a concentration of 50 ng/µl (Table 1). Each week ten animals from each of the four strains were transferred to four new plates, separated by strain.

Table 1: The strains used in this study

Strain	Genotype	Extrachromosomal Array
HV855	adsl-1/h2T l; psEx305	*psEx305*[50 ng/µl pTG96 (sur-5p::GFP) + 50 ng/µl pBluescript]
HV856	adsl-1/h2T l; psEx306	*psEx306*[50 ng/µl pTG96 (sur-5p::GFP) + 50 ng/µl pBluescript]
HV873	adsl-1/h2T l; psEx324	*psEx324*[5 ng/µl pAA6 (lin-61p::*adsl-1*::GFP) +50 ng/µl pTG96 (sur-5p::GFP) + 45 ng/µl pBluescript*]
*Bluescript is an, empty vector		

Transgene construction

lin-61 (the adsl-1 promoter) and sur-5 promoters were then amplified using primers (HindIII lim-7p F and BamHI lim-7p R) and the N2 genomic DNA. Afterwards, the product of the amplification was purified by running 10 µl on gel to make sure the correct fragment was amplified, and a PCR cleanup kit was used to purify. The plasmid and the amplicon were digested separately using the same set of restriction enzymes (BamHI and HindIII). The reactions were run on electrophoresis gel and the bands that had the correct band sizes were isolated, purified via NEB® PCR cleanup kit, and had their concentrations measured using nanodrop. A ligation reaction was set up that had a 3:1 ratio of the backbone plasmid to insert molecular weight ratio (. 3x insert DNA mass:1x linearized vector plasmid). QIAprep Spin Miniprep Kit Cat No./ID: 27104. The newly constructed plasmid was transformed to E. coli bacteria (NEB® 5-alpha Competent E. coli (Subcloning Efficiency) Catalog C2988J) on Lysogeny broth (LB) with the corresponding antibiotic. A countable amount of colonies were present. Colony PCR was used to determine the presence of the plasmid in a couple of the colonies. The positive colonies were miniprepped using QIAprep Spin Miniprep Kit Cat No./ID: 27104. The plasmid was then sequenced for confirmation. Once confirmed, the animals were injected in the gonads with the mix. One of two promoters were used to create the original constructs, one was the lin-61/adsl-1 and the other was sur-5. The lin-61/adsl-1 promoter is expressed in the same location and acts as the promoter for *adsl-1*, while sur-5 is expressed everywhere within the *C. elegans* worms. The construction of the plasmid and injection was done by Abdulkareem AlShaheeb.

Balanced *adsl-1* knockout animals, (HV855, HV856, HV873) were injected with a constructed plasmid (Figure 2) to make the strains in Table 1. All strains were then observed under a GFP microscope and the adsl-1/adsl-1 progeny were taken to be studied. The plasmids used in this study are shown in Figure 2 below. The full list of the components of the strains are can be found I Table 1.
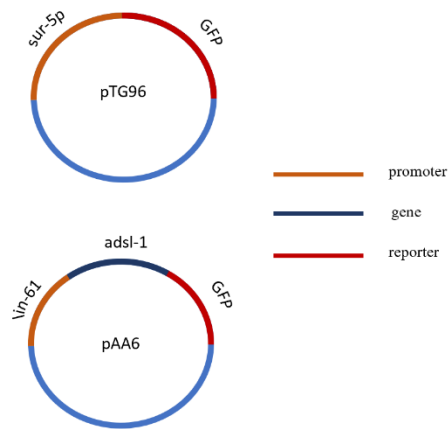
Figure 2: The constructed plasmids. There are three plasmids that underwent the process of construction. The middle of the constructs indicates the name of the plasmid(s) used. The orange curve shows the promoters used, while the dark blue for gene used, and red for reporter used.
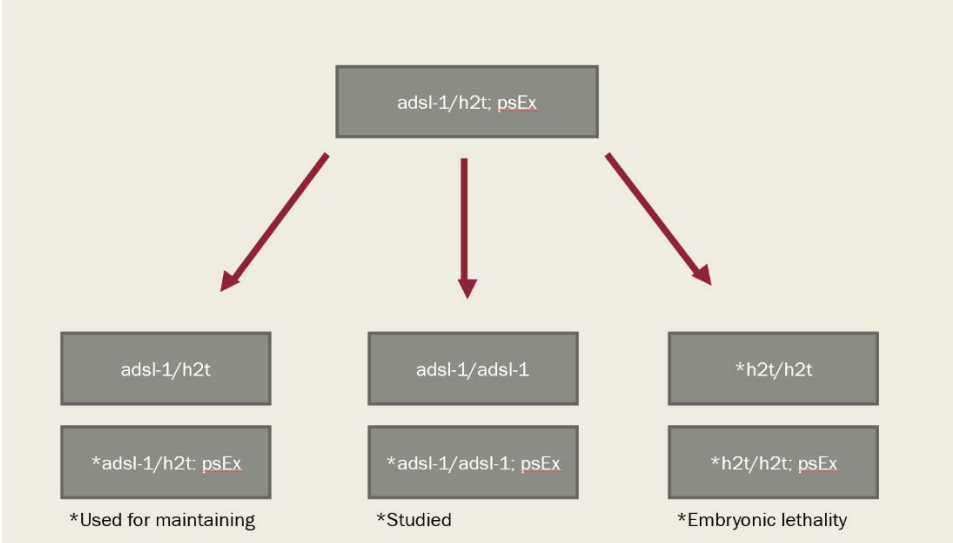
Figure 3: Possible progeny of each transgenic animal with the balancer strain. This figure shows all of the possible progeny for the heterozygous adsl-1/balancer animals. Both the h2t/h2t and h2t/h2t; psEx progeny are subject to embryonic lethality. The adsl-1/h2t; psEx was used to maintain the population and the adsl-1/adsl-1 psEx progeny were studied.

Fertility Assays

For the control strain, four animals were transferred, while for the HV855 strain, 15 animals were transferred, 14 for the HV5856 strain, and 11 for the HV873 strain. First, the animals were maintained. During the maintenance process, ten egg laying L3 to L4 (adsl-1/h2t for control; adsl-1/h2t: psEx for experimental) *C. elegans* were transferred onto an NGM plate spotted with op50 where they remained for the rest of the experiment. Then L3-L4 hermaphrodites were placed into individual plates, where they stayed for the remainder of the

experiment, starting three days after maintenance. They were incubated at 20°C for an additional two days before egg laying was documented for the following five days after. For the control, the protocol called for the transfer five animals into their own individual plates but instead only four were successfully picked. For the HV855, HV856, and HV873 strains, the protocol called for 20 of each strain to be picked but were unfortunately unsuccessful due to mistakes made during the initial picking process. The animals picked to be transferred were the adsl-1/adsl-1 progeny and they were picked using a GFP microscope. The GFP of the adsl-1/adsl-1 for the control animals is not expressed anywhere in the *C. elegans*, while the adsl-1/adsl-1; psEx animals used for the experimental groups expressed the GFP everywhere but the pharynx. More details on how animals were picked for to be transferred in included in Table 2 below.

Table 2: Imaging using GFP Microscope

Possible Progeny	GFP Present
adsl-1/h2t	GFP present only in pharynx
adsl-1/adsl-1	No GFP
h2t/h2t	Lethal (eggs do not hatch)
adsl-1/h2t; psEx	GFP in pharynx and everywhere
adsl-1/adsl-1; psEx	GFP everywhere but pharynx
h2t/h2t; psEx	Lethal (eggs do not hatch)

Results

Will restoring expression of ADSL to its original location rescue fertility?

In order to determine if restoring *adsl-1* to its original location will result in rescue of fertility, we used the lin-61/adsl-1 promoter when constructing the plasmids to restore expression of *adsl-1* in the mutants. We isolated and observed the adsl-1/adsl-1; psEx progeny of the adsl-1/h2t psEx strain in the experimental strain (HV873). For the control consisting of mutants without any injected plasmids, we isolated the adsl-1/adsl-1 progeny of the adsl-1/h2t. For the control, none of the four samples laid any eggs. As for the two other control strains (HV855 and HV856), neither had any animals that laid any eggs, of the 15 HV855 collected and 14 HV856 collected. For the experimental (HV873), of the 11 animals observed, only three lad any eggs. the number of eggs each animal laid were recorded (Table 3).

Table 3: The number of eggs laid for each worm for each strain for five days

Strain	Control					HV 855					HV 856					HV 873				
Day / Worm	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5						0	0	0	0	0	0	0	0	0	0	0	0	0	18	43
6						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7						0	0	0	0	0	0	0	0	0	0	0	0	0	0	23
8						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12						0	0	0	0	0	0	0	0	0	0					
13						0	0	0	0	0	0	0	0	0	0					
14						0	0	0	0	0	0	0	0	0	0					
15						0	0	0	0	0										

It was expected that the control animals would not lay eggs, this was seen in all four animals of the control. This is because the control strain is simply the mutant *adsl-1* animals without input of any DNA fragments (Table 3). I also found that the strains where the sur-5p::GFP plasmid was injected (HV855 and HV856) resulted in no eggs laid in any case (Table 3). Lastly, the experimental strain containing lin-6::*adsl-1*::GFP, was expected to result in cases of eggs being laid and this was the case in three of the 11 observed animals. The number of eggs laid were counted and recorded each day after they were transferred. Only on day four were there any eggs laid and it was only by one animal. On the last day, three animals had laid eggs. The sample size for the experimental strain (HV873) was 11 and of those 11, three laid eggs. These results indicate that 27.3% of the experimental transgenic animals were fertile compared to 0% of the controls.

Discussion

The results of this experiment support our original hypothesis that restoring expression of *adsl-1* to its native location will lead to the rescue of fertility. With that being said, a vast majority of *C. elegans* with this extrachromosomal array were not able to lay eggs, which brings in to question why? If we were to restore *adsl-1* to its native location using the lin-61/adsl-1 promoter, we should be able to see high efficacy but from this we are able to see that only 27.3% of the experimental animals showed rescue in fertility. We speculate that the injection of the constructs led to an incomplete rescue. In order for reproduction to be restored back to the *C. elegans* both the gonad and ovum need to be rescued. We believe that a partial rescue occurred where either the gonad or ovum were rescued but not both leaving the *C. elegans* unable to reproduce. In order to see if this hold up, first, we would look to see if any have a gonad using higher power magnification. Then we can investigate whether or not the ovum was rescued using

PCR or a western blot. Another reason for this low efficacy, we speculate that maybe the extrachromosomal array is not expressed in the same way in every animal and that it does not rescue the same way for all animals.

Acknowledgements

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Effectiveness of host cell protein removal during depth filtration – Effect of filter chemistry

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Abstract
Recent advancements in upstream processing (USP) of monoclonal antibodies (mAbs) have increased the load on downstream processing (DSP). The increased cell density of the product stream leaving the bioreactor means a higher concentration of contaminants associated with the production of mAbs. One such example is host cell proteins (HCPs), impurities that can create challenges for the operation of protein A affinity chromatography and hydrophobic interaction chromatography used for mAb purification. Recent studies have shown that depth filters can bind many of these small impurities, decreasing the load on subsequent filters and chromatography columns. This study aimed to examine the binding characteristics of two commercial depth filters to understand the relationship between a depth filter's chemical composition and its ability to remove HCPs. Two depth filters with comparable pore sizes, each made from different filter media, were tested using a series of model proteins. The model proteins were chosen to match the range of typical HCPs based on their isoelectric points (pI), molecular weights, and hydrophobicities. These model proteins were. The X0SP filter, which has polyacrylic fibers and a synthetic silica filter aid, showed a higher binding capacity for α-chymotrypsin, conalbumin, and myoglobin than the X0HC filter, which has cellulose fibers and diatomaceous earth as the filter aid. The X0SP filter is particularly well suited for removing positively charged HCPs with binding capacities of more than 600 g/m^2 at low conductivity. These results provide important insights into the performance characteristics and proper selection of depth filters for the purification of monoclonal antibodies.

Introduction

      Monoclonal antibodies (mAbs) are a class of revolutionary pharmaceuticals used to treat a wide range of diseases, including cancer, multiple sclerosis, and rheumatoid arthritis.[1] By 2017, two-thirds of all mAbs in the market were produced inside Chinese Hamster Ovary (CHO) cells.[1]

      One issue that arises when synthesizing mAbs is that, in addition to the antibody of interest, the product stream leaving the bioreactor will also contain residual host cell proteins (HCPs) generated by the CHO cells.[2] Due to their synthesis using non-human expression systems, the administration of these HCPs to humans has the potential to provoke an immune response, reducing both the safety and efficacy of the biopharmaceutical.[3] As such, the viability of mAbs is heavily dependent on the purification process designed to remove these HCPs, as

well as nucleic acids (DNA and RNA), cell membrane fragments, and any bacteria and viruses that might contaminate the antibody product.

The purification process of these contaminants is known as downstream processing (DSP). Many downstream processing steps, such as protein A affinity chromatography and hydrophobic interaction chromatography, can separate HCPs from the mAb solution.[4] However, these chromatographic operations are quite expensive, and resin fouling caused by HCP accumulation can shorten the lifetime of the columns, leading to frequent cleaning and eventual replacement.[5] Maximizing the number of HCPs removed in the initial clarification process could decrease the load on subsequent operations, thereby decreasing the overall cost of the DSP.[4]

We believe that depth filters are the key to reducing the number of HCPs in mAb solutions before they are processed by other unit operations. Depth filtration is commonly used as the first step in the clarification of the cell culture fluid from the bioreactor, effectively removing the host cells and large cell debris via size exclusion.[6] However, Nejatishahidein et al.[7] have shown that depth filters can also remove smaller impurities, such as HCPs, through intramolecular interactions with the depth filter media. Several studies have shown that depth filters are able to adsorb/bind HCPs due to a combination of electrostatic and hydrophobic interactions.[8]

The protein binding characteristics of a depth filter depend on the chemical composition of the adsorbent. Depth filters consist of several components, including polymeric fibers that provide structural integrity, a high surface area adsorbent (often referred to as a filter aid) that is able to filter out impurities, and a binder that holds the different components together. Conventional depth filters typically contain diatomaceous earth, a naturally derived silica-based porous material with a large surface area for HCP binding. One drawback of diatomaceous earth is that it can contribute to leachable components, which may impact the filter's performance and that of subsequent unit operations in the DSP.[9] Filters containing all-synthetic silica, as opposed to naturally-derived materials, have been shown to contribute significantly smaller amounts of leachable components, making them a more consistent and robust option.[9] Synthetic depth filters have also demonstrated improved HCP removal under some experimental conditions[9], although the generality of this result has not yet been established.

Nguyen et al.[9] compared the number of HCPs (in parts per million or ppm) that remained after filtration through a B1HC filter (containing diatomaceous earth) and an X0SP filter (containing synthetic silica). Although they conducted experiments with other filters, such as the D0SP and the X0HC, most of their experiments were run through either a B1HC filter or an X0SP filter. The problem with comparing these two filters is that they have different pore size ranges. Furthermore, this study did not standardize the pH of the feed solutions when running the experiments.

The objective of this study was to garner new insights regarding the relationship between a depth filter's composition (diatomaceous earth or synthetic silica) and its capacity for removing HCPs. The X0SP was compared with the X0HC to compare the effectiveness of filters containing diatomaceous earth and synthetic silica in adsorbing HCPs.

Materials and Methods

  A series of model proteins were used based on their isoelectric points (pI), molecular weights (MW), and hydrophobicities (GRAVY number), as discussed by Nejatishahidein et al.[7] Table one shows the protein selection and their relevant values. All model proteins were obtained from Sigma-Aldrich as lyophilized powders, which were then dissolved in 150 mM (1x) phosphate buffered saline solution (PBS, AM9625, Thermo Fisher Scientific, Waltham, MA) with the pH adjusted to 7.4. All protein solutions were filtered through 0.2 μm polyethersulfone (PES) syringe filters (VWR 28145-501) immediately before running them through the depth filters to remove any large aggregates or undissolved protein.

TABLE 1: Physical properties of model proteins examined in this study

Protein	Catalog number	Source	MW (KDa)	pI	GRAVY
Albumin	A2153	Bovine serum	67	4.8	0.064
Ovalbumin	A5503	Chicken egg white	45	4.9	−0.663
α-Chymotrypsin	C4129	Bovine pancreas	25	8.8	−0.436
Conalbumin	C7786	Chicken egg white	77	6.6	−0.475
β-Lactoglobulin	L2506	Bovine milk	17.5	5.3	−0.006
Myoglobin	M0630	Equine skeletal muscle	16.9	7	−0.396
Ribonuclease A	R4875	Bovine pancreas	13.7	9.6	−0.162

  Experiments were performed using either the Millistak+® Pod Depth Filter X0HC, which contains diatomaceous earth and cellulose, or the Millistak+® HC Pro Pod Grade X0SP, which contains polyacrylic fibers and synthetic silica (Millipore Sigma, Burlington, MA). Filters were initially flushed with 150 L/m^2 DI water for 30 minutes and then flushed with an additional 50 L/m^2 of 150 mM PBS. This extensive flushing was needed to remove any leachables. The model protein solution was then run through the filter at a constant filtrate flux of 150 L/m^2/hr (LMH), which was maintained by a Masterflex L/S Peristaltic roller pump (Gelsenkirchen, Germany) on the permeate exit line. All experiments were performed at room temperature (20-24°C).

  Permeate samples were collected throughout the experiment. Feed and filtrate sample concentrations were measured using a NanoDrop 2000c Spectrophotometer (Thermo Scientific, Waltham, MA) based on the UV absorbance at a predetermined wavelength for each protein.

Data and Results

Figure 1 shows data for the protein concentration in the permeate samples, normalized by the protein concentration in the feed solution, obtained during the depth filtration of 0.1 g/L feed solutions containing either α-chymotrypsin, myoglobin, or conalbumin, in 1x PBS at a filtrate flux of 150 LMH. Both myoglobin and conalbumin are nearly neutral proteins at pH 7.4, whereas α-chymotrypsin is positively charged. The filled symbols show results for the X0HC filter, while the open symbols show results for the X0SP filter. The data are plotted as a function of the volumetric throughput, defined as the cumulative filtrate volume divided by the membrane area. Larger volumetric throughput corresponds to a longer filtration time, with a volumetric throughput of 1500 L/m^2 corresponding to a 10-hr. filtration experiment.

The initial permeate samples have little-to-no proteins since all of the proteins in the feed solution are bound by the filter. As the protein binding sites within the filter become saturated, the protein concentration in the permeate solution increases, eventually approaching a value nearly equal to that in the feed solution. The X0SP filters show significantly higher binding capacities (delayed breakthrough curves) than the X0HC filters for all three proteins, with myoglobin having the most significant difference.

Figure 2 shows corresponding data for the filtration of the same set of model proteins but with 0.2 g/L concentrations. Again, the highest binding capacities were obtained with the X0SP filter, with the myoglobin requiring more than 900 L/m^2 of filtration to saturate the binding sites within the filter (i.e., to achieve a normalized permeate concentration of one). Interestingly, in the 0.2 g/L solutions, the binding capacity for chymotrypsin on the X0SP filter was greater than that for conalbumin. This behavior is precisely the opposite of what was observed in the more dilute 0.1 g/L solutions. This likely reflects a difference in binding affinities for these proteins, with the conalbumin saturating the binding sites at a lower concentration than the chymotrypsin.
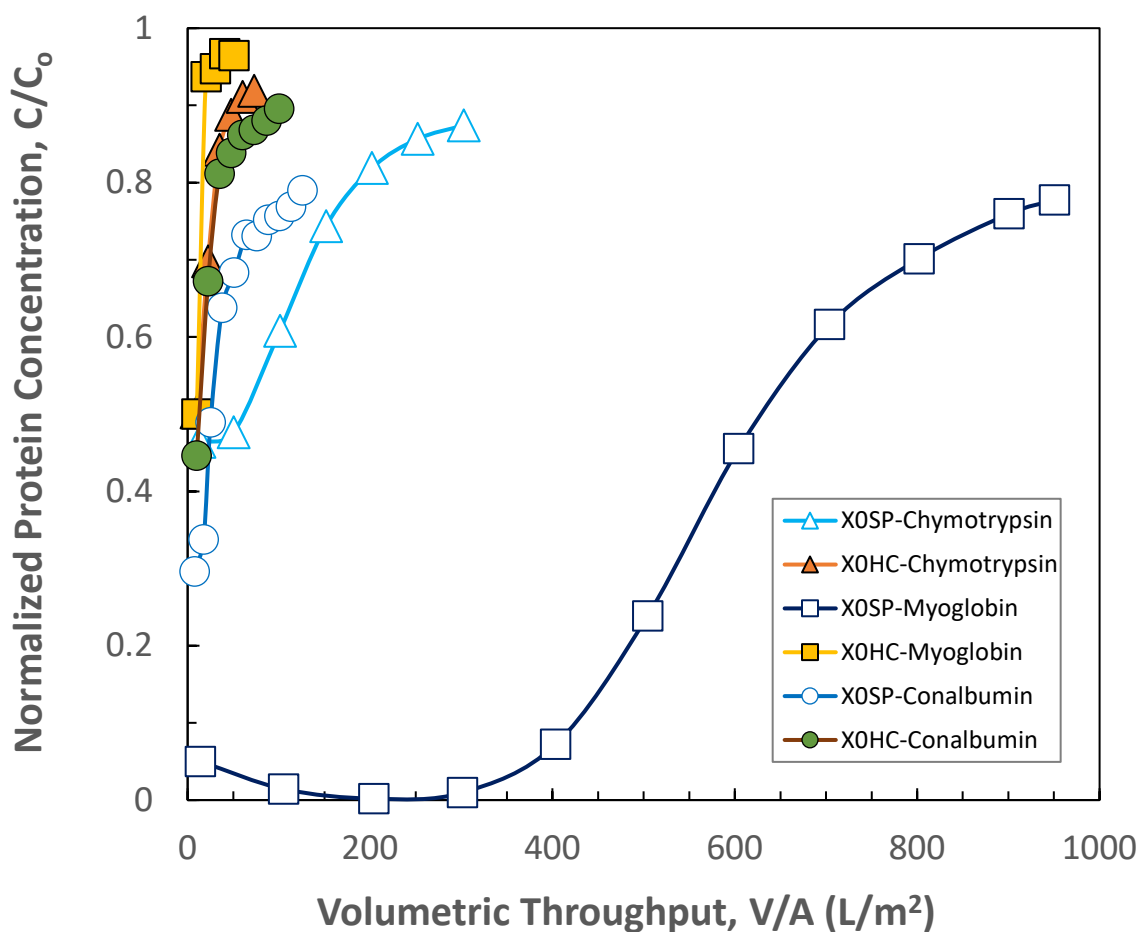
FIGURE 2: Normalized protein concentrations in permeate samples as a function of volumetric throughput during filtration of 0.2 g/L solutions of the model proteins in 1x PBS through the X0SP and X0HC depth filters

Figure 3 shows the breakthrough curves for the model proteins at a concentration of 0.5 g/L. The normalized protein concentrations increase much faster with increasing volumetric throughput for the 0.5 g/L solutions since the higher protein concentration in the feed leads to more rapid saturation of the binding sites within the depth filters. However, the general trends in the data for the different model proteins are similar to that seen with the 0.2 g/L solutions, with myoglobin having the greatest capacity on the X0SP filter but the lowest capacity on the X0HC filter.
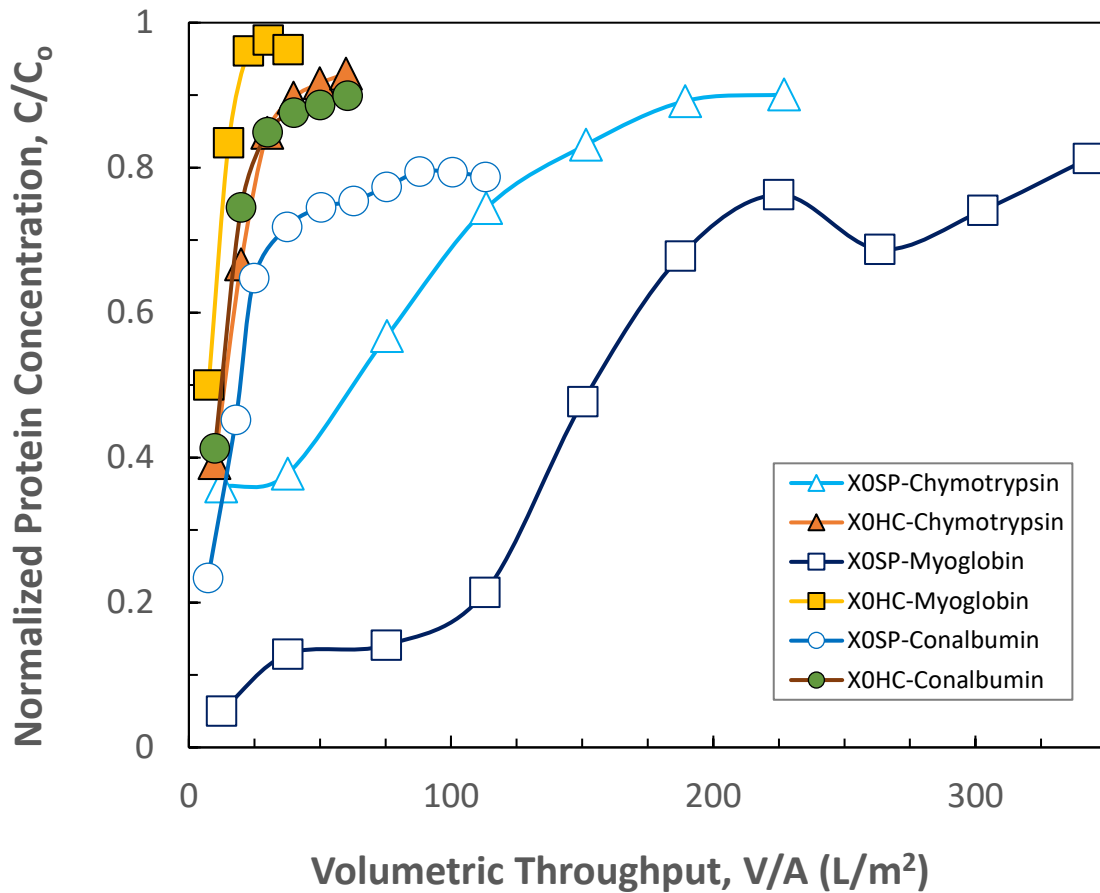
FIGURE 3: Normalized protein concentrations in permeate samples as a function of volumetric throughput during filtration of 0.5 g/L solutions of the model proteins in 1x PBS through the X0SP and X0HC depth filters

Conclusions

This study is the first to directly compare the binding capacities of model HCPs through a filter containing diatomaceous earth with one containing synthetic silica while controlling for the filter pore size, solution pH, and buffer strength. The X0SP filter showed much higher binding capacities for α-chymotrypsin, myoglobin, and conalbumin, indicating that replacing the traditional diatomaceous earth depth filters with synthetic silica depth filters may be key in decreasing the number of HCPs in the product stream after initial clarification by depth filtration.

The greatest binding capacity on the X0SP (synthetic silica) filter was seen with myoglobin, which is a small neutral protein that is relatively hydrophilic. This suggests that electrostatic interactions are relatively unimportant in protein binding to the X0SP depth filter, at least at the relatively high conductivity (150 mM PBS) examined in these experiments. In contrast, the X0HC filter showed very low binding of myoglobin, suggesting that the underlying binding mechanisms for the X0HC and X0SP depth filters may be very different.

Future experiments need to be performed with more proteins to be able to compare the two filters across a broader range of protein molecular weights, isoelectric points, and hydrophobicities. Such data could potentially be used to develop correlations between the binding capacity and the properties of both the proteins and the depth filters. This could enable biomanufacturers to select specific depth filters that are able to remove problematic host cell proteins based on their known biophysical properties. This would significantly improve the development of downstream processes that can effectively handle the increased product titer from modern bioreactors used to produce monoclonal antibody products.

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The Population Dynamics of Various Pseudomonas Pathogens in Different Mushroom Types

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Abstract

Bacterial blotch is a complex of diseases that results in spotting and discoloration in a variety of mushroom species. In Pennsylvania and other US regions, it is one of the most important diseases to study due to its wide impact on commercial mushroom production. As of now, we know that at least 11 species of *Pseudomonas* cause blotch disease in Pennsylvanian mushrooms. In this study, we are researching whether the virulence of previously identified blotch pathogens remains consistent on a variety of cultivated mushrooms over time. We want to determine whether there are differences in the virulence of these *Pseudomonas* strains on one type of mushroom and whether a certain strain is more virulent than the other. The goal of this research is to increase our understanding on the mechanisms of these pathogens so that management strategies can be improved, thus reducing the impact of disease on the yield and quality of commercial mushrooms. Four different mushroom varieties were inoculated with four different Rifampicin resistant strains and a control buffer. Pathogenicity tests were conducted to collect data for bacterial growth, which was analyzed through statistical distribution. The results indicated susceptibility of the Oyster and King Bolete mushrooms to all the *Pseudomonas* strains, as they allowed growth of bacteria in the tissue. On the other hand, both the Maitake and Shiitake varieties, recognized medicinal mushrooms, were not susceptible and displayed no physical characteristics of infection. This raises questions about the potential of utilizing these medicinal mushrooms as a treatment for blotch disease in other mushroom types, which can be further studied in future work.

Introduction

Bacterial blotch, a complex of diseases that affects a number of mushroom species, is important to study due to its wide impact on mushroom yield and quality. Some of these diseases include, but are not limited to; Pits, Brown Blotch, Ginger Blotch, Diffuse Grey Blotch, Drippy Gill, and Marbled. There are a variety of strains that can cause these species. Some strains with recognized names, and that have been confirmed to be pathogenic are *Pseudomonas tolaassii*, *Pseudomonas agarici*, and *Pseudomonas constantinii*. On the other hand, some strains (while confirmed

pathogenic) are not recognized under official names like *Pseudomonas gingeri*, *Pseudomonas reactans* and *Pseudomonas fluorescens*[3].

It is known that at least 11 species of *Pseudomonas* cause blotch disease in Pennsylvanian mushrooms. *Pseudomonas* is the genus of a type of bacteria, it consists of multiple species that cause a variety of disease. The species are very diverse overall, with a total of 166 named species and a mere 189 remaining unnamed. The identification of *Pseudomonas* species from environmental samples had previously been accomplished using an MLSA of *gyrB*, *rpoD*, *gapA*, and *gltA* that was obtained from both named and hypothetical unnamed cliques. While there are a total of 10 recognized clades, 7 remain unnamed[3]. More work has to go into further identifying and grouping these species. By doing so, our understanding of the mechanisms of mushroom disease can be amplified.

This is particularly important for Pennsylvania, which hosts the mushroom capital of the world. Within the United States, the mushroom industry contributes an economic impact of $3.1 billion annually and creates a total of 21,000 jobs. In Pennsylvania alone, the mushroom industry induces an economic impact of $1.1 billion annually and creates more than 8,600 local jobs[1]. Essentially, this research is key to the economy.

Additionally, mushrooms have been used as medicine for thousands of years and have played an important role in oriental medicine[11]. Some commonly used mushrooms are shiitake, maitake, and reishi. Many of our recognized medicinal mushrooms have been found to have anti-tumor and immunostimulant properties, as well as being good sources for B vitamins, fiber, and antioxidants[10]. Thus, mushrooms are not only nutritious for human consumption, but provide additional benefits due to their composition. In fact, the psychedelic properties of some mushrooms could even lead to new treatments for depression and anxiety, as is being studied at John Hopkins University[6].

We want to further increase our understanding of the various pathogens causing blotch disease in order to develop management strategies, in hopes of combatting the reduction in yield and quality of our commercial mushrooms. We want to determine whether there are differences in virulence among strains on one type of mushroom and whether a given strain is more virulent on one type over another. Population dynamics is the study of how and why populations change over time, so we intend to investigate how the presence of certain pathogens has changed over time in these specific mushroom species. The goal of this research is to understand the microbial factors influencing blotch pathogens on mushroom (*Agaricus bisporus*) caps and eventually translate this knowledge to all edible mushrooms. This can lead to the development of management strategies to decrease blotch through biological control and increase commercial mushroom production.

Materials and Methods

Inoculum Preparation

The mushroom samples were treated with an inoculum of the assigned strain in media. For this project 2 [*P. gingeri*] strains and 2 strains from Clade 4 (C4) were tested; BP1480, BP1482, BP1484, BP1485. The preparation of the inoculum consisted of streaking for single colonies of the selected strains onto nutrient agar and rifampicin plates. Rifampicin is an antibiotic prescribed to treat a variety of infections. The strains were rifampicin resistant, ensuring that only these bacterial strains would grow. Single colonies of the selected strains were streaked for from a -80 °C refrigerator onto NA + Rif plates and left for 48 hours. The bacterial colonies grown were then streaked onto another plate as a lawn using a Q-tip and phosphate buffer, then left to in a 27 °C incubator for 48 hours. The bacteria were then removed from the plate used a dampened sterile cotton swab with phosphate buffer and transferred to 25 mL of 0.01M phosphate buffer. The OD was adjusted to 0.6 +/- 0.01 the day before the experiment. NA = Rif media was made for the population assay.

Collection of Mushroom Varieties

A total of 300 mushrooms were collected from Phillips Mushroom Farm in Kennett Square, PA. It was 75 of each mushroom variety (Oyster, Shiitake, Maitake, King Bolete), enough for 3 replicates per time point (T = 0, T = 0.5, T = 1.5, T = 2.5, T = 3.5). While in the growth rooms, hairnets and latex gloves were worn to avoid contamination. The mushrooms were collected in labelled brown paper bags and placed in coolers to with ice packs to keep them fresh. Once back in the laboratory setting, they were laid out in an open area until the next step.

Mushroom Preparation and Inoculation

These mushrooms were surface sterilized in bleach and rinsed with water to remove remaining bleach. The stems were cut off using a chef knife, since we only wanted to use the caps. The mushrooms were then put in a glass petri dish and assigned a treatment. They were placed randomly in plastic containers, with dampened autoclaved paper towels, to eliminate any environmental bias or impact concerns. The spread of disease can be greatly affected by environmental conditions, so a random number generator was used to assign each mushroom and treatment a number to stop this from being a concern. The mushrooms were then inoculated with their assigned treatment using a pipette, spotted with 10μL of the inoculum. The trays were then covered and allowed to incubate at room temperature for 48 hours.

Population Evaluations (Assay)

For the recovery of these samples, a cork borer and scalpel were used to remove a 1 cm^2 piece of the inoculated mushrooms. 200 mL of phosphate buffer was added to tubes and weighed, then weighed once again with the mushroom sample in. These values were subtracted to determine the weight of the sample. The mushroom pieces were then macerated with a sterile pestle and centrifuged for 10 seconds to facilitate obtaining the liquid sample from the tubes for plating. The Tissuelyser II was used to disrupt the tissue, the tubes were homogenized for 20 seconds at 20 m/s then briefly flicked. For dilution, 100 mL of the homogenate was transferred to the top row of a 96-well plate with 90 µL of 0.01 M phosphate buffer added to subsequent rows. Once the first row was filled for all columns, a multichannel pipette was used to transfer 10 µL of the first row to the second row (1:10 dilution). The samples were pipetted up and down 5 times and

then 10 µL was transferred to the next row (1:100 dilution) until 6 dilutions were done. Starting with the most dilute row, the multichannel was then used to carefully spot 5 µL 6 columns onto a labeled NA + Rif plate. After the samples were spotted onto our previously made plates and left to dry for a bit, they were left to incubate for 48 hours to allow the growth of bacterial colonies.

Data analysis

These bacterial colonies were then counted over five days to observe the disease progression, only where sufficient countable colonies were observed. These values were then log transformed to calculate the mean and variance for each strain using CFUs. The average log CFU per gram of mushroom tissue was graphed for each mushroom and treatment to be statistically analyzed, taking the limit of detection, the minimum number of bacteria that can be observed in the sample, into consideration. Observations were also recorded for any physical changes noticed in the mushrooms and pictures were taken to document this progression, utilizing a phone camera.

Results
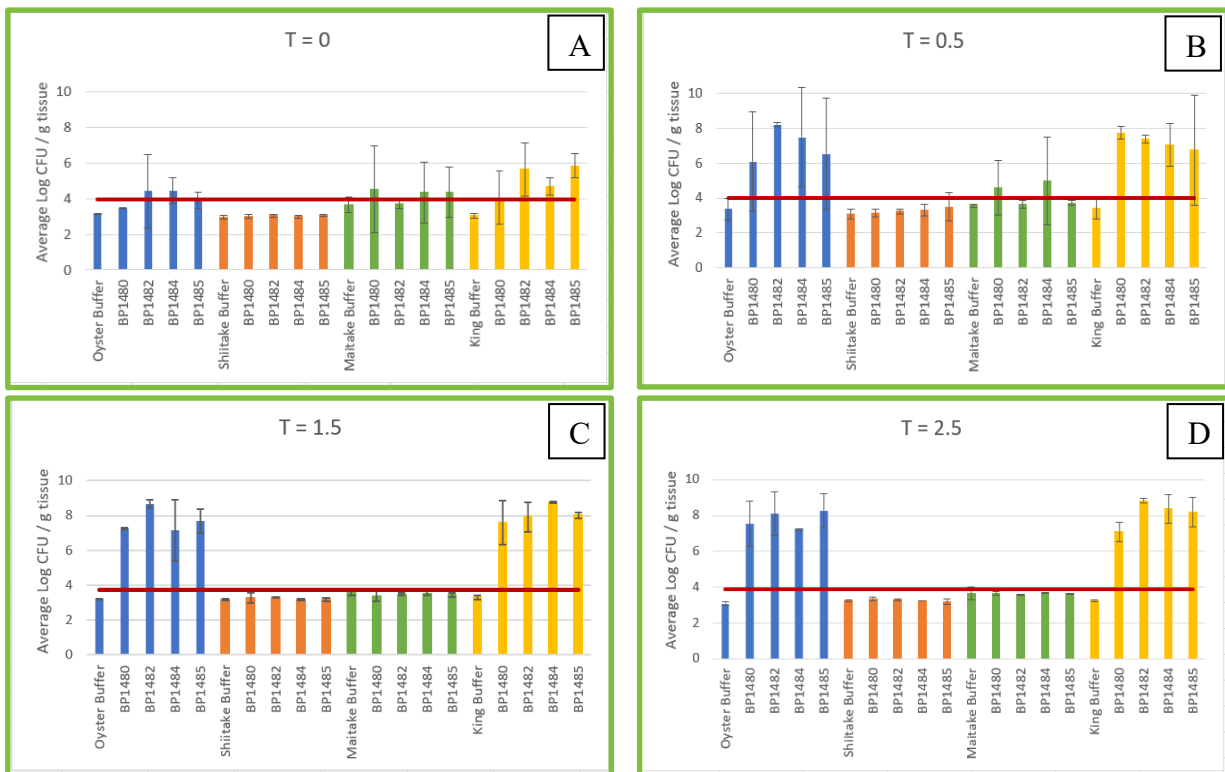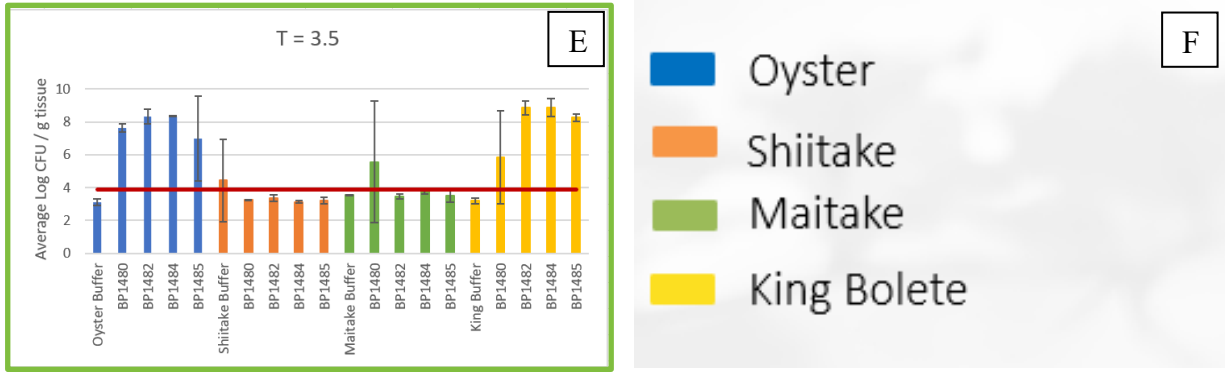
Figure 1 The average log CFU per gram of tissue was calculated for each mushroom type and treatment, then graphed per time point to observe the population dynamics per T. The red line represents limit of detection for each run. Each mushroom variety was assigned a color **(F)**. Few colonies could be observed at the time of inoculation **(A)**. However, the values increased over time for both oyster and king bolete. The values remained the same throughout for the control, the phosphate buffer, for all mushroom varieties. On the other hand, little to no colonies were observed for either maitake or shiitake mushrooms. At the end, only oyster and king bolete had significant differences **(E)**.
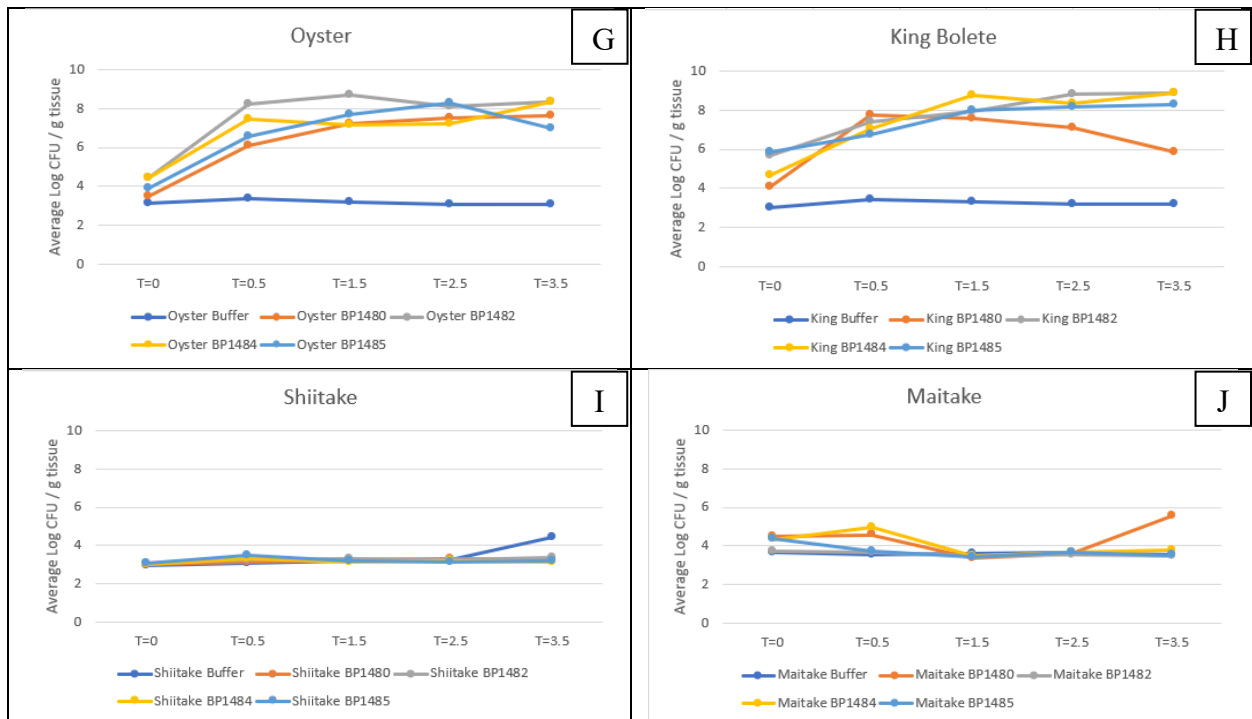
Figure 2 The results were graphed separately so we could observe the progression per mushroom variety. Both oyster **(G)** and king bolete **(H)** experienced an increase in bacterial presence over time, for all the strains. The buffer remained low for all varieties. There was minimal to no progression for both maitake **(J)** and shiitake **(I)**. Further statistical analysis has to be conducted to determine the significance of these results, specifically the trend observed for strain BP1480 in King Bolete, as it seemed to decrease slightly over time.
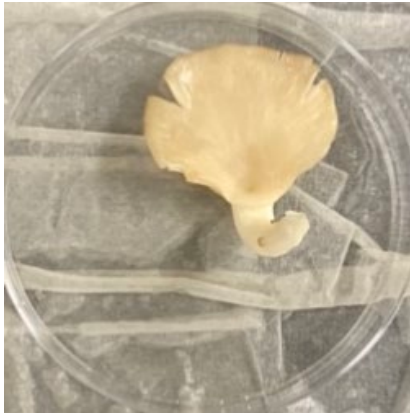
20

Oyster (T = 0)

Oyster (T = 3.5)

Shiitake (T = 0)

Shiitake (T = 3.5)
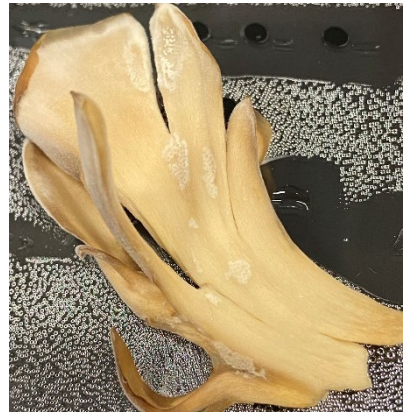
Maitake (T = 0)

Maitake (T = 3.5)
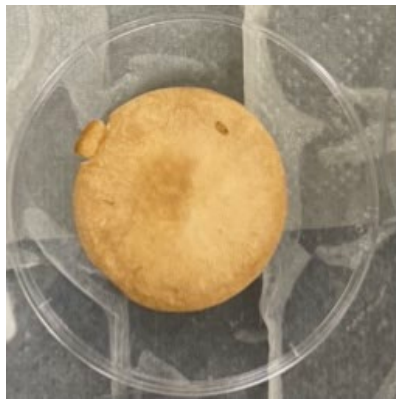
| King Bolete (T = 0) | King Bolete (T = 3.5) |

Figure 3 The physical differences observed were photographed. In the left column, this is what the mushrooms looked like at the beginning of the experiment (T = 0), just a few hours after inoculation. They still look relatively healthy. The right column shows how some of the mushrooms changed in appearance at the end (T = 3.5). Shiitake **(N)** and maitake **(P)** mostly showed signs of aging. On the other hand, oyster **(L)** and king bolete ® had discharge and significant change in color.

Discussion

Our results indicate that both oyster **(G)** and king bolete **(H)** mushrooms are susceptible to all the *Pseudomonas* pathogens, as they allow for the growth of bacteria in mushroom tissue. The colony forming units found per gram of tissue significantly increased over time. Thus, this is a suitable host for all the *Pseudomonas* strains they were inoculated with. On the other hand, shiitake **(I)** and maitake **(J)** mushrooms do not appear to be susceptible to these pathogens. The colony forming units per gram of tissue did not pass the limit of detection and were not physically observed on the plates after incubation. According to farm growers, blotch disease is not observed on either of these varieties, further supporting our findings.

Both shiitake and maitake are medicinal mushrooms for humans and are often found in either pill or serum form to treat a variety of health complications. Shiitake has been found to have antimicrobial properties[5]. Previously conducted studies have suggested that they have bioactive compounds that could protect against cancer and inflammation, but more work has to be conducted. Additionally, they might be able to boost immune support, improve heart health, and have promising antiviral and antibacterial properties.[7] Maitake has shown to have antibacterial, antimicrobial, and antiviral properties in previous experiments. Its components have activated several immune system cells and natural killer cells. The mushroom contains polysaccharides that that help the body's immune response and have thus been used as a booster against HIV and cancer, though more research has to be conducted.[4] Our results indicate that they have the ability to either suppress or inhibit bacterial growth of these *Pseudomonas* pathogens.

In the future, we intend to repeat this experiment again to gather more data and test for statistical significance in our findings. We want to further investigate the antibacterial and antimicrobial properties within shiitake and maitake to potentially figure out what compound(s) makes them

effective against these *Pseudomonas* pathogens. To our knowledge, no one has thought of using extracts from these mushrooms as a treatment for blotch disease in other mushrooms. If we can isolate the compound that is effective against blotch disease, a treatment could potentially be created, which would contribute to our current management strategies.

Acknowledgements

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Archetype Analysis of golden eagle migration patterns using Bayesian Methods

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Abstract

Animal migration has the potential to be a very good indicator of environmental changes that could affect us all. It also helps us understand the different species with whom we share this planet. In order to do the mentioned above, we analyzed a monthly golden eagle (*Aquila Chrysaetos*) location data. The main research question was whether covariates, such as age, could be a big factor on their migration routes. This exploration was possible through an archetype analysis, which is a statistical nonparametric approach that represents each individual as a mixture of multiple estimated archetypes. In addition to a traditional archetype analysis, we developed a new approach to archetype analysis, in which covariates are considered, and a subset of the archetypes is defined by existing golden eagles who exhibit known, interpretable behaviors, in order to be fitted using Bayesian methods and Markov Chain Monte Carlo simulations. This approach was developed using R with Machine Learning techniques and Bayesian Statistics. Once the analysis was complete, we were able to exhibit that covariates such as age influence birds' behavior and their migration routes, concluding that the older they get, the more likely they will belong in a non-migratory archetype. This novel approach showcases a new proposal for such databases and optimize processes in ecological research.

Keywords: Archetype analysis, Bayesian methods, MCMC, spatio-temporal statistics, R.

1. Introduction

Machine learning is a powerful tool that is currently being used in many areas of science, finance, and industry. However, it can be abstract, and hard to digest due to its algorithms and complex components. Supervised learning has a measure of success (or lack thereof) that can be used to measure effectiveness, whereas unsupervised machine learning or "learning without a teacher" (Hastie et al, 2009) draws inferences from data sets without labels, therefore, it finds patterns when one is not sure what one is looking for. There are multiple unsupervised learning techniques, such as K-means clustering algorithms, Gaussian Mixture Models, Principal Component Analysis (PCA), and so forth. In this paper, I will concentrate on Archetypal Analysis (AA).

AA was first introduced by Cutler and Breiman (1994); they proposed an approach that would characterize the "archetypal patterns" in a data set. Their first example was a question of how many sizes were needed to fit all Swiss soldiers faces in face masks. Contrary to what clustering analysis offers (using the "average" members of certain groups as the prototype), the idea of AA is enclosing the data set into a gradient, where the individuals are weighted combinations of the archetypes. In other words, every soldier has a mask that can cover their face; therefore, the mask will be large enough to cover everyone's face, but a mask that is slightly larger than their face can still be worn.

In this article, we will be analyzing a monthly Golden Eagle (*Aquila Chrysaetos*) telemetry data consisting of 180 bird-years of monthly location observations. The data was obtained over the course of 6 years, where the earliest observations are from 2012 and the latest are from 2018 and it can be seen in Figure 1. Each observation represents one coordinate point as follows: $[X_1, X_2, \ldots, X_{12}]$, and $[Y_1, Y_2, \ldots, Y_{12}]$ in the Cartesian plane. The data consist of 180 bird-years from 63 unique golden eagles, as some birds were tracked for multiple successive years.
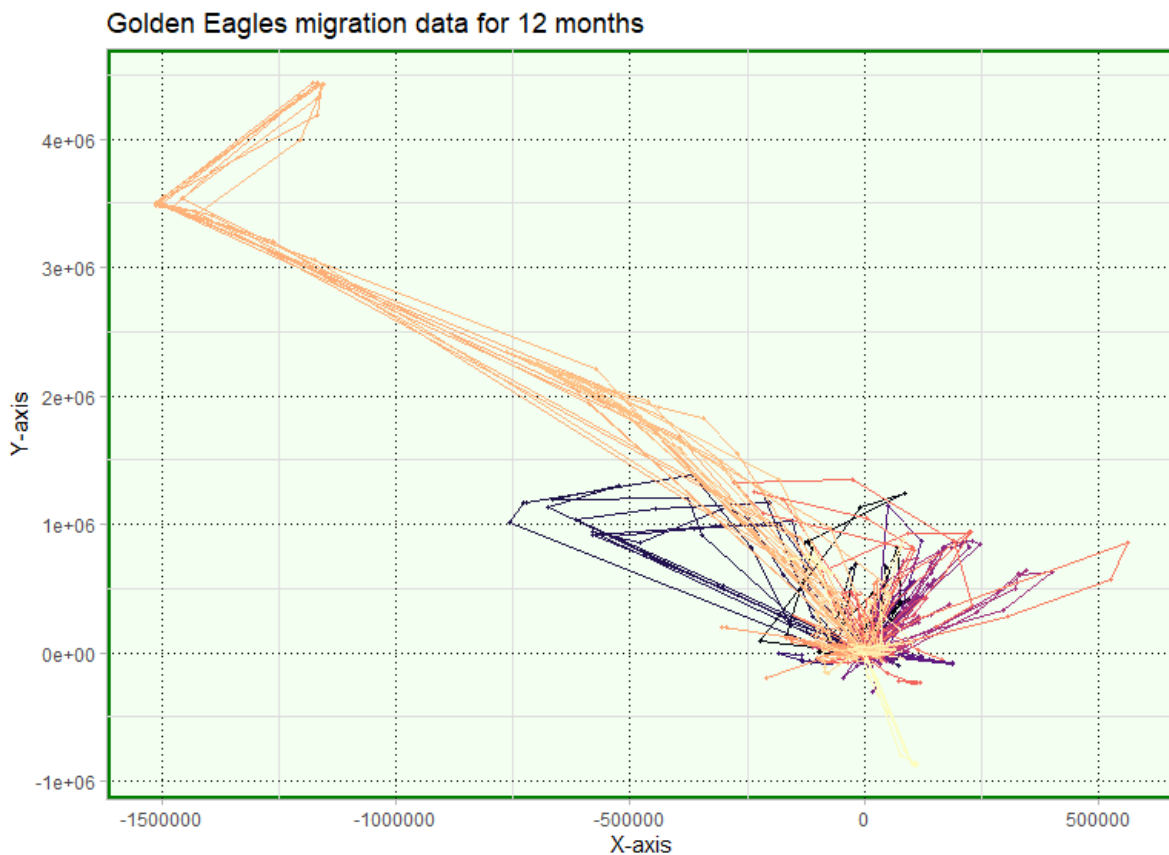
Figure 1: Plot for 63 unique birds with 180 bird-years, where different shades of colors represent the 180 different bird-years. This data set was normalized so that all start at (0,0)

Ecologists have increasingly used hierarchical Bayesian statistical (Conn et al, 2018; Hobbs and Hooten, 2015; Sahu, 2022; Kéry and Royle, 2020) since they can account for uncertainty in ecological analysis (Cressie et al, 2009), and provide an approach to model latent patterns common in ecological systems.

One thing that distinguishes animals is a power they have of moving themselves from place to place (Gray, 2013). This power allows us to say that different birds can move differently from each other. Lack (1968) notes that in many bird migrants, a higher proportion of juveniles than adults migrate, in other words, birds move differently as they age. This paper revolves around two premises on animal behavior: different birds move differently, and birds move different as they age.

In this work we develop a novel Bayesian Hierarchical Model to provide a data driven classification of bird migration strategies, and to explain how birds change migratory behavior as they age. The remainder of this manuscript is organized as follows. In Section 2, an outline of the data processing and data visualization can be found. In Section 3, the results are shown along with different plots obtained. In Section 4, there is a brief summary and discussion concerning our findings to wrap up our writing.

2. Methods

This section is organized as follows. In Section 2.1, an outline of the data processing and data visualization can be found. In Section 2.2, a background information on Archetypal Analysis considered in this work is provided along with the first model on our data. In Section 2.3 the use of covariates (such as age) to improve the model can be found with an AA analysis and Bayesian approach. Lastly, Section 2.4 talks about the implementation of algorithms such as Markov Chain Monte Carlo to satisfy our study.

2.1 Exploratory Data Analysis

We conducted an Exploratory Data Analysis (EDA). As noted previously, our data consisted of 180 different bird-years from 63 different eagles, which meant that there were some birds that were tracked more than one year. The birds that were tracked the most were 4C.Angus_11 and 4C.Eddys_11. Figure 2 shows data from these two eagles tracked over seven years. Despite the fact that these two birds have the most observations (more data leads to lower estimation variance, which results in better predictive performance), we can see that there is a lot of variance and uncertainty. This paper tries to tackle this problem with a Bayesian approach, which will be explained later in Section 2.2, and with the use of age as a covariate to improve our model.

The constant data manipulation from wide tables to narrow tables, and vice-versa was crucial to create visualizations such as Fig. 1 and Fig. 2 with the `ggplot2` library and animations that were created with the `gganimate` library. Code can be found in the Appendix of this document.
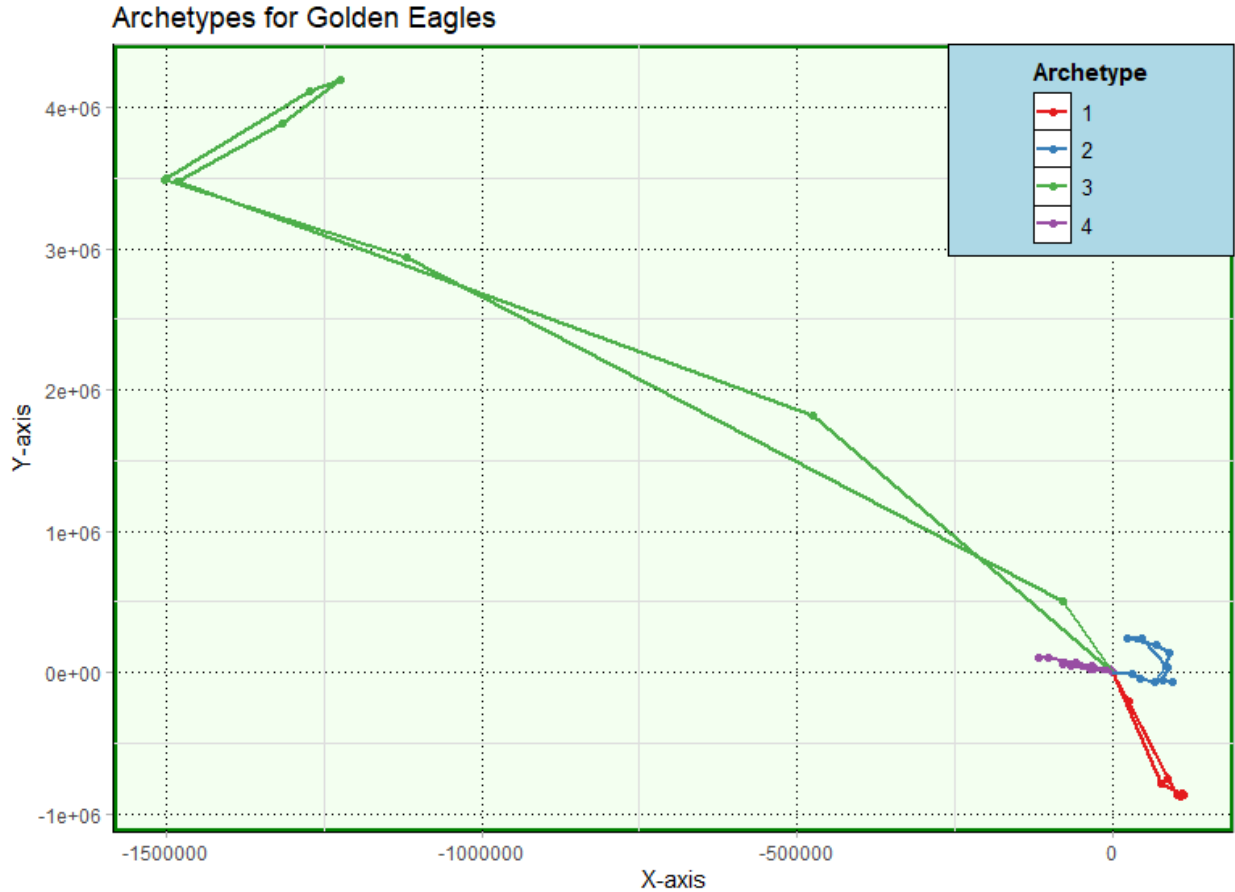
Figure 2: Monthly observations of two birds aged 1 to 7. *4C.Eddys_11* shows a relatively consistent migration pattern. Both birds show a trend of decreasing their migration distance as they age.

The goal of our analysis is to provide a data driven classification of bird migration strategies, and to explain how birds change migratory behavior as they age. To do so, we create two new variables from the telemetry data. The *distance* variable, as its name says, is the total distance traveled by the birds given by (1) where d_i is the distance in form of a scalar quantity from point d_i and d_{i+1} in the data set

$$\sum_{i=1}^{12} d_i$$

which can also be written as

$$\sum_{i=1}^{12} \sqrt{x_i^2 + y_i^2}$$

Where x_i and y_i are the vectors that create scalar d_i.

Another variable that we created was *age*. This variable was made by counting the number of repetitions a bird had and transforming them into years. In other words, if an eagle had only one row, its respective age would be 1, whereas the eagles' age in Fig. 2 would be 7 years old.

2.2 Archetypal Analysis

The fundamental idea of AA is to approximate each point in a data set as a convex combination of a set of archetypes (Bauckhage and Thurau, 2009). These are made with the `archetypes` package created by Eugster and Leisch (2009). Our first goal is to explain the variation in migratory behavior in golden eagles. We base our analysis around Archetypal Analysis (AA), an unsupervised learning approach that views each multivariate data point (bird-year in this case) as a weighted average of a set of estimated archetypes.

A simple but effective heuristic tool for choosing the number of archetypes, is the elbow criterion, and for this, we graph a scree plot. A scree plot is used to determine the number of factors to retain in an exploratory factor analysis (FA) or principal components to keep in a principal component analysis (PCA) according to Lewith et al. (2010) (see Fig. 5). The plot consists of RSS (also known as the Residual Sums of Squares) as the y-axis, and the different archetype values as the x-axis. The value of k (k will be the notation used for the number of Archetypes through the remainder of the manuscript) is selected as the point where the elbow is located (Cabero et al., 2021). The higher the k, the lower the RSS. However, although we want to have the lowest RSS to minimize errors and to have a more accurate model, there is a fundamental problem: overfitting. The main idea is to balance out goodness of fit with the fitted data.

Figure 3: Scree plot for archetypes on Golden Eagle data set.
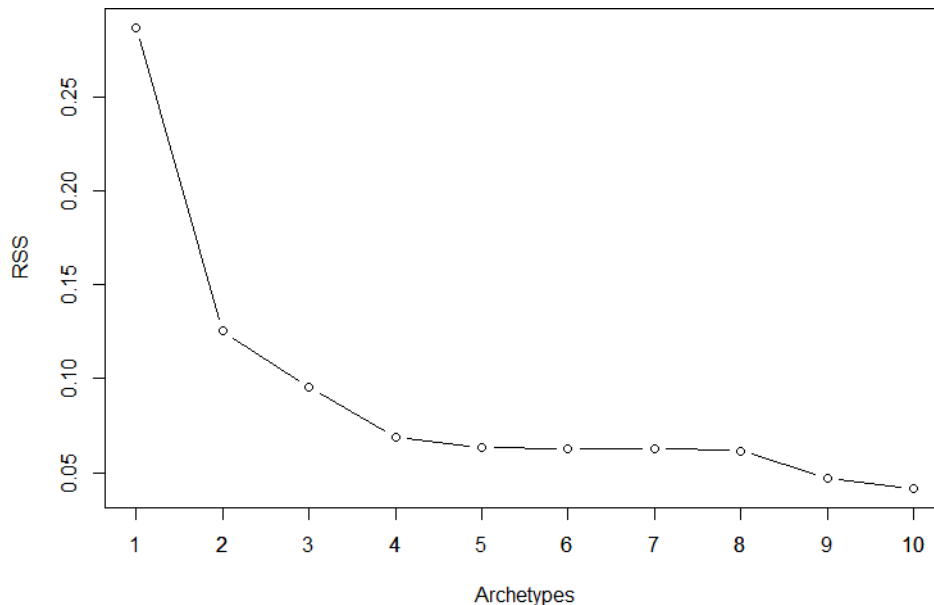
Following the elbow criterion, the number of archetypes that is chosen for our data set is $k=4$. Once we pick the number of archetypes, AA will estimate the respective archetypes (α) for the data set. Since we have our desired k, our data points will have weights that correlate to the archetypes they are most similar to. We model every bird year's archetype weights as a Dirichlet Distribution (a continuous multivariate probability distribution with a support of $x_1, x_2, \dots, x_n$ where $x_i \in (0,1)$ and $\sum_{i=1}^{n} x_i = 1$) and depending on the highest weight, we can classify whether the bird is a migrator and whether the bird fits in a determined archetype.

We can visualize these different classifications in Fig 4, which is a plot that shows the four different archetypes created by the unsupervised machine learning algorithm. There are three non-migratory archetypes (archetype number 1, archetype number 2, and archetype number 4), and a migratory archetype (archetype number 3).

It is worth mentioning that there are a lot of cases that belong in either Weight 2 or Weight 4. However, we can find birds that get caught in a cluster between these two weights mentioned above and are not represented by any archetype in specific. This problem is tackled in Section 2.3 considering covariates, manipulating the Archetypal Analysis fitting particular cases and changing the geographical paths of our different ks.
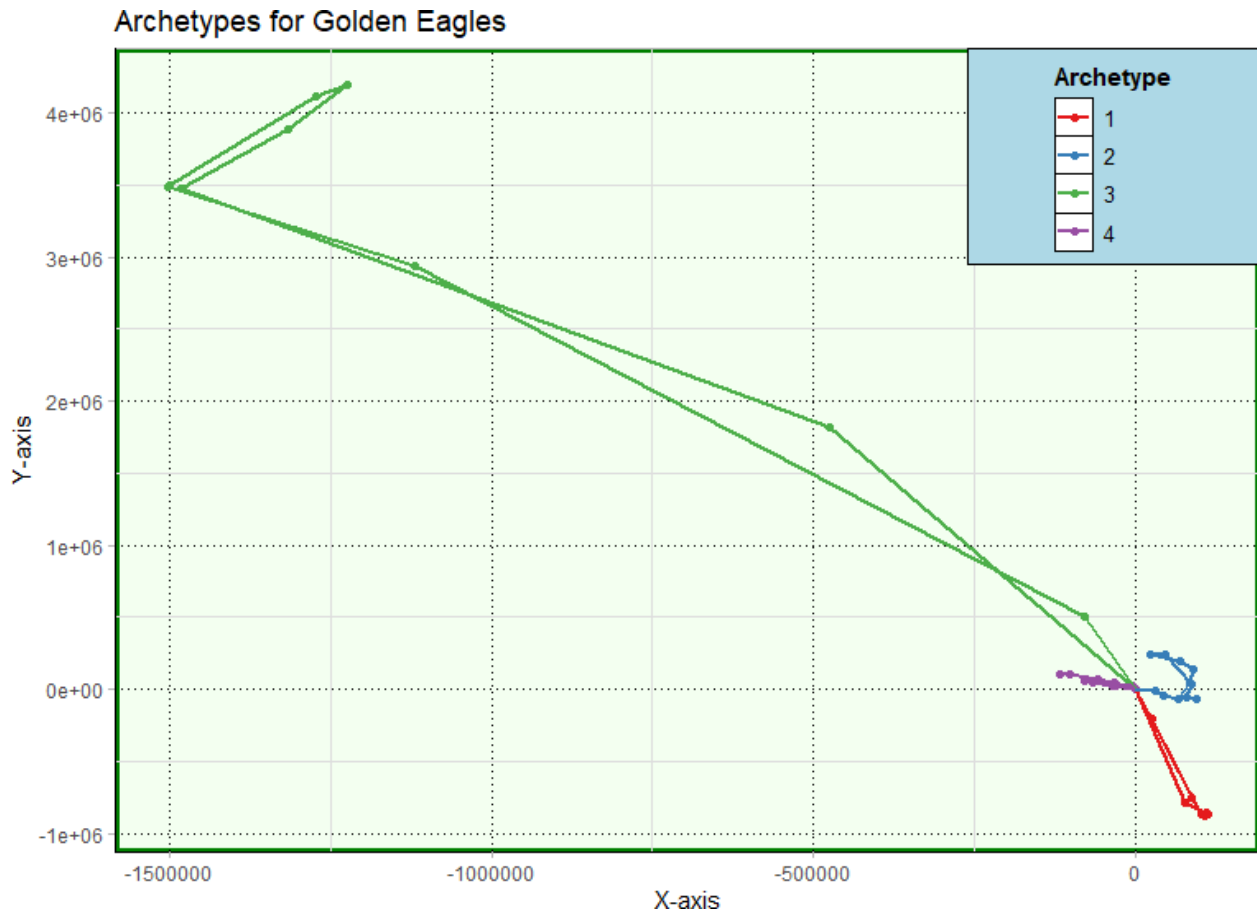
Figure 4: Monthly observations for the four different archetypes for bird-years.

2.2.1 Bayesian Inference and Hierarchical Modeling

Bayesian inference is a method of statistical inference that is gaining more popularity in the ecological field. Ellison (2004) says that Bayesian inference differs from the frequentist[1] inference in four different ways:

- Bayesian inference gives a quantitative measure of the probability of a hypothesis being true in light of the available data, whereas frequentist inference assesses the probability of the data happening given a certain hypothesis.
- Their notions of probability differ: Probability is defined by frequentist inference in terms of long-run (infinite) relative frequencies of events. In Bayesian inference, however, probability is defined as a person's level of belief in the possibility of an event.
- Prior information is used in Bayesian inference along with the sample data, whereas frequentist inference solely employs the sample data.
- Model parameters are treated as random variables in Bayesian inference, whereas they are treated as estimates of fixed, true quantities in frequentist inference.

We approach the analysis of this data set using a Bayesian Hierarchical Model (BHM). Our BHM starts with 2, where Y_i is our data set composed by our 180 eagle with their 24 different observations (monthly observations in the form $X_{i, ...,} Y_i$. It has a normal distribution where the kth column $\mathbf{a}_k$ of $\mathbf{A}$ is the kth archetype, and $\mathbf{h}_i$ is the archetype weights for data i. σ^2 is our random parameter (standard deviation) that accounts for error.

$$Y_i \sim N(\mathbf{A}\mathbf{h}_i, \sigma^2),$$

The BHM starts breaking down into branches and we can see this in 3. $\mathbf{A}$ being our archetype has a normal distribution where $\mathbf{Y}$ is our data and $\boldsymbol{\omega}_k$ is the weights of our data. This altogether, form the convex hull of data $\mathbf{Y}$. τ^2 accounts for our variation as σ^2 did in 2.

$$\mathbf{a}_k \sim N(\boldsymbol{Y}\boldsymbol{\omega}_k, \tau^2),$$

In line with the Bayesian approach, we have to specify some suitable prior distributions for all the random parameters in our model. Therefore, the parameters that we have mentioned and explained in this section, will have prior distributions with their respective support.

We have Exponential distributions for $\tau^2 \sim Exp(10)$ and $\sigma^2 \sim Exp(10)$, for our variation parameters, and we have Dirichlet distributions for $\boldsymbol{\omega}_k \sim Dir(1.0)$ and $\mathbf{h}_i \sim Dir(1.0)$ for the archetype weights.

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[1] also called classic, it is an approach to statistics based on a frequency view of probability in which it is assumed that it is possible to consider an infinite sequence of independent repetitions of the same statistical experiment (Everitt and Skronda, 2010)
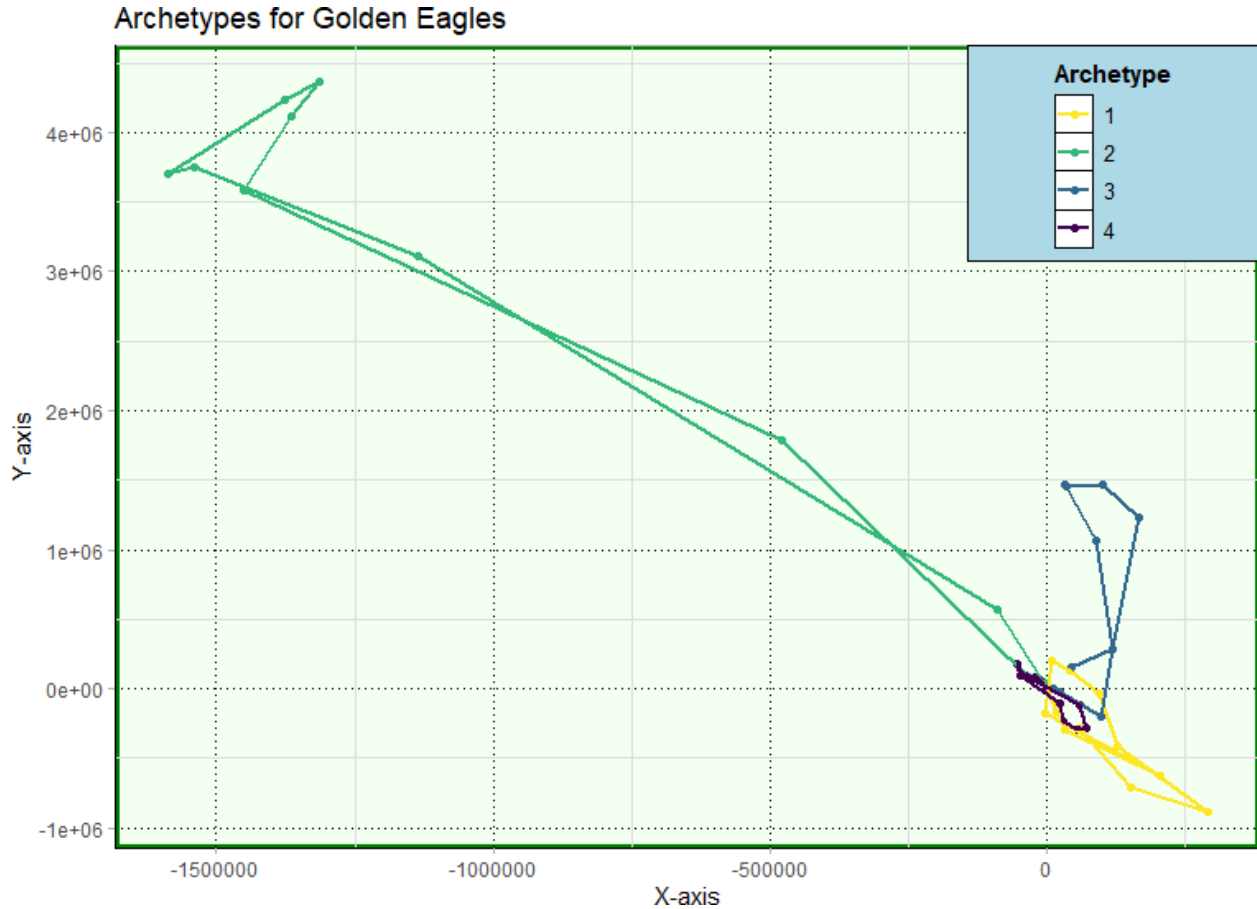
Figure 5: Monthly observations for the four different archetypes for bird-years. Note that these four estimated archetypes have different migration patterns compared to Figure 4.

2.3 Bayesian Hierarchical Modeling considering a covariate

It was mentioned previously how birds moved different as they aged, and how one of our goals was to explain how birds changed migratory behavior as they aged. For this reason, we need to change the model we built in Section 2.2.1. Recall our Bayesian Hierarchical Model: $Y_i \sim N(\mathbf{A}\mathbf{h}_i, \sigma^2)$. Our model has a normal distribution where the kth column $\mathbf{a}_k$ of $\mathbf{A}$ is the kth archetype, and $\mathbf{h}_i$ is the archetype weights for data Y_i. Then, we have $\mathbf{h}_i$, modeled with a Dirichlet prior distribution as $\mathbf{h}_i \sim \text{Dir}(1.0)$.

Even though our Bayesian model accounted for uncertainty, we can note that it doesn't have age at all. In this Section, we will modify our previous model considering a covariate (*age* specifically), for the sake of improving model's accuracy, reducing uncertainty and accounting for our variable of interest (*age*).

We originally modeled the archetype weights as $\mathbf{h}_i \sim \text{Dir}(1.0)$, where the $\text{Dir}(1.0)$ was a diffuse prior. To model the effect of *age* on migratory behavior, as captured by the archetype model, we specify a prior for $\mathbf{h}_i$ that varies with the *age* of the individual bird.

$$\mathbf{h}_i \sim \mathrm{Dir}(\alpha_i),$$

where α_{ik} will be the new parameter for the prior distribution of $\mathbf{h}_i$. This α_{ik} is modeled as

$$\alpha_{ik} = e^{(\mu_k + \beta_k X_i)},$$

where μ_k is the intercept of the weight model, β_k is the coefficient for the effect of age on the weight of the ^{kth} archetype and X_i is the age of the bird in bird year i. Recall now in Section 2.1 where it was mentioned that a variable called *age* was created based of the number of years observed each individual had.

Since parameters such as μ_k and β_k were added, we assigned their prior distributions, with $\mu_k \sim N(0,10)$, and $\beta_k \sim N(0,10)$. For clarity, we repeat our full model as follows

$$Y_i \sim N(\mathbf{Ah}_i, \sigma^2)$$
$$\mathbf{a}_k \sim N(\boldsymbol{Y\omega}_k, \tau^2)$$
$$\boldsymbol{\omega}_k \sim Dir(\mathbf{1.0})$$
$$\tau^2 \sim Exp(10)$$
$$\mathbf{h}_i \sim Dir(\alpha_i)$$
$$\alpha_{ik} = e^{(\mu_k + \beta_k X_i)}$$
$$\mu_k \sim N(0,10)$$
$$\beta_k \sim N(0,10)$$
$$\sigma^2 \sim Exp(10)$$

2.4 Markov Chain Monte Carlo

We conducted inference on our BHM using Markov Chain Monte Carlo Methods. The use of Markov Chain Monte Carlo (MCMC) allows to learn about unknown elements of our model by performing numerous random draws from the posterior distributions of those unknowns conditioned on the data (Hobbs and Hooten, 2015). We implemented MCMC using the `nimble` package in R. We assessed convergence by visual inspection of the chains and by computing the effective sample size of each parameter. The ESS (effective sample size) for all parameters was larger than 30000.

3 Results

The estimated archetypes can be seen in Figure 6. These four archetypes were obtained with the implementation of our Bayesian Hierarchical Model with *age* (See Section 2.3). We can say that archetype 2 is relatively a non-migratory archetypes, as opposed to archetype 1, archetype 3 and archetype 4.

We were able to see the evolution of our grouping process through this paper. Firstly, we started with a purely algorithmic classification based of AA in Figure 4. Secondly, we developed a BHM and the migration routes changed significantly as shown in Figure 5. Lastly, we added *age* as it can be seen in Figure 6.
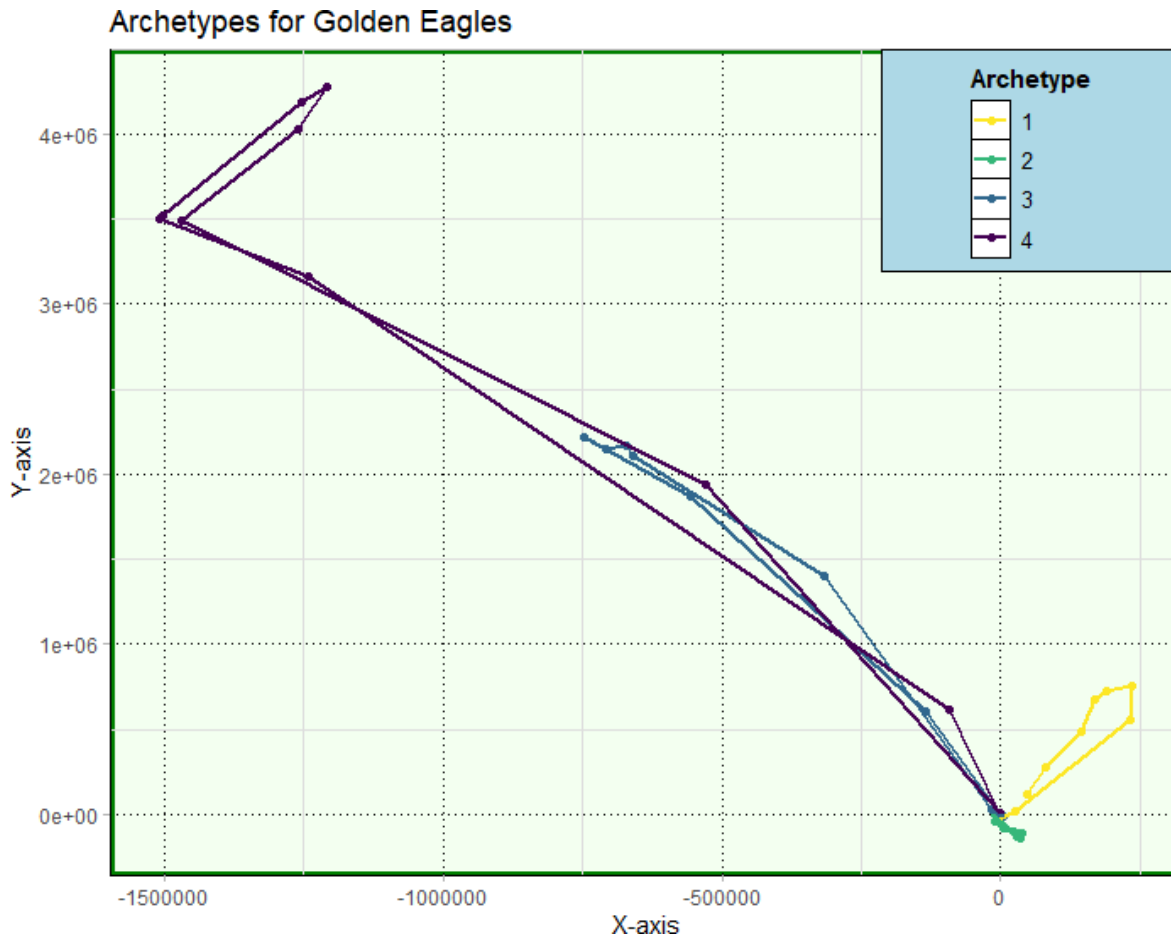
Figure 6: Monthly observations for the four different archetypes.

Once we had the different archetypes migration routes, the goal was to find if the covariate *age* was a significant factor for each bird and their respective archetype pattern.

The result of the analysis mentioned above can be shown in Figure 7. This stacked percentage bar chart illustrates how average weights corresponding to archetype number 2 increase with age, while all other archetypes, especially archetype number 3, decrease. Archetype 1, and archetype 4 decrease as well, but at a lower rate.

These percentages were obtained from the MCMC output, and from:

$$\frac{e^{\widehat{\mu_k}+\widehat{\beta_k}X_i}}{\sum e^{\widehat{\mu_k}+\widehat{\beta_k}X_i}}$$

where $\widehat{\mu_k}$ and $\widehat{\beta_k}$ are the posterior means for the effect of age on the weight of the kth archetype.
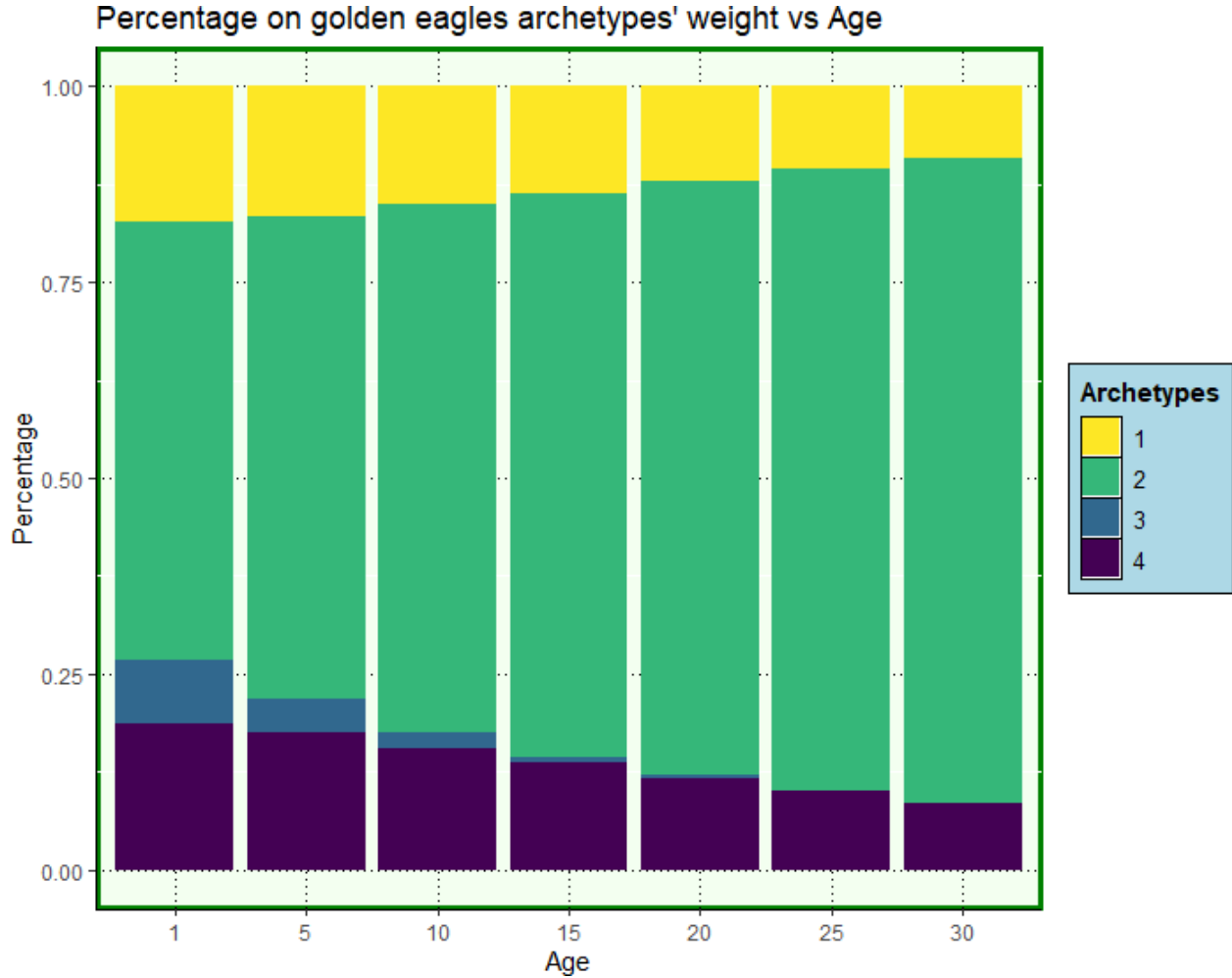
Figure 7: Stacked percentage bar chart that shows how archetype number 1 increases per year.

Archetype 2 is a non-migratory archetype. We observe how there is an increase on the weight of this certain archetype through the years. This has a constant positive trend in the lifespan of a golden eagle. This archetype also has the feature of having the highest weight for every single year. Contrary to archetypes number 1 and 4, which do not have a notorious percentage compared to the non-migratory type by the end of the 30th year. It is important to highlight that archetype number 3 is disappears and is practically non-existent by the 20th year. As shown in Figure 6, Archetype 2 is the non-migratory archetype, whereas the rest are migratory.

The main research question was whether covariates, such as age, could be a big factor on the eagles' migration routes. This question was answered in the form of a stacked bar chart (See Figure 7. The effect of the covariate *age* can be thought as a great indicator of whether the animal will

belong to a determined archetype and how the animal will behave migration wise. Therefore, *age* is a big factor on their migration routes. One can conclude that the older that the golden eagles get, the higher the likelihood that they will belong to a non-migratory archetype.

4 Discussion

We analyzed a monthly golden eagle (*Aquila Chrysaetos*) location data in this paper. This exploration was made using an archetype analysis, which is a statistical nonparametric approach that represents each individual as a mixture of multiple estimated archetypes. In addition to a traditional archetype analysis, we developed a new approach to archetype analysis, in which covariates are considered, and a subset of the archetypes is defined by existing golden eagles who exhibit known, interpretable behaviors, in order to be fitted using Bayesian methods and Markov Chain Monte Carlo simulations.

It is important to highlight the use of Bayesian hierarchical modeling in animal movement data. BHM can provide reliable models that can result in straightforward and understandable insights. The fitting of *age* was trouble-free with the use of this approach.

A possible extension to our current approach could be the use of more covariates, such as sex and temperature. This could provide insight into when a golden eagle's movement is being motivated by hormonal and/or environmental factors, as opposed to a purely migrational effect with an algorithmic analysis. This could allow for models that predict birds' movement to have a better understanding of the animal behavior and have an expectation for whether the bird will migrate.

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Appendix

The coding of this project can be found in the author's personal GitHub account.

abraham-arbelaez.github.io

Language and Aging: A Neuro-Cognitive Assessment of Aging Across the Lifespan

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Abstract

As we age, there is often some degree of cognitive decline. Difficulty with speech comprehension and language production often provokes frustrating experiences across the lifespan, especially in older adults. These encounters do not solely influence cognition, but also human perception and interaction within society (Hummert et al., 2004; Kemper, Finter-Urczyk, Ferrell, Harden, & Billington, 1998). Interestingly, studies have indicated that language comprehension is maintained as language production declines. While aging is frequently linked to detrimental effects in speaking, there is still a clear sense of knowing the word. There are competing theories regarding the underlying causes of age-related deficits in and speech, such as transmission vs inhibitory deficits, compensation and dedifferentiation, and processing speed. These cognitive changes are associated with neural decline, and word retrieval failures. Studies have presented the notion that older adults are often slower and less efficient compared to younger adults, raising the possibility that retrieval issues may be influenced by age-related declines in phonology and processing speed. In this study, we looked at two factors that might influence speech: phonology and frequency. One aspect of the study stresses the connection between phonological neighborhood density (PND) and word retrieval failures to develop our understanding of the neurological and behavioral foundations of age-related deficits in speech. In correlation with PND's, high frequency words (apple, cat, house), also have been shown to have a notable influence on word retrieval. Retrieval deficits often occur when individuals encounter words with sparse phonological neighborhoods as well as low frequency words (banjo vs cat). We are interested in how cognition, age, and the brain affect language production. Here, we used the picture naming task to examine reactions times and activation levels across the lifespan. The experimental study analyzed the number of neighbors a word has in correlation with high frequency words to interpret whether this changes the way we process information.

Introduction

Although some aspects of language remain intact throughout adulthood, such as intellect and language comprehension, there are cognitive problems associated with word retrieval (CITE). In past research, we observed notable negative effects on speech and aging. The cognitive problems associated with word retrieval failures have been reflected in previous studies, such as ToT (Tip of the tongue states), in which an individual is not able to accurately produce a word even if there is a vivid sense of knowing it (Burke et al., 2004; Burke et al., 1991; Maylor, 1990; Rastle and Burke, 1996). Other age-related declines in speech associated with production include phonological neighborhoods and the facilitation of production. In this study, we look at two factors that may influence speech: how a word sounds (phonology) and how often a word is encountered (frequency). The more phonologically similar neighbors a word has, the greater the surge of priming to target phonological representations and the faster they will reach threshold (Vitevitch & Sommers). The overall goal of this current research is to improve our understanding of the neural and behavioral bases of age-related declines in speech by analyzing where speech deficits occur, and the retrieval of phonological information appears to decline with aging (Burke and Shafto 2004; Mortensen, Meyer, & Humphreys, 2006). Retrieval deficits often occur when individuals encounter words with sparse phonological neighborhoods as well as low frequency words such as banjo vs cat. (Landauer and Streeter, 1973). We aim to integrate theories to explain why deficits occur through fMRI studies of language and production to find the link between language production and behavioral performances (Wlotko et al. 2010).

Inhibition Deficit Theory: Link Between Working Memory and Comprehension

There are several theories about why older adults have language production difficulties. The link between working memory and comprehension led to the development in the inhibitory deficit theory (Hasher and Zacks 1988; Lustig et al. 2007). This theory suggests that older adults process more information compared to younger adults, but this may prevent them from completing the task at hand (Healey et al. 2008). Functions of inhibition may include controlling entry to one's focus, the ability to control inappropriate responses, and deleting irrelevant information from working memory. Working memory has shown the largest age effect (Bopp and Verhaeghen 2005) and may have a mass impact on language processing and executive function. Working memory, specifically executive function, may impact language processing in older adults. This notion is supported by additional studies supporting this hypothesis, illustrating that increasing working memory demands in older adults resulted in slower speech rates (Kemper et al. 2003). Inhibition deficits may increase information entering working memory, even if this information is not dedicated to task success. The inhibitory deficit theory also suggests that attentional performance may be impacted by age-related declines in the capacity to suppress irrelevant information. (Lustig et al. 2006), reading speed (Carlson et al. 1995; Connelly et al. 1991), memory (Collette et al. 2009), and pattern learning (Kramer et al. 1994), suggesting that such a deficiency may be responsible for changes in a wide range of cognitive functions, including some aspects of language. This may contribute to the notion that older adults are less able to ignore irrelevant thoughts and actions than young adults (Lustig et al. 2006), as

well as why older adults often generate off topic speech (e.g., Arbuckle, Nohara-LeClair, & Pushkar, 2000). Declines in inhibition support the notion that age related declines in inhibitory control result in an increase of information entering working memory, which may impede them from completing the desired goal (Hamm and Hasher 1992). This may contribute to the underlying language production deficits. In terms of capacity, performance should improve across a wide range of tasks depending on the amount of preserved mental disk space. Although older adults may be able to process more information, it might divert them from finishing the task at hand. A variety of cognitive functions can change because of age-related deficiencies in the capacity to suppress irrelevant information, including memory, pattern learning, and attentional performance (Lustig et al. 2006). Although older adults can still access inhibitory processes, they may find it more challenging to activate strategies that lead to success making it increasingly difficult to ignore irrelevant thoughts, resulting in slower retrieval times. (Diaz. Et. Al).

Transmission Deficit Theory: Age-Related Differences in Language

There are competing theories as to why older adults have language production declines such as cognitive slowing, inhibition deficits, and phonological deficits. There is evidence suggesting that the evidence is consistent with the transmission deficit model, which explains that ageing weakens connections between semantic and phonological representations of verbal knowledge (Burke and Shafto 2004). Contrary to the inhibition deficit theory, declines in inhibition support the notion that age related declines in inhibitory control result in an increase of information entering working memory, even if the information is not for task success. Older adults are not unable to recruit inhibitory processes but may experience increased difficulty initiating strategies that lead to success (Murray et al. 2015).   The transmission deficit theory was put forth to explain how language changes with age, and to make predictions about language development. In contrast to the inhibition deficit theory, the TDT theory overall puts the focus on connections between nodes within semantic and phonological networks that are weakened with age (e.g., Thornton & Light, 2006), while the inhibition deficit theory emphasizes the age-related neural declines in working memory and comprehension (Hasher and Zacks 1988; Lustig et al. 2007).

The Transmission deficit theory makes specific predictions about language such as declines in frontal and superior regions with more posterior and inferior regions displaying less decline in older adults (Diaz et al 2016). Language production relies on the frontal gyri, which may also explain the deterioration of production across a lifespan. The connections between nodes within semantic and phonological networks are weakened with age, reducing the degree to which one node can prime (process that triggers retrieval) another node (MacKay and Burke 1990). The age – related weakening of connections will limit the transmission of priming from lexical nodes to associated phonological nodes, reducing the likelihood of phonological activation, which is why the transmission deficit theory is linked to higher word retrieval deficits in older adults (James and Burke 2000). Infrequent or nonrecent use of a word and aging of the participant weaken connections to and within the phonological system (Burke et al., 1991; Burke & Shafto, 2004). Although the semantic and phonological systems are interconnected, the

semantic system is more interconnected than the phonological system (Burke et al. 1991; James and Burke 2000; Laver and Burke 1993). There can be a weakening across the network, but the phonological system is the most vulnerable. This decline in production may contribute to age related declines in phonology (James and Burke 2000).

The transmission deficit theory is unique to language and production decline since vocabulary and semantic knowledge improves over a lifespan. The phonological system appears to be the most vulnerable (Burke and Shafto 2004). Inhibition is more generalized in the sense that inhibition of information which is irrelevant to one's goals is a key contributor to differences in performance among individuals. One of the reasons why we compare the IDT vs. the TDT is because they make different predictions. For example, in contrast to what the TDT suggests, if older individuals experienced inhibition deficiencies, this would signify that they really had more activation (stronger phonological priming, stronger semantic priming, etc.). To evaluate where exactly retrieval deficits are occurring, we conducted behavioral assessments aimed at examining declines in inhibition, processing speed, language production, and phonological neighborhood density. Although word retrieval skills deteriorate with age, there is evidence to explain why these deficits are occurring: Compensation vs dedifferentiation.

Compensation vs De-differentiation

It is evident that word retrieval failures may be associated with compensation. Compensation refers to the recruitment of more regions to fulfill the task at hand, this illustrates how an individual uses resources in response to task demands. When there is a high cognitive demand, compensation refers to the improvement in cognition that occurs when resources are enlisted; this may differ between older and younger persons (Good et al. 2001; for a review, see Madden et al. 2012; Resnick et al. 2003; Salat et al. 2004). While studies in younger adults have shown to prefer a more challenging and more rewarding process, a common observation in fMRI studies with older adults is bilateral patterns of activation (e.g., Gerlach et al. 1999; e.g., Tyler et al. 1995; Wright et al. 2012). Younger adults have more unilateral patterns of activation, while older adults promote increased activation within the brain (Logan et al. 2002). The key to interpreting patterns of activation is to identify maintained or improved performance. compensatory processes or dedifferentiation. People up regulate to perform better, but research suggests that it results in dedifferentiation (Diaz et al. (2014). Older adults often recruit more regions to compensate for regions lacking in retrieval, which may be counter intuitive. Older adults upregulate and are more sensitive to contextual information (Madden 1988), since they are unable to keep up with the information like younger adults. When task difficulty increases, there may be an increase in brain activity that does not actively support performance on a production task. Brain activity typically rises until it hits a threshold, after which it begins to fall (Diaz et al 2016). The activation of brain circuits related to cognitive abilities that younger adults have access to but do not employ for the task at hand may be used to predict trends in recruitment. While older adults might prefer a less challenging but less rewarding strategy, younger people might favor the opposite. Although younger adults can recruit through the same processes, it is less likely to improve their performance (Cabeza et al. 2002). As we age, there may be connections so weak that they respond poorly to phonological cues, this is where

dedifferentiation occurs in the pre-frontal cortex (e.g., Cabeza 2002; Ghisletta and Lindenberger 2003; e.g., Park et al. 2004). We see evidence in age related decline in phonological sensitivity. Although adults can do the task, they are sensitive to it (Madden 1988), which results in de-differentiation. Making the connection between compensation and effective performance makes it easier to tell if activation differences are the result of dedifferentiation or inefficiency. (Diaz et al. (2014)

The Present Research

In the present study, we study how PNDs, and high frequency words predict increased accuracy in word retrieval by analyzing when deficits occur, and why adults have language production declines. Older adults have larger vocabularies, but both younger and older adults display similar word associations. This indicates that both age groups exhibit semantic priming effects, which computes to spreading activation through associative networks. This brings up a key factor in age related deficits: language comprehension. The Inferior Frontal Gyrus (IFG) is the primary cognitive control function, primarily the left IFG as it supports executive function (Braver et al. 1997; Dove et al. 2000; Moss et al. 2005; Swick et al. 2008; Zhang et al. 2004). The right IFG seems to contribute to language comprehension successfully but does not support successful behavior during language production. (Geva et al. 2012) Comprehension remains intact as we age. Since semantic aspects of comprehension change less as we age, the ability to utilize comprehension and memory retrieval is preserved throughout the lifespan. Processing speed may also contribute to differences across memory tasks due to declines in working memory. For example, older adults do not seem to utilize predictive information the same way young adults do (Federmeier and Kutas 2005). Meaning that guiding behavior requires the brain to process information at higher activation which older adults may not possess. The link to the reorganization of the dorsal stream may predict structural deterioration within the brain. Even though some parts of language processing have a significant left lateralization, recent research indicates that as people get older, the right IFG is more commonly recruited, creating a more bilateral dorsal stream. (e.g., Tyler et al. 2010a; Wierenga et al. 2008). Language production also seems to recruit IFG, regardless of age, like language comprehension does. It has been noted that older adults recruit to this area during semantic (Meinzer et al. 2009; Meinzer et al. 2012b) and phonological verbal fluency tasks (Meinzer et al. 2009). These findings show that in older adults, at least one key language region of the left-lateralized dorsal stream still plays a significant role in language production (Vigneau et al. 2011). While studies in younger adults have shown that greater phonological overlap elicited less activation in younger adults, a common observation in fMRI studies with older adults is bilateral patterns of activation (e.g., Logan et al. 2002). Our hypothesis states that increased phonological overlap in correlation with frequency will predict increased accuracy in word retrieval.

Methods

Participants and Design

Participants in this cross-sectional study of language deficits and aging were _40__ adults from the ages of 18-89 (M age =47.00, SD age= _19.17). Participants recruited had to meet necessary requirements before being eligible for the study. In order to evaluate age-related variations in language production, participant ages were distributed across the lifespan (see Fig. 1 for a histogram of the age distribution). All participants were right-handed, monolingual, and had little to no exposure to other languages. This was an important factor to incorporate because evidence has suggested that bilingual individuals often make use of the brain differently None of the subjects had serious neurological, psychiatric, or physical issues (Christensen et al., 1992), and all had normal or corrected-to-normal eyesight. It was necessary for the participants to be right-handed; since language is oriented in the right hemisphere, left-handedness demonstrates bilateral activation, and the MRI averages patterns of activation. It was also important to decline people who take prescription medications for mood, such as anti-depressants, anti-anxiety medications, or mood stabilizers as it affects the brain. This is also true for people with major medical conditions such as cancer, diabetes, or heart disease with at least a 6-month remission phase. Participants also had to have at least graduated high school in order to reduce potential outliers.
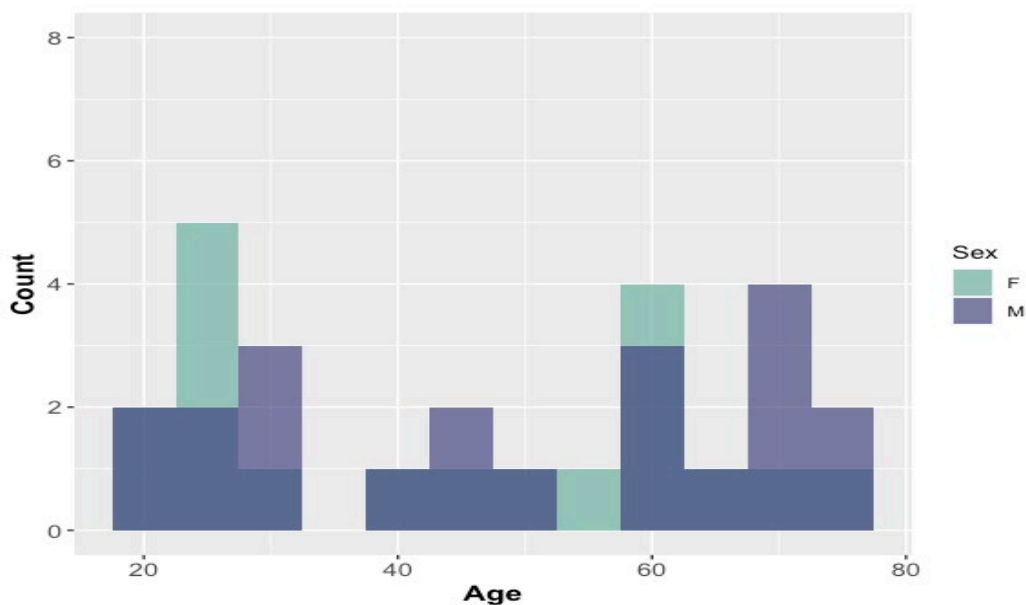
Figure 1 – Distribution of participant's age. Forty adults, roughly evenly distributed across the lifespan. Mean age = 47.00, SD age = 19.17)

Apparatus: Surveys, software used for data collection, MRI (Magnetic Resonance Imaging)
Measures: Neurocognitive tests, self-report measures of attitudes

      Prior to the in-person session, each participant completed a series of neuro-cognitive tests to assess levels of cognitive functioning, such as working memory, speed, executive function, and language. A Qualtrics survey was included to assess cognitive impairments, where we collect data related to demographics as well as information used to screen out participants due to cognitive impairments. This included demographic info, the geriatric depression scale (GDS) to screen for depression(Yesavage et al., 1982), the WAIS vocab task to assess language/reading abilities, author recognition task (ART) to assess reading habits, and a color vision test (Ishihara plates) to assess for color blindness These psychometric tasks also included the MoCA (Montreal cognitive assessment) to screen for mild cognitive impairment or dementia; WAIS-III vocabulary, digit-symbol, and digit span subtests to assess working memory (Wechsler et al., 1997); phonemic (F, A, S) and semantics (animals) categories to screen for verbal fluency (Patterson, 2011); the author recognition test to assess reading habits (Acheson et al., 2008); the California Verbal Learning Test to assess immediate and delayed memory (Woods et al., 2006); simple and choice reaction time tests to assess speed 3 ; a reading span task (Conway et al., 2005; Loboda, 2012), a computerized version of the Stroop task (Stroop, 1935), and a story elicitation task. Age was significantly inversely correlated with measures of working memory and word retrieval and significantly correlated with measures of speed (simple speed, choice speed, and digit symbol) and inhibition (Stroop) (backward digit span, verbal working memory, immediate and delayed recall). Although word retrieval is higher in younger adults, we observed no significant changes immediate and delayed recall across the lifespan. In previous studies, age and reading preferences were positively connected, with older adults reporting greater author familiarity (ART task), It has been translated as more reading experience (Acheson et al., 2008).

      The verbal fluency tasks' widespread use is partly due to its connection to executive functioning. Participants must access words from their vocabulary, which requires access to the mental lexicon. It requires concentration and identifying specific words accurately., all of which need executive control processes. (e.g., Fisk and Sharp, 2004). Thus, deficient performance in the fluency tasks should be a sign of vast verbal ability or executive control deficiencies. Prior to the MRI session, we schedule an in-person session where we administer a computerized version of a series of tasks including a speed task (processing speed), choice reaction task (ability to process more info), a Stroop task (attention capacity/counterbalance), vision acuity test (FracT) assessing if participant has normal/corrected to normal vision), the Pitt reading span (make judgement whether a sentence is right or wrong), and verbal memory (immediate/delayed recall of a series of words). Then, we may correlate the findings with fMRI data analysis.

Stimuli and Procedure

Here, we used the picture naming task to examine reactions times as we measure phonologically dense neighborhoods. This experiment analyzes how PND's, and frequencies of words interact, then we will be able to interpret whether this changes the way we process information. By integrating theories in behavioral findings and the linkage between behavioral performance and age-related differences, we can accurately identify underlying causes of age-related deficits in speech. The overarching goal is to conduct behavioral assessments of cognitive abilities in older and younger adults aimed at examining inhibition, speed, and language function. We collected data on declines in inhibition, processing speed, and phonological aspects of language to analyze how the brain operates when processing language.
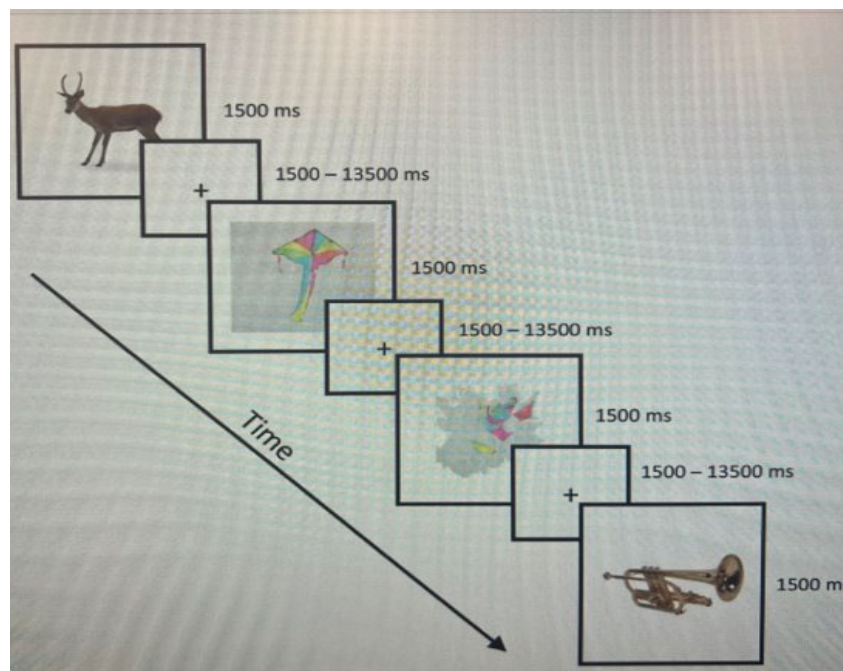
Figure 2 - Participants named diverse pictures in phonological neighborhood density (e.g., deer, kite = high PND, trumpet = low PND), and abstract pictures (control condition) (Diaz et. al.)

In this study, we look at two factors that may influence speech: phonology and frequency. The denser the word, the more difficult it is to produce, the less frequent, the more difficult it is to retrieve. To examine how cognition, age, and the brain affect language production, we administer a picture naming task. Participants performed a picture naming task in the MRI scanner. Each trial consisted of 191 photographs, presented over a white background. Participants were instructed to overtly name the photograph as quickly as possible while still responding to the picture precisely. Participants were also asked to be as specific as possible in their answers (e.g., toast instead of bread).

To control for brain activation to basic visual and motoric features, we included a control condition that consisted of 50 photographs that had been abstractly transformed to yield unrecognizable objects that maintained the basic characteristics of a recognizable photograph. This is to control the brain's response to visual and motoric elements. Images depicted common concrete objects from a variety of categories such as animals, clothing, food, and household items. To assess PNDs in correlation with high frequency words, we included a combination of high frequency words and phonologically dense words to assess reaction times based on the frequency of PNDs and frequent words. High frequency words and PNDs were varied across the items to allow us to investigate whether an increase in words retrieval was observed based on these factors. Words with high phonological conditions (moth, cloth, broth), are high phonologically, but we do not see these words often (frequency). The picture naming task helps determine whether words with high PND in correlation with higher frequency of the words result in higher word retrieval. We then record the reaction times to assess how this changes the way we process information. This experiment will analyze how PND's, and frequencies of words interact, then we will be able to interpret whether this changes the way we process information.

During the MRI portion of the study, we assess for disfluency with words that have dense neighborhoods. The participants were prompted to participate in the MRI portion of the study to analyze activity within the brain. This is the most critical aspect of the study and was performed to measure the phonological neighborhood density to measure how individuals interpret sound patterns and meaning. The picture naming task is a language production task. Visual perception, recognition, and the addition of nonverbal conceptual understanding of the depicted item are the first steps in the picture naming process. The next two levels of lexical access are as follows: A lexical phonological representation is accessed after accessing a lexical semantic representation (the phonological word form, or lexeme) (Graves et al). We manipulate a variety of pictures and focus on a specific target name to link the lexical phonological form to semantic information that is recalled through activity within the brain (Graves et al). When a node is has frequently been activated over the course of a lifetime, the rate and amount of priming transmitted across its connections increases (MacKay, 1981;1982). Stronger connections between lexical and phonological nodes for words with high frequency tend to prevent phonological errors, which often happen when an incorrect node in a phonological domain receives more priming than the correct node when the activating strategy is applied. The likelihood of word substitutions for low frequency words over high frequency words may be explained by the frequency factor. (Stemberger, 1984) and why object naming is faster for high than low frequency names (Huttenlocher & Kubicek, 1983; Oldfield & Wingfield, 1965). Phonologically, if we insert, delete, or substitute a phoneme for sound such as cat, hat, at, scat, we can predict higher retrieval rates in older adults. The number of neighbors a word has creates higher activation density and refers to how dense the network is (number of connections). (Vitevitch & Sommers, 2003). We examine word disfluency with densely populated neighborhoods in the MRI machine, where we monitor how long it takes for them to speak. The terms are less common and more difficult to pronounce depending on the density of the word. After the participant says the target word, we assess the responses correctness. This is to assess how the brain processes language in congruence with reaction time and phonological density.

Behavioral Results

Older adults are often slower and less accurate in the picture naming task, pointing to cognitive slowing (Morrison et al. (2003). Task difficulty in congruence with low density words was dependent on analyzing activation levels in the brain. For the MRI analysis, we observed regions which produced the highest levels of activation in congruence with PND increases/decreases and task difficulty. We analyzed activation levels within the brain and noted the activation levels based on the frequency of the word and PND. We were interested whether high frequency of a word predicts higher retrieval vs high frequency of PNDs through analysis of the brain via optiBET. This is where we analyze whether compensation or dedifferentiation is prevalent across the lifespan. Higher level cognitive processing is more significantly impacted by age-related deterioration in sensory processing. For the same task, different brain regions are active in various situations (older vs younger), consistent with the MRI, there does not seem to be any behavioral variance in reaction time. We can examine if age disparities are constant throughout the course of a lifespan by enlisting more brain regions. We were able to foresee that there are noticeable variations, but they are not particularly significant. Connections between nodes become stronger or more efficient with use. Although we use our entire brain, this is not always the most effective use of it. Since it is more effective to execute activities more effectively, we desire components to be more specialized- this is what is seen in older adults. When we recruit too many regions of the brain, networks become subject to dedifferentiation (Diaz et al). Adults recruit more data; however, it is hypothesized that they overrecruit in other regions to make up for other regions where they underrecruit. The results of behavioral outcomes depend on comprehension and dedifferentiation, which is analyzed via optiBET (brain extraction script).

Preliminary Findings and Results

In order to determine the impact of PND, Age, and the relationship between PND and frequency, we used a scatter plot regression analysis. In order for the manipulation to be effective, ex- act congruence in the onsets was necessary because our analyses primarily focused on phonological neighborhood characteristics (M.T. Diaz, H. Karimi, S.B.W. Troutman et al. Neuroimage 225 (2021) 11751), and all other responses were classified as errors. Responses were coded for accuracy based on the exact response of the given word in response to the MRI picture naming task. Since we are assessing for disfluency, the target word must be exact due to the PND. Subcategories of errors were created, and the responses were used to assign scores. Acceptable alternatives (stick, branch), word retrieval failure (uh, I don't know), phonological disfluency in which sound is the same as the target response ("Muh" "muzzle"), semantic disfluency ("pi. Pickle" "cucumber"), or if the first word was incorrect, but the response was accurate ("uh" ... "glasses), and an incorrect response. We also included an abstract photo in which a participant was to respond "picture", acting as the control condition. Although we detected no significant age differences in the phonological and frequency variable, we notice a stronger age difference in the phonological condition in comparison to our frequency condition. We predict that we will detect more distinct age differences in the future.
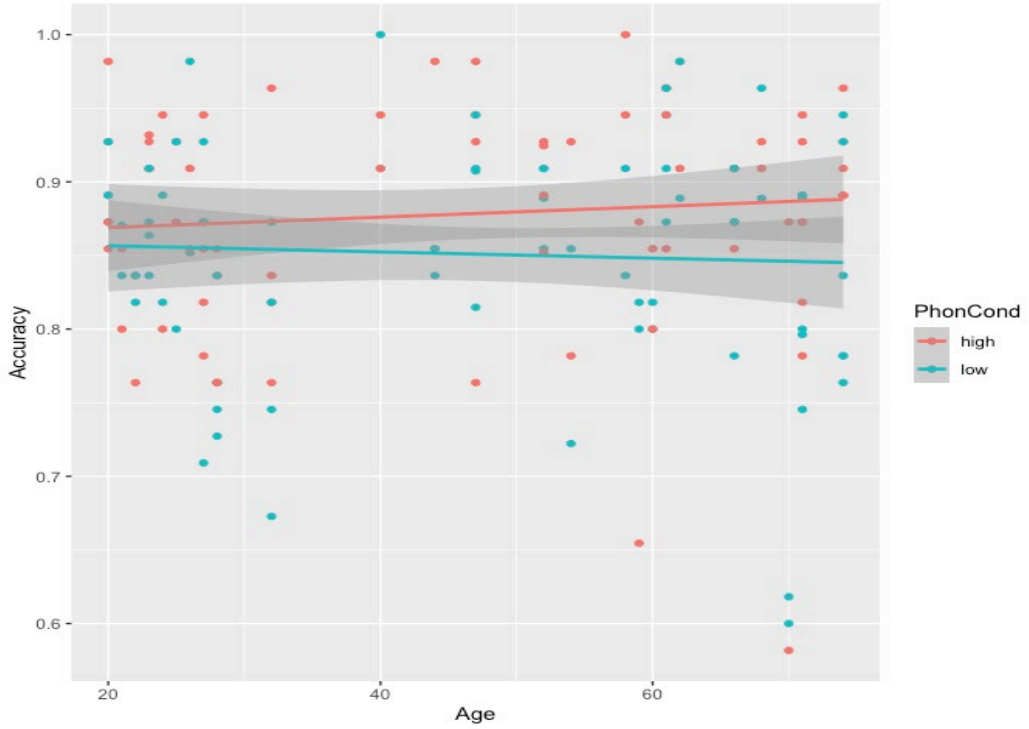
Figure 3 - Phonological Condition and Accuracy
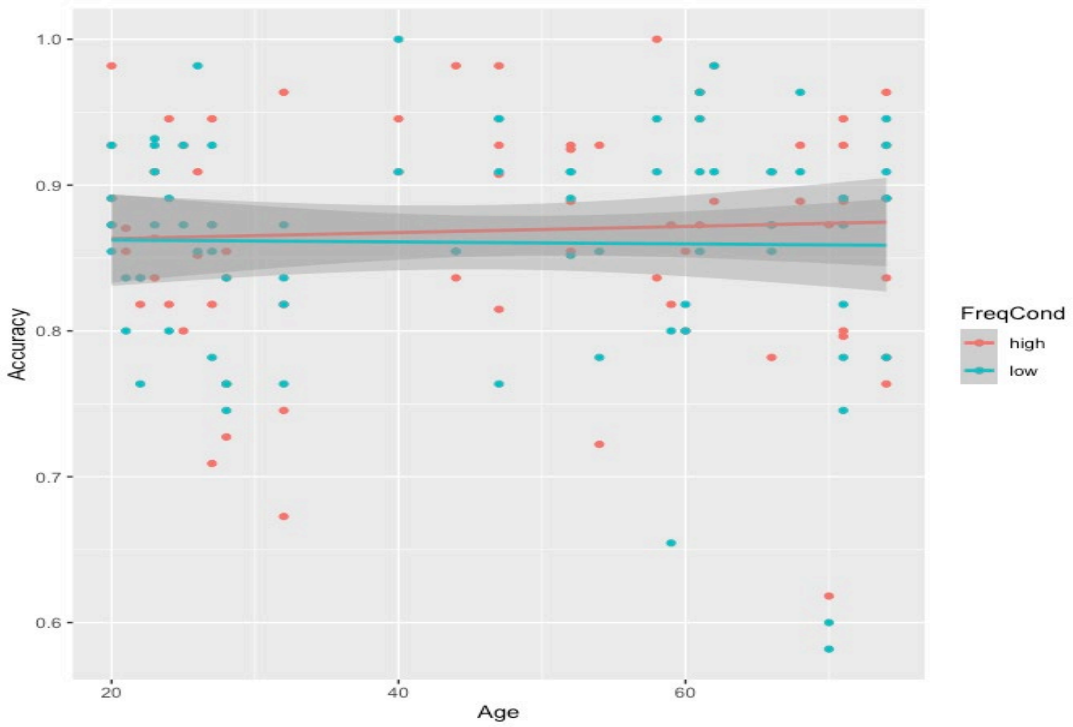
Figure 4 – Frequency Condition and Accuracy

For the MRI analysis, we observed regions which produced the highest levels of activation in congruence with PND increases/decreases and task difficulty. Based on a previous study analyzing retrieval rates of PNDs, there were no strong age-related differences in sensitivity to phonology, there were age-related differences in picture naming (Diaz. Et.al) We were interested whether high frequency of a word predicts higher retrieval vs high frequency of PNDs. Although phonological neighborhood density portrayed a more significant effect, it was evident that there was no significant age difference between PND and frequency. This may be due to the relatively small sample size (N=40). In future data analysis, we aim to recruit a larger and more diverse sample to see a more significant age difference. In correlation with our neuropsych data, we used a pairs panel to calculate the mean for semantic and phonemic(N=0.46) (Fig. 5). We noticed a stronger age difference in phonemic. In future data collecting, we can predict stronger age-related differences in verbal fluency.
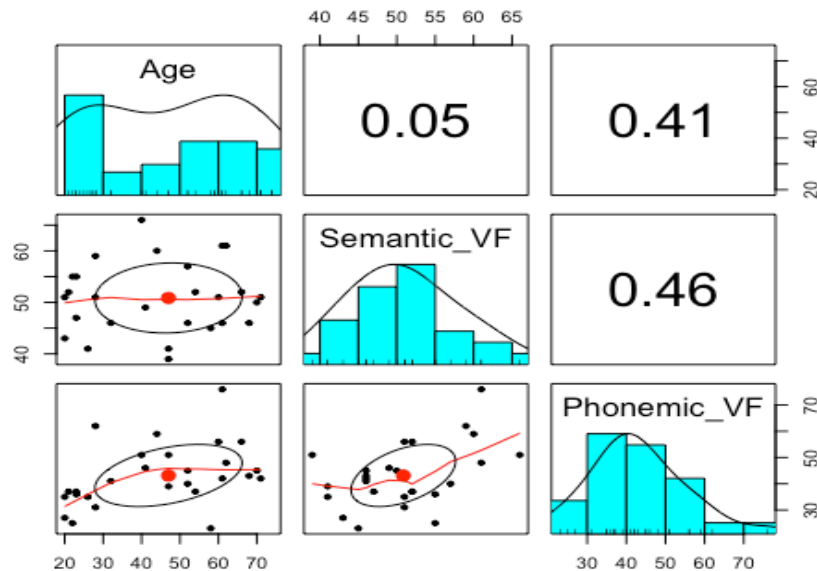
Figure 5 – Semantic and Phonemic Correlations.

We ran a pairs panel correlation test (figure 5) to predict retrieval rates (delayed recall) in correlation with our measure of reading (Author Recognition Task). Our findings indicate that there was no significant age difference between the two variables. No significant age difference was detected, although older adults are less accurate in retrieval times. However, this may also have to do with our small sample size. What can be found unusual is that the age differences between PND and frequency are not significant. However, we did notice more distinct age differences in the data collected from the MRI analysis (refer to figure 3), so the presented p-values are unlikely to be relied on.
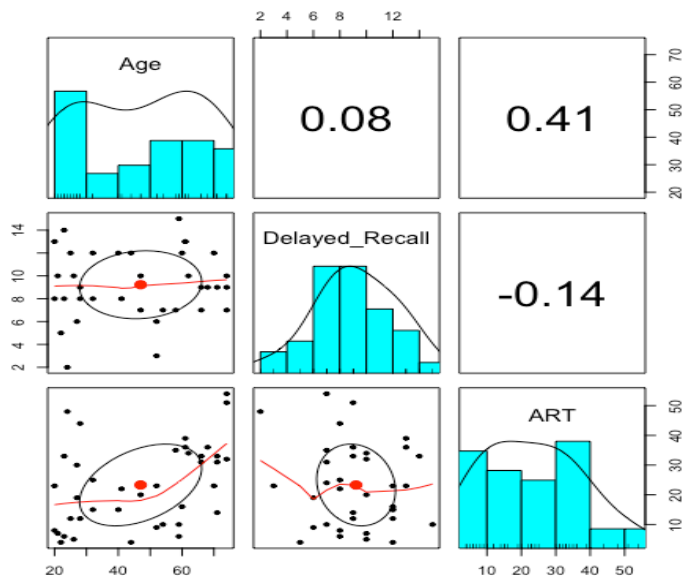
Figure 5- pairs panel correlation test (delayed recall, ART).
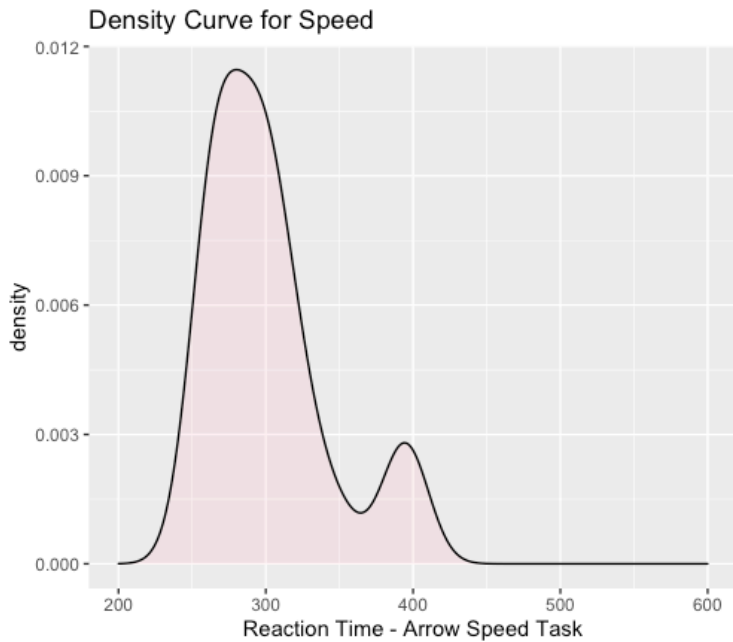
Figure 6 – Density curve to analyze processing speed (Speed arrow task). Processing speed may contribute to differences across memory tasks due to declines in working memory.

Discussion

Our sample size consisted of 40 participants, which is a significantly small population. Additionally, 3 of the 40 participants had been excluded from the study due to covid reasons and a low MoCA score. Given this, there is a lack of variability to determine the hypothesized causes and effects of aging and language across the lifespan. Also, there is the limitation of the measures we used such as the Qualtrics survey. Since one of the behavioral sessions is self-administered, there is a chance of bias in question-answering in verbal fluency (ART). Therefore, there is a lack of reliability in the scores for each participant. More importantly, we did not get to analyze activation levels in the brain via optiBET, so we cannot conclude where comprehension vs dedifferentiation is occurring. Based on the results, we hope to see a significant age difference in correlation with PND and frequency and its effect on word retrieval.

Limitations

Limitations to consider in our findings would be the small sample size (N=40). In immediate and delayed recall, even though older adults are more likely to have word retrieval failures, there was no significant age difference We could anticipate a stronger impact of phonological neighbors on language output if inhibitory deficits decline with age because if more phonological neighbors are engaged, this might increase the activation of the intended target. In this study, we found no significant age differences in correlation with PND and frequency of words. No linear correlation was found between age, PNDs, and frequency, indicating that there is no direct relationship between PND and frequency. Therefore, PND in correlation with frequency of words, may show a significant age effect in the future

The question stands on whether we will notice distinct age differences in the future. There is a sense that words with dense neighborhoods do predict increased word retrieval, as we saw in the graph, so for the data to show no distinct age difference in PND and frequency, may indicate an error in the methodologies. Further studies may involve collecting data from a larger sample size as well as integrating older adults into our data set. The study also focuses on brain imaging analysis via optiBET. The results would underline the role of the left hemisphere language regions (precentral, supramarginal, and inferior frontal gyri) and bilateral superior temporal gyri in phonological processing. In previous studies, fMRI results showed that objects with more PNDs generated less activity, which may be interpreted as facilitation, primarily in bilateral superior temporal gyri, and bilateral lateral occipital cortex, regions that support phonological aspects (Heim et al., 2003; Vaden et al., 2010). However, we do not currently have results to find exactly where the age differences are occurring to determine compensation vs de-differentiation.

Previous studies in PNDs and aging have suggested that throughout the lifespan, results in brain sensitivity to phonological neighborhood structure is maintained, but retrieval difficulty—as indicated by more errors and functional activation—increases with age (Diaz et al). Overall, evidence suggests that the transmission deficit theory best accounts for age-related

changes in language production, even though processing speed and inhibitory control may contribute to trends in the data that have been observed. (Diaz et al). According to the transmission deficit theory, the absence of redundancy in the phonological and orthographic nodes makes the phonological system particularly susceptible to age-related decline. (Burke and Shafto 2004), which may contribute to higher retrieval rates in PNDs. Our two variables, PND and frequency, can interact in picture naming (Diaz et al 2021). Overall, these findings show that PND may consistently affect language production over the life span. Our data suggests that PNDs do predict increased word retrieval, even more so than frequency words. Our results may suggest that with increasing age, older adults may have greater difficulties with overt production, and have higher levels of activation in language-relevant areas as well as domain-general executive and memory resources. (Diaz et al 2021), we hope to correlate this finding with data analysis in the future.

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Fathers' Alcohol Problems and Parenting Behaviors with Adolescents

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Abstract
Fathers' excessive alcohol usage can cause problems in a family. Fathers' alcohol problems are also associated with higher depression and antisocial behavior, that may both have negative associations with family processes. This research paper examined the association between fathers' alcohol problems and associated risks (depression, antisocial behavior) and fathers' parenting behavior during father-adolescent interactions. We hypothesized that a father's alcohol problem may increase the risk of fathers' harshness and insensitivity during father-adolescent interactions. The sample consisted of 227 families (51% female children recruited as infants) through New York State birth records. Families were assessed at periodic intervals between infancy and late adolescence. Fathers reported their alcohol problems and depression at all time points and father-adolescent interactions were observed and coded in early adolescence. These measures were used in the current research project. Results suggested that fathers' alcohol problems were not significantly correlated with father harshness and sensitivity. Also, father alcohol group status was not significantly correlated with father harshness and father sensitivity. However, we did find that both father alcohol problems and father sensitive parenting during a laboratory task were associated with fathers' antisocial behavior. Together, these results suggest that paternal alcohol problems measured in infancy were not directly associated with fathers' parenting behavior during laboratory-based discussion tasks in adolescence but may be indirectly related via paternal antisocial behavior.

Since birth, children are taught to depend on their mothers and fathers. Because of this, parents are particularly important in a child's life. Research has shown that positive parenting is the foundation of children's well-being and healthy development (National Academies of Sciences, Engineering, and Medicine, 2016). Fathers' parenting especially can impact the well-being of a child (Towe-Goodman et al., 2014). In fact, Towe-Goodman and colleagues (2014) suggest that fathers' sensitive parenting in toddlerhood has an individualistic and vital role in toddlers executive functioning, which shows the importance of early caregiving for the development of these skills. Specifically, fathers' sensitive parenting during play at 24-months predicted children's executive functioning at 3-years of age. In addition, Tavassolie and colleagues (2016) found that fathers' authoritarianism in parenting predicted increased child behavior problems. This suggests that father parenting style has an impact on the behavior problems of young children.

Similarly, Rinaldi and colleagues' (2012) findings revealed that fathers' authoritarian parenting predicted toddlers' problem behaviors while authoritative paternal parenting predicted adaptive behaviors. This provides more evidence to show that paternal parenting does in fact impact child development. Besides evidence showing that fathers' parenting impacts children's development, there is also evidence to suggest that paternal parenting can affect adolescent development too. In fact, Bronte-Tinkew and colleagues (2006) suggest that having a positive father-to-child relationship reduces the possibilities of participating in risky activities in adolescence. The authors also suggest that fathers authoritarian parenting style increases the risk of adolescents getting involved with delinquent activities and substance use. Although we have evidence that paternal parenting impacts child and adolescent development, less is known about parenting styles in fathers with alcohol problems.

While we know less about parenting styles in fathers with alcohol problems, we do know that paternal alcohol problems have negative effects on children (Eiden et al., 2007). Indeed, Eiden and colleagues (2007) found that there was an indirect association between fathers' alcohol problems and children's internalization of rules of conduct or conscience through fathers' sensitivity during play interactions at age 2 years. In this sample, fathers with alcohol problems displayed lower levels of sensitivity with their toddlers than fathers without alcohol problems. This in turn was associated with children's later internalization of rules (Eiden et al., 2007). Furthermore, children with parents who have alcohol problems were at an increased risk of using alcohol and other substances in adolescence (Eiden et al., 2016). Likewise, Eiden and colleagues (1999) found that fathers with alcohol problems had more negative interactions with their infants than fathers without alcohol problems. In fact, fathers with alcohol problems had lower sensitivity, lower positive affect, fewer verbalizations, higher negative affect, and lower infant responsiveness (Eiden et al., 1999). From the literature, we know that fathers with alcohol problems tend to parent their young children less sensitively and more negatively than fathers without alcohol problems. Further research suggests that the negative association between paternal alcohol problems and developmental outcomes extends into adolescence. In one study, paternal alcohol problems predicted less of an attachment between adolescents and their fathers, and it also predicted higher adolescent alcohol involvement (Cavell et al., 1993). Likewise, adolescents of fathers with alcohol problems reported higher levels of positive expectancies (expectancies concerning positive alcohol effects for adolescents) than children of fathers without alcohol problems (Cavell et al., 1993). Adolescents with positive expectancies reported higher levels of heavy drinking (Colder et al.,1997). However, what is less clear is whether fathers with alcohol problems parent their adolescent children less sensitively or more harshly than fathers without alcohol problems.

When considering father alcohol problems and father parenting, it is also important to consider paternal depression and antisocial behavior because these psychological symptoms have been associated with both parenting and alcohol problems. For example, fathers' depression mediated the relationship between fathers' alcohol problems and fathers' sensitivity during play interactions with their infants (Eiden et al., 1999). Likewise, fathers' report of their own depressive symptoms predicted overactivity in disciplinary encounters in fathers with substance use disorder (Kelley et al., 2015). This literature shows that the relation between depression and

alcohol problems has been shown to affect fathers' parenting style. Furthermore, when fathers engaged in high levels of antisocial behavior, the more time they lived with their children, the more behavior problems their children had (Jaffee et al., 2003). Also, children born to antisocial fathers had higher rates of externalizing behavior (Blazei et al., 2003). Therefore, these studies show the importance of considering paternal depression and antisocial behavior when studying the relation between father alcohol problems and father parenting.

In the current study, we will consider whether fathers with alcohol problems parent their adolescent children less sensitively or more harshly than fathers without alcohol problems. Based on the current literature we hypothesize that fathers with alcohol problems will parent their children more harshly and less sensitively, than fathers without alcohol problems.

Methods

Participants

The initial sample consisted of 227 families (111 girls, 116 boys) with 12-month-old infants. These families were classified into two groups at the time of recruitment: the nonalcoholic group consisting of parents with no or few alcohol problems and the alcohol problem group with families in which at least one parent met a diagnosis for alcohol abuse or dependence ($n = 125$). Within the alcoholic group at recruitment, 76% of the families had only the father ($n = 95$) who met criteria for alcohol abuse or dependence, 6% had only the mother who met criteria for alcohol abuse or dependence ($n = 7$), and 18% had both parents who met criteria for alcohol abuse or dependence ($n = 23$). Given the study hypotheses regarding the potential effects of fathers' alcohol problems and antisocial behavior, families in which only the father met diagnostic criteria for alcohol abuse or dependence were included in this study. Thus, the final sample consisted of 197 families, with 102 in the nonalcoholic (NA) group and 95 in the father alcoholic (FA) group. The study was approved by the University at Buffalo Social Science Institutional Review Board.

The majority of parents in the study were White (92%), approximately 6% were Black, and 2% were Hispanic, Native American, or other. Parental education ranged from less than a high school degree to postgraduate degree, with more than half of the mothers (59%) and fathers (54%) having completed some post–high school education. Annual family income ranged from $4,000 to $100,000 (U.S. dollars), with the mean income $43,626 ($SD = $20,937). The mother's age at recruitment ranged from 21 to 41 years ($M = 30.8$, $SD = 4.40$) and the fathers from 21 to 58 years ($M = 33.14$, $SD = 5.94$). All of the mothers were living with the father of the infant in the study at the initial assessment, and most parents (88%) were married to each other.

Procedure

The names and addresses of families were obtained from the New York State birth records for Erie County. Parents who indicated an interest in the study were screened by telephone with regard to sociodemographic characteristics and other eligibility criteria. Parents were primary caregivers and cohabitating since the infant's birth. Women who reported drinking moderate to heavy amounts of alcohol during pregnancy were excluded from the study to control

for potential fetal alcohol effects. During the telephone screen, mothers were administered the Family History Research Diagnostic Criteria for alcoholism with regard to their partners' drinking (Andreasen et al., 1987), and fathers were screened with regard to their alcohol consumption, problems, and treatment. Because we had a large pool of families potentially eligible for the nonalcoholic group, once a family was recruited into the alcohol problem group, they were matched with a nonalcoholic family on race/ethnicity, maternal education, child gender, parity, and marital status. The sample was predominantly White (informed written consents were obtained from both parents, and child assents were obtained in fourth and sixth grade).

Families were assessed at seven different child ages (12, 18, 24, and 36 months; kindergarten [5–6 years of age]; fourth grade [9–10 years of age]; and sixth grade [11–12 years of age]). Extensive observational assessments with both parents and children were conducted at each age. This article focuses on 12-month alcohol problem data and effortful control data in the fourth and sixth grades. Families were compensated for their time in the form of gift cards, toys, and monetary compensation.

Measures

Father Alcohol Problems

The University of Michigan Composite International Diagnostic Interview (UM-CIDI) adapted to a self-report questionnaire (Anthony et al., 1994) was used to assess alcohol abuse and dependence at 12 months. Several questions of the UM-CIDI were reworded to evaluate "how many times" a problem was experienced instead of whether it happened "very often." For abuse criteria, recurrent alcohol problems were described as those occurring at least three to five times in the past year or one to two times in three or more problem areas. In addition to the screening criteria *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV; American Psychiatric Association, 2000), criteria for alcohol abuse and dependence diagnoses for current alcohol problems (in the past year at 12 months) were used to assign final diagnostic group status (American Psychiatric Association, 2000). Fathers were assigned to the alcohol problem group if they met one or more of the following: (a) Research Diagnostic Criteria for alcoholism according to maternal report on the screening interview (Andreasen et al., 1986); (b) acknowledged having a problem with alcohol or having been in treatment for alcohol problems, was currently drinking, and had at least one alcohol-related problem in the past year; or (c) indicated having alcohol-related problems in three or more areas in the past year or met DSM-IV criteria for abuse or dependence in the past year based on the UM-CIDI.

Father Antisocial Behavior

We used a modified, 28-item version of the Antisocial Behavior Checklist (Eiden et al., 2004; Zucker and Noll, 1980) to assess paternal antisocial behavior when the infant was 12 months old. Fathers were asked to rate their frequency of involvement in aggressive and antisocial activities over the course of their lifetime with a 4-point Likert scale ranging from 1 = *never* to 4 = *often* (e.g., shoplifted, taken part in a robbery, been question by police, defaulted on a debt). The scores were summed to create a composite score for antisocial behavior.

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Higher scores indicate higher levels of antisocial behavior. The internal consistency of the 28-item measure in the current sample was quite high (α = .90).

Father Depression

The Center for Epidemiological Studies Depression scale (CES-D; Radloff, 1977) was used to measure fathers' depressive symptoms at several time points from infant age 12 months to fourth grade. The CES-D is a scale designed to measure depressive symptoms in community populations. It is a widely used, self-report measure with high internal consistency and strong test–retest reliability (Boyd et al., 1982). Paternal depressive symptoms were fairly stable, with across time correlations ranging from 0.49 to 0.72. Fathers' scores on this measure were averaged across time and the internal consistency of this final composite variable was high (Cronbach's α = .88).

Father-Adolescent Interaction

First, father and child were asked to discuss and try to resolve four issues on which they disagreed based on parent and adolescent ratings on the Issues Checklist (Prinz et al., 1979). This interaction was videotaped and lasted 5 minutes. Following the conflict task father and child participated in the happy task. Dyads were given 3 minutes and asked to talk about the positive aspects of one another and their family. Participants were videotaped during this discussion as well. The two interaction tasks were not counterbalanced; all parent-child dyads were given the conflict task first. These interactions were coded for father harshness and sensitivity using the Iowa Family Interaction Rating Scales (Melby et al., 1998) by two coders who were unaware of other information regarding the families including fathers' alcohol problems. The sensitivity scale included items such as positive reinforcement, child centered behaviors, humor, positive mood, warmth-support, prosocial behaviors, and physical affection. The harshness scale included items such as intrusiveness, angry coercion, hostility, and antisocial behavior from father to child. Coders were trained on the scales until they achieved at least 80% reliability. Inter-rater reliability was calculated on 16% percent of the interactions and the Intra-class correlation coefficients ranged from .81 to .87 for fathers' harshness and sensitivity variables.

Results

In order to test our question of if father alcohol problems predict harsh and sensitive parenting in adolescence, we conducted bivariate correlations. First, we examined associations among fathers' education, total family income, fathers' total antisocial behavior, fathers' sensitivity, fathers' harshness, fathers' alcohol problems, and fathers' depressive symptoms. We found that father antisocial behavior and a total number of alcohol problems variables had high skewness and kurtosis. Because of this, we did a square root transformation on father antisocial behavior and total number of alcohol problems variables and used the transformed variables in our analyses.

When we ran our bivariate correlations, we included our predictor variables (average father alcohol problems from 12 months to fourth grade and father alcohol group status), our outcome variables (father sensitivity and harshness at fourth grade), and our covariates (lifetime

measure of antisocial behavior and fathers' average depression from 12 months to fourth grade). We included a lifetime measure of father antisocial behavior and fathers' depressive symptoms from 12 months to fourth grade as covariates because depression has been strongly correlated with high substance use (Stover et al., 2012) and fathers' antisocial behavior was associated with the child's conduct problems (Jaffee et al., 2003).

After running our bivariate correlations, we found that father alcohol problems were not significantly correlated with father harshness $r(148) = -.03$, $p = .7$, or sensitivity, $r(148) = -.09$, $p =.25$. Father alcohol group status was also not significantly correlated with father harshness $r(148) = .010$, $p = .91$ and father sensitivity $r(148) = -.13$, $p = -.12$. However, there was a significant association between father alcohol problems and father antisocial behavior, $r(148) = .37$, $p < .001$, and father' antisocial behavior and fathers sensitive parenting, $r(148) = -.23$, $p = .004$.

Table 1

Correlations Between Variables of Interest

Variables	1	2	3	4	5	6	7	8
1. Father Education	1							
2. Total Family Income	.41**	1						
3. Antisocial Behavior	-.32**	-.31**	1					
4. Sensitive Parenting	.26**	.14	-.23**	1				
5. Harsh Parenting	-.07	.03	-.09	.43**	1			
6. Alcohol Problems	-.12	-.12	.37**	-.09	-.03	1		
7. Depression	-.08	-.19**	.29**	-.08	-.01	.25**	1	
8. Alcohol Group Status	-.21**	-.05	-.38**	-.13	.01	.59	.158	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Figure 1

Bivariate Correlation Between Average Alcohol Problems and Antisocial Behavior
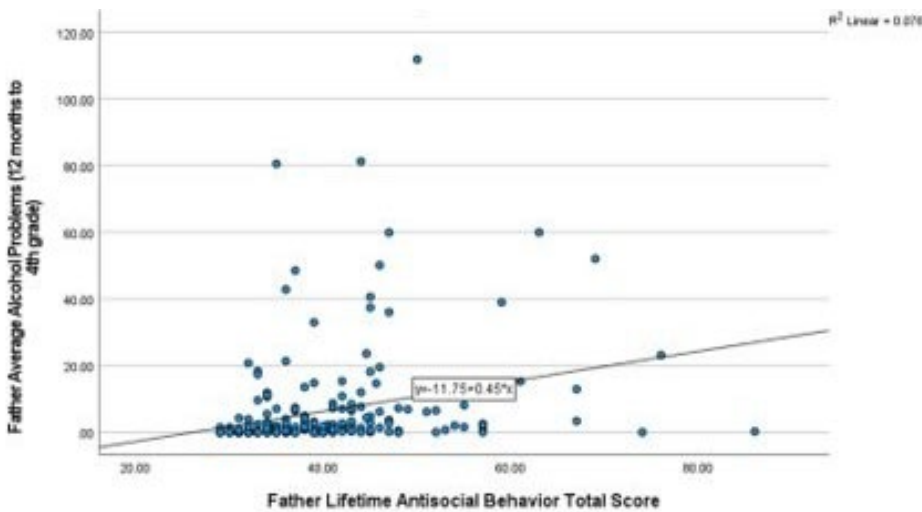
Figure 2

Bivariate Correlation Between Father Antisocial Behavior and Father Parenting Sensitivity
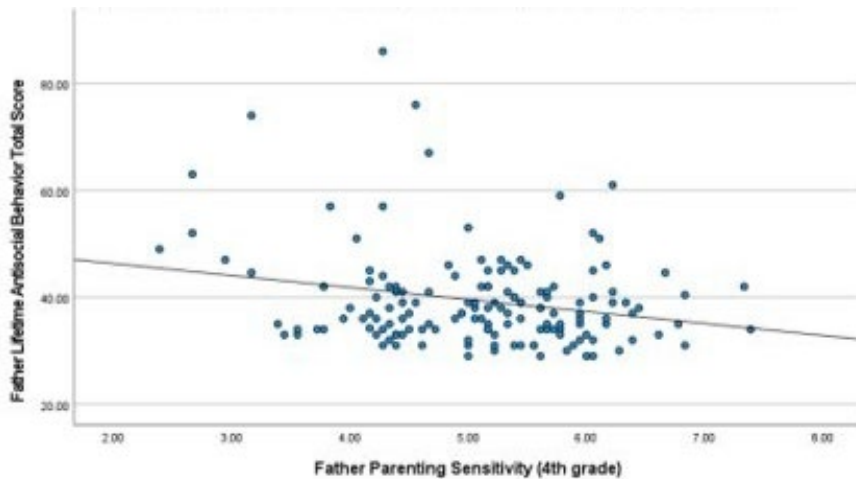
Discussion

We wanted to consider whether fathers with alcohol problems parented their adolescent children less sensitively or more harshly than fathers without alcohol problems. Based on the current literature we hypothesized that fathers with alcohol problems would parent their children more harshly and less sensitively than fathers without alcohol problems. Our hypotheses were not supported by the data. Father alcohol problems were not significantly correlated with father harshness or father sensitivity. Also, father alcohol group status was not significantly correlated with father harshness and father sensitivity. This suggests that paternal alcohol problems measured in infancy were not directly associated with fathers' parenting behavior during laboratory based discussion tasks in adolescence.

However, father alcohol problems were significantly correlated with father antisocial behavior and father antisocial behavior was significantly correlated with father sensitive parenting. The correlation between father antisocial behavior and both fathers' alcohol problems and fathers' sensitive parenting suggests that antisocial behavior might be the link between fathers' alcohol problems and fathers' harshness and sensitivity. In support of this conclusion, other researchers have found that parents with antisocial behavior tend to discipline in unpredictably and exhibit more neglectful parenting (Tory et al., 2011). Further, previous research with the current sample has found that fathers with alcohol problems tend to exhibit more antisocial behavior than fathers who do not experience alcohol problems (Eiden et al., 1999). Together, these findings support our conclusion that antisocial behavior may link father alcohol problems and sensitive parenting practices.

Another potential reason we did not find significant results could be because of social desirability bias. Social desirability bias is "the tendency of research subjects to give socially desirable responses instead of choosing responses that reflect their true feelings" (Grim, 2010). We believe that social desirability bias may have influenced fathers' responses to questions about their alcohol use and problems because they might not have been honest about the amount of alcohol they consumed and want to appear socially competent. We also believe that social desirability bias may have influenced fathers' harsh parenting behavior in the interaction task. Fathers may not have parented as harshly as they typically would because they know that they were being observed.

Finally, it is possible that fathers' alcohol problems measured closer in time to fathers' interactions with their adolescents would be significantly associated with fathers' parenting behavior. One possibility is that fathers' who had alcohol problems in infancy may have gotten treatment and have fewer or no longer have alcohol problems when their children are adolescents. Indeed, several studies have found that child behavior outcomes improved when fathers received treatment for alcoholism (Andreas et al., 2006) and that father parenting behavior improved and CPS involvement decreased when heavy-drinking fathers of adolescent children entered family-therapy (Lam et al., 2009). For this reason it is possible that father alcohol problems do predict father parenting behavior, however, father alcohol problems may need to be measured in adolescence to accurately predict father parenting in adolescence.

Limitations

Although our study had many strengths including the number of participants, particularly the number of fathers who participated, our study also had its limitations. One especially important limitation was the racial composition of the fathers. The majority of fathers were Caucasian (89%), African American (7%), and the rest were Hispanic or Native American (4%). Race is an important thing to consider because this study cannot be generalized to fathers of different races. In addition, the majority fathers (55%) had received some post-high school education or had a college degree. Because the majority of fathers had relatively high levels of education, this study may not relate to fathers who had a relatively low level of education.

Future Directions

  In general, more research on father parenting is needed. According to our results, father parenting may be indirectly related to father alcohol problems and future studies should look at other variables like antisocial behavior that may be indirect variables in this relation. Other variables may include the role of mother parenting as a protective buffer. Having a mother who is sensitive and does not parent harshly may protect against fathers harsh parenting (McKee et al., 2007). Furthermore, couple relationship qualities could be another variable that may impact father parenting. Also, research should take into consideration sex differences in father-child interactions as a variable. As found by other researchers, fathers tended to parent their sons in a more authoritarian style, than their daughters (Conrade et al., 2001). Lastly, future studies should include more racially diverse samples. The sample should have more diversity in their range of education and socioeconomic status.

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We Are Still Here: Expanding Empathy Through Humanization and Cultural Appropriation

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Abstract

Although empathy has been deemed an innate mechanism and is essential to multicultural interactions, research indicates that many factors inhibit a person's willingness to empathize with someone, such as how cognitively taxing it can be. This empathy avoidance trend may be more pronounced when targets are outgroup members depicted as suffering due to social disparities (Benally, Ochai, Ciappetta & Soto, 2020; Cho et al., 2019). This can create hostile environments for minorities trying to navigate society, such as Native Americans, who have historically suffered immense social injustices during the formation of America and continue to be negatively impacted by systematic inequalities. The present study uses the Empathy Selection Task (Cameron et al., 2019) to examine whether White students empathize better with visibly distressed Native American individuals when primed with a video intended to increase familiarity with/humanization of Native Americans or a video displaying implicit instances of cultural appropriation of Native American symbols. In the following study we demonstrate that both humanization of Native Americans *and* depictions of cultural appropriation increased empathy approach with Native American suffering, suggesting that people empathize more with Native American suffering after being reminded either about their common humanity or how this humanity has been stripped away (moral outrage).

Introduction

Empathy has many different definitions across the various subfields of psychology (e.g., neuroscience, cognition, development). Bohart & Stipek (2001) highlight the importance of distinguishing these many definitions in understanding the role it plays in evaluating moral contexts. Across these definitions, there are multiple behaviors (in animals and humans) that have been identified as markers of being empathetic (e.g., social mimicry, feelings of discomfort when watching another person suffer). Many of the mechanisms (e.g., mirror neurons) behind these behaviors have been deemed innate to humans and highly social animals like monkeys and dolphins (Gallese, 2005). Prior research suggests that these innate mechanisms can be actively ignored or avoided altogether based on present contextual factors and the empathizer's motivation to empathize with a target (Gray, Schein & Cameron, 2017; Brethel-Hauwitz et al. 2018). Examples of such motivational factors include, but are not limited to, the degree or type of perceived harm to the target (Gray, Schein & Cameron, 2017), social relationships with the target such as whether they represent ingroup/outgroup members (Brethel-Hauwitz et al. 2018), and the extent to which morality is considered at all (Haidt, 2001).

Even so, understanding the factors behind an individual's unwillingness or reluctance to empathize is, arguably, more important. In the current paper, we focus on a socially derived definition of empathy by de Waal (2008) that emphasizes the cognitive processes which enable individuals to perceive and understand another's emotions and can motivate individuals to act on these perceptions. De Waal's definition was also used by Brethel-Hauwitz et al. (2018) and demonstrated to be correlated with participants choosing more altruistic options towards strangers (i.e., likelihood to donate a kidney). This definition of empathy allows us to understand the extent to which the decision to empathize (empathy approach) reflects altruistic tendencies across differing contexts. For example, choosing to empathize with a marginalized outgroup member in a context that may highlight one's privilege may be very difficult and therefore signal greater altruism than choosing to empathize with an ingroup member. Our study manipulates the context in which a person is asked to empathize to demonstrate how present societal portrayals of Native Americans may affect the way others approach or avoid engaging in empathy with members of this group.

Empathy and Native Americans

Solidarity among groups was once a key to survival when discerning danger and it continues to be an active defense mechanism against modern dangers like cyberbullying (Mann, 2018). In multicultural societies (i.e., varying in race, socioeconomic status, ability etc.) like America, outgroup empathy is essential in sustaining positive cooperation and survival. This is especially salient in times of global dangers such as the coronavirus, racism, and human trafficking pandemics we are currently facing. With recent atrocities, such as the murder of George Floyd in May 2020, the lack of cohesion in our multicultural society, and subsequent lack of empathy, was put on full display as George Floyd's cries of "I can't breathe" were displayed for the world to see in a nine-and-a-half-minute video. Floyd's murder was the beginning of many systematic changes in areas ranging from politics (e.g., the passage of non-discriminatory bills) to professional sports (change of the Washington Football team's mascot). These hostile environments can be encouraged on a commercial level through the acceptance of such mascot stereotypes and encouraged by people around the world to promote similar stereotypes. Racist mascots like that of the former Washington football team were particularly mentioned by the American Psychological Association to contribute to hostile environments for minorities living in America (American Psychological Association, 2005).

Despite being America's original Peoples, Native Americans remain some of the most marginalized ethnic groups in society given the high rates of social disparities between these communities and other segments of society (Adakai et al., 2017). Although Native Americans make up around 2% of the population, up to 40% of Americans indicated that they are not aware Native Americans still exist (Shear et al., 2015). Moreover, the United States Constitution continues to label Native Americans as "Merciless Indian Savages." Such labels are not only dehumanizing in nature, but they often combine with inaccurate depictions of Native Americans in the mainstream (Washington Football team's Mascott, the r*dskins) to portray a skewed picture of modern Native Americans. In a 2017 Ted Talk, Houska (2017) explains the connection between these instances of dehumanization and how they continue to make it a lot easier for the Government to "run over" Native Americans' personal and political rights. As one example of this, consider the Dakota Access pipeline, which was built across Native American homelands despite strong opposition by the Native American community. Davis (2002) explained that

Americans lack ability to understand how such issues (e.g., racist mascots) relate to the ongoing societal marginalization of Native Americans, makes it difficult to understand the Native American struggle for sovereignty and other struggles affecting quality of life for this group.

In concluding her talk, Houska's with her listeners to "Stand with us [Native Americans], *empathize*, learn, grow, and change the conversation." Indeed, empathy has been identified as an important part of demonstrating moral behavior such as altruism to strangers (Brethel-Hauwitz et al., 2018). Nevertheless, the literature also indicates that humans tend to show a robust preference for avoiding empathy (Cameron et al., 2019), especially when targets are portrayed as suffering on a mass scale (Cameron & Payne, 2011). Therefore, the goal of the following study is to examine how humanizing rhetoric and depictions, as well as potentially dehumanizing depictions, such as cultural appropriations, may lead to differences in people's willingness to empathize with America's original people. More specifically, the following study is a direct answer to Houska's call by examining the willingness of White individuals to engage in empathy when faced with Native American suffering after viewing different portrayals of Native Americans.

Empathy Avoidance

Cameron et al. (2019) determined that the process of empathizing requires cognitive work, which people robustly prefer to avoid. Within Cameron and colleague's Empathy Selection Task (EST) participants are presented with a picture of a visibly distraught individual and asked to either describe the individual objectively (i.e., characteristics such as age or gender) or to empathize with them in a short sentence describing their feelings. Cameron and colleagues identified *empathy avoidance* as the consistent tendency among their participants to choose to describe individual targets depicted as suffering over empathizing with them. Thus, people might set personal limits on how much they want to empathize based on how hard they want to work. Other studies also demonstrate people's limitations in empathizing based on the number of individuals depicted as suffering. For example, Cameron & Payne (2011) demonstrated that people are more likely to feel efficacious when empathizing with a single suffering individual than they are with a suffering group of individuals (i.e., mass causalities form natural disasters). Since Cameron and colleague's original study, other studies have used modified versions of the EST to understand the boundary conditions of empathy avoidance using various social contexts (e.g., assessing empathy avoidance with African American individuals depicted as suffering from racial inequality; Cho et al., 2019). Studies have also examined the empathic response to Native Americans portrayed as suffering (Benally, Ochai, Ciappetta & Soto, 2020), which directly informs our approach in the current study. For example, consistent themes in each of the studies have indicated that White American participants are generally less likely to empathize with photos of distressed Black and Native Americans. In addition, the presence of social disparities information with the suffering individuals (e.g., "The person in the photograph is suffering. Native Americans die from alcoholism at a rate of 189% higher than any other racial group in America.") also predicted empathy avoidance more so than when no additional disparity information was presented (i.e., "the person in the photograph is suffering").

Aside from invisibility, Native Americans also face both implicit and explicit prejudice and discrimination from those Americans they do interact with (Harjo, 1992). Despite being America's original inhabitants, Native Americans continue to be considered outgroups to many Americans, both systematically and socially (Houska, 2017). Consequently, Native Americans were the last racial group to gain citizenship in 1924, and consistently

demonstrate more suffering than other Americans in social areas such as suicide, alcoholism, and pre-mature deaths (Centers for Disease Control and Prevention [CDC], 2007). What many people often fail to recognize is that many of the social disparities Native Americans face today may have their roots in the "legacy of chronic trauma and unresolved grief across generations" which scholars suggest was enacted upon them by the dominant European culture (Brave Heart & DeBruyn, 1998). Researchers have also connected behaviors such as heavy alcohol consumption (Chartier & Caetano, 2010) to historical losses of land, people, and culture (Whitbeck et al., 2004). These historical injustices and misrepresentation narratives in America's society might make empathizing with Native Americans an uphill battle in most cases. This is in addition to explicit discriminatory patterns in social interactions such as outgroup exclusion, which can identify members of said outgroups as homogenous and inferior (Tajfel, 1982). All in all, the combinations of obstacles such as general empathy avoidance tendencies can create a large disconnect between the majority of Americans and Native Americans. In response, the following study will attempt to manipulate the contextual factors under which Native Americans are presented (humanization vs cultural appropriation) to determine if these differing contexts increase or decrease people's willingness to empathize.

Other findings from Benally, Ochai, Ciappetta & Soto, (2020) suggest that prior training in empathizing (e.g., perspective-taking) may help mitigate empathy avoidance. The researchers suggested that these "empathy experts" may have increased efficacy in identifying with and or communicating with outgroup members (i.e., students from diverse backgrounds), explaining their decreased empathy avoidance as opposed to most other studies using the EST. Therefore, interventions that increase people's understanding of humanizing aspects of an outgroup may also increase their efficacy and thus their willingness to empathize. Findings from the literature would concur that empathy toward individual outgroup members can facilitate a greater willingness to accept the humanity of all members of that outgroup (Gubler, Halperin, & Hirschberger, 2015).

The Present Study

In order to evaluate the factors that influence empathy approach or avoidance toward Native Americans, the present study made use of a modified version of the EST used in Benally, Ochai, Ciappetta, & Soto's (2020). This modified version is modeled after the social disparities' context featured in their study, which presents Native American suffering as a result of social disparities currently facing Native American populations. The dependent variable was our participant's willingness to engage in empathy as determined by the number of times they chose to feel with the targets as opposed to describing them objectively throughout their trials (empathy choice). We measured our dependent variable based on the mean empathy choice exhibited by participants across the EST trials (percentage of trials participants chose to empathize over describe) across both conditions. Responses above the one-way analysis for variance suggested participants were more on the empathy approach side versus empathy avoidance.

Given the wide-ranging level of experience that majority populations have with Native Americans, and the fact that familiarity can increase empathy (Elfenbein, Beaupre, Levesque, & Hess, 2007; Ickes, 1997), we decided to use participant's experience with Native Americans as a covariate when examining the effects of our contexts. We hypothesized that our participants would demonstrate more empathy with targets when primed with a video that aims to humanize Native Americans relative to a video depicting cultural appropriation of Native American symbols and images.

Methods
Participants

Participants were a total of 140 White undergraduate students at Penn State (74 in our humanizing condition; 66 in our Cultural Appropriation condition). Participants were predominantly female (81%), all over the age of 18 (mean age = 19), and mostly freshman (72%). They completed the study for course credit. The majority of our participants also indicated they did not have any experience interacting with Native Americans, consistent with Shear et al.'s 2015 finding that roughly 40% of Americans are not aware Native Americans still exist. Although this American reality was reflected in our study, it was hard to generalize how participant's pre-experience with Native Americans could have shifted the results with only two participants indicating they had a great deal of experience with Native Americans.

Materials and Measures

Demographics and Native American Exposure. We collected the following demographic information as part of the completed survey: age, gender, religiosity, political orientation, ethnicity, and year in school. Finally, given prior research indicating that experience with Native Americans can influence empathy motivation towards this group (Benally, Ochai, Ciappetta, & Soto, 2020) we asked about participants' prior experience in interacting with Native Americans. The questions included: How much experience have you had interacting with Native Americans/American Indians? How interested would you be in learning about Native Americans/American Indian culture and history? How competent would you feel in having a conversation with a Native American/American Indians in the future? How familiar were you with the facts and statistics about Native American/American Indian experiences presented with the pictures? These questions were asked on a scale of 1to 3 (i.e., 1= not at all and 3= a great deal). Notably, 96 of our 140 participants (68%) indicated they had little to no experience with Native Americans, while 42 (30 %) said they had some experience with Native Americans. Only two indicated they had a lot of experience interacting with Native American individuals. On average our participants indicated a moderate political preference with an average political orientation rating of 3.83 on a 7-point scale (1=very conservative and 7=very liberal).

Humanization Condition Stimuli. In order to present Native Americans in a humanizing manner we chose the YouTube video: "Proud to be (Mascots)" for our humanizing condition. This 2-minute video educates viewers on Native American culture, by highlighting the names of specific Native American Tribes (e.g., Navajo, Arapaho, Blackfoot), their modern occupational titles (e.g., soldier, doctor, lawyer), famous Native Americans (e.g., Billy Mills and Bill Rodgers), and everyday roles that they play (e.g., mother, brother, sister). These various names, titles, and role are narrated by a Native American narrator with a serious tone, while coupled with clear pictures and videos of examples of Native Americans. The video ends with a black screen and narrator stating "the one name that Native Americans do not call themselves…" followed by a picture of a Washington r*dskin's logo on a football helmet. We expected this video to increase familiarity with Native American targets and thereby possibly increase then tendency to empathize with Native Americans. The video will be shown to participants before they complete the modified EST were asked a comprehension check question (e.g., Please name one of the Native American tribes mentioned in the video).

Cultural Appropriation Condition Stimuli. To present a less humanizing depiction of Native American culture, we chose a promotional video of the Washington r*dskins (and their mascot) demonstrating cultural appropriation of Native American imagery and symbols. The video we used is a two-minute rendition of the former Washington r*dskin's 'fight song' called Hail to the r*dskins. Throughout the video, images of fans dressed as Native Americans are portrayed, as well as highlights from the football team. Other brief images shown demonstrate spectators and the Washington team's band with traditional headdresses that are typically only worn for Native American ceremonial uses. A review of the current literature suggests that such instances can indirectly inflict pain to Native Americans, even when the agent is not aware the pain is being felt (Gray, Young & Waytz, 2012). Although Gray, Young & Watson's (2012) paper implies that intention is an integral part of perceived harm (i.e., a possible motivational factor for empathizing), Tara Houska (2017) illustrated how the lack of awareness for Native American issues in Americans is harmful to the existence of modern Native Americans (i.e., loss of culture, lack of acknowledgment of community issues). Therefore, introducing this instance of cultural appropriation could help trigger an empathic response from participants as they witness inaccurate portrayals in the video in addition to the real faces and statistics of the targets in our study. To ensure participants viewed the entire video, we included a comprehension check question asking what team the video was promoting at the end of the video.

Empathy Selection Task Modified (EST). The present study's design was modeled after the original empathy selection task developed by Dr. Daryl Cameron and Colleagues in 2017. People's strong preference to avoid empathy was originally observed using the Empathy Selection Task (EST), where participants were asked to respond to a series of photographs with target individuals' faces. The task's intent was to assess the participant's dichotomous selection to regulate their emotional experience by asking them to choose to either write a sentence objectively describing the target (describe) or to write a sentence feeling what the target is feeling (feel). For the present study, the stimuli and trial structure of the EST was modified as follows. Our study included all of the same pictures, which always depicted Native American individuals in distress with a short vignette indicating, "the person in the photograph is suffering." We used the previous study's 'social disparities' condition, which included information on social disparities faced by Native American communities following the vignette. We used this condition because participants demonstrated the greatest relative empathy avoidance in this condition. Participants were asked to complete 20 trials of our Empathy selection task after viewing the video outlined by their condition.

Additional Measures. Our survey incorporated additional measures that were not used in the current study. Participants completed the Interpersonal Reactivity Index (IRI) which comprised of personal distress (PD) and Empathic Concern Scale (subscale of the interpersonal Reactivity Index) which measures participants' feelings of warmth, compassion, concern for others (Davis, 1980) and the Identification with All Humanity Scale (IWAH).

Procedures

Our study used a between-studies online survey design. Approximately half of our participants watched the "proud to be" video (humanizing Native Americans) before completing the modified EST described above, and the other half watched the cultural appropriation video depicting the Washington redsk*ns and their mascot.

Participants first read and agreed to the consent form by indicating they were above the age of 18 and wished to participate in the study. Participants were then assigned to one of the two conditions to watch either the humanization video or the cultural appropriation video prior to beginning the EST task. Participants answered a brief comprehension check question on the video's contents and then completed the modified EST. Following the EST, participants filled out the demographic section, and additional questions not relevant to the purpose of the present study and therefore not discussed further (NASA task load index, empathic concern scale, identification with all-humanity scale).

Data Analytic Approach

Our primary dependent variable was the overall mean empathy choice exhibited by participants across the EST trials (percentage of trials participants chose to empathize over describe) across our two conditions (humanization and cultural appropriation). We used a one-way Analysis of Variance (ANOVA) to test the differences between conditions while controlling for exposure to Native American culture. We also tested whether the mean empathy choice score for each condition was significantly different from .50 using a one-sample t-test to see if there was evidence of empathy avoidance in each condition, regardless of the differences between conditions.

Results
Preliminary Results

The final sample size of 140 included only those participants who provided a correct response to our attention check question after the corresponding video for each condition was watched. Of the 140 participants included in the final analyses, 30.7% of them had previously completed a similar EST task, but findings did not differ by previous experience with the task, so all participants were retained in the final analysis. Overall, the results indicated that people tended to choose to empathize with the targets more than they chose to describe the targets objectively, with 72.9% in the cultural appropriation condition ($SE = 0.1$) and 54.9% in our humanizing condition ($SE = 0.03$). A one-sample t-test revealed that both the humanizing condition, $t(73) = 2.64$, $p = .01$, and the cultural appropriation condition, $t(65) = 4.58$, $p < .01$, was significantly different from .50 indicating a significant empathy *approach* across both conditions.

Primary Analyses

The results of a one-way ANOVA comparing our humanization and cultural appropriation video prime conditions, while also controlling for our participant's prior experience in interacting with Native Americans revealed a significant main of condition, $F(1, 135) = 3.86$, $p = .05$, indicating that the conditions were significantly different from each other. This hypothesis was in the opposite direction of our expected results such that the cultural appropriation condition yielded a significantly more empathy approach than the humanizing condition, although both conditions demonstrated empathy approach. Interestingly, both of our conditions were higher on empathy approach for the social disparity condition in the previous study (46%).

Discussion

The goal of the present study was to demonstrate how humanizing rhetoric such as a video describing the many names Native Americans identify with, as well as a cultural appropriation video, might impact people's willingness to engage in pro-social behavior (empathy) with outgroup members. We hypothesized the humanizing condition would generate a greater empathy approach and our cultural appropriation condition would lead to less empathy avoidance. Although we saw more empathy approach with the humanizing condition, we surprisingly saw an even greater empathic response with our cultural appropriation condition. Both conditions were significantly different from the 50% choice level expected if participants were choosing to either describe or feel randomly throughout the EST.

Humanizing Condition

Our humanization condition was marked by the "Proud to Be" video, which was part of the 2013 Change the Mascot Movement launched by the Oneida Nation to chance the NFL's Washington football team mascot. Results within this condition were statistically significant and demonstrated some empathy approach, although not more than our cultural appropriation condition as was expected. Upon further evaluation of our stimuli, our video may have overplayed the resilience, strength and other positive descriptions of Native Americans, which may not have been consistent with the statistics we presented. With the video's breadth of images, video clips, narrated titles and names, it is hard to determine what stood out most to participants or what they thought of Native Americans generally after watching. Still, evaluating participant's subjective responses overall might provide further insight into their thoughts about the study as a whole.

Another fact to consider when evaluating these results was that Washington football team did away with their r*dskin mascot in July 2020, a month after this study began. By the time the participants had completed our study, the name had been changed for approximately 5 months and participants may have been well aware of this movement. With the central theme of the video being changing the mascot, participants may have considered the message outdated or taken care of considering how long the name had been changed. Therefore, although the majority of our participants answered empathetically, their responses may have been more empathetic had the topic not been on the forefront of pop media. On the contrary, the lack of societal awareness on this issue could have had the opposite effect like the results of Benally, Ochai, Ciappetta & Soto, (2020). Additionally, since the change of the name, many individuals and organizations such as the Native American Guardians Alliance have spoken out in opposition of the name change and worked to preserve Native American heritage, including 'historical' mascots. Therefore, any participants who share this view might have response less empathetically.

Cultural Appropriation Condition

Much like the Humanizing condition, our Cultural Appropriation condition was marked by its unwarranted displays of the appropriation of Native American culture by the Washington football team and non-native individuals associated with the organization (i.e., wearing headdresses, utilizing ceremonial objects, the 'hail to the r*dskins theme song). Surprisingly, the participants within this condition responded more empathically than our humanizing condition as well as all of the conditions in Benally, Ochai, Ciappetta & Soto, (2020).

Unlike the humanizing "Proud to Be" video, the "hail to the r*dskins" does not openly demean the former Washington football team mascot. Consequently, the open endorsement of the former mascot may have triggered participants to take an altruistic (i.e., empathic) stance when answering the EST. Again, the historical change to the Washington mascot in July of 2020 may have played a role in this condition as well considering this study began in May 2020. Aside from the social aspects of the name change, organizations like the National Congress on American Indians, note that calling a Native American person a r*dskin in person could constitute charges at the school and federal level ranging from bullying to hate crimes (i.e., provided the name "r*dskin" is graffitied on a Native American's property). For similar reasons, the American Psychological Association deemed such mascots as aids in creating a hostile environment for minorities in 2005, six years before the video was made (American Psychological Association, 2005).

We estimate that such historical changes and societal focus on racial issues (e.g., Instagram's Black out Tuesday to stand with the Black Lives Matter movement June 2, 2020) might have been prevalent in the minds of participants who took our survey. Our White participants could have felt particularly obligated to answer empathically considering such changes and potential feelings of "White guilt" (Swim & Miller, 1999) in reaction to both the video prime and our stimuli. According to Swim & Miller, this "white guilt" could have triggered participants to react in the most protective or altruistic way (i.e., choosing to empathize). As mentioned, we did collect subjective information on how our participants felt about the study overall but did not include such information in our final analyses. Additionally, Penn State saw its first student organizations to support Native American students (i.e., the Indigenous Peoples Student Organization and the American Indian Society for Science and Engineering) in the Spring of 2020 (Baker, 2020). According to the Indigenous People Student Organization Advisor Tracy Peterson, the organization has not only helped bring acknowledgement to students here at the university, but the land the university was built on," which is something our participants could have been aware of. This awareness could have also triggered an ally response if any of the participants learned of Native American issues on the University level, as well as the National level.

Limitations and Future Directions

One of our most important limitations within this study was the limited and homogeneous nature of our participants, who were all White, Penn State students who were 81% female. With the majority of our participants being freshman students in psychology, our study reflected a small subset of not only White people, but Penn State students as well. To generate a more inclusive sample, we would have to go beyond psychology subject pools and expand to more than college-aged individuals, which we predict might decrease empathy approach. A more diverse sample with older individuals might also reflect the lack of awareness of social issues considering how the majority of social media users are ages 18-29 (Pew Research Center, 2019). Additionally, our sample may have had other demographic factors such as sex differences in empathy, where self-identifying females tend to demonstrate more empathy behaviors than self-identifying males as young as two years old (Hoffman & Levine, 1976). Also, college-aged students may have more plasticity in their willingness to empathize (Grühn et al., 2008). Consequently, future studies should aim to collect data from a larger audience with greater diversity in age, ethnicity and location.

Given the geographic location of this study (i.e., Pennsylvania, which contains no tribal lands), our participants presumably largely lacked in experience interacting with Native Americans. Therefore, future studies could seek White participants closer in proximity to Native American tribes (e.g., border towns near Native American reservations) to develop a fuller picture of outgroup empathy towards Native Americans. Therefore, future studies performed with White individuals at schools located on or nearer Native American reservations or populations could provide a sense of how proximity to Native American culture might influence motivation to empathize.

Another area that may have affected our results was our inability to equate the responses between conditions. Although our main EST and demographic questions were the same, we did not include any pilot tests to determine how our participants reacted to our video prime nor if they actually created the desired humanization or cultural appropriative effects. In fact, one of the original intents of selecting the cultural appropriation video was to present a video that we thought was once societally accepted (i.e., shown in commercials or at Washington football games) we assumed our participants might not immediately recognized as cultural appropriation (i.e., not seeing a problem with the video's elements nor connecting them to the EST's social disparities). Any failed recognition of this cultural appropriation according to Tara Houska is just as harmful to modern Native Americans and the problems they face. As mentioned before, adding pilot studies or questions referring specifically to participant's reactions to the video in future studies could help gage how the stimuli is received. Better understanding how the initial video prime is received could help generate how participants connect instances of cultural appropriation to the current struggles Native Americans face in society.

Lastly, our study did not have an accurate control condition to compare with the results of each individual condition. We did not have a no-video condition like the Benally, Ochai, Ciappetta & Soto, (2020) study, which allowed them to demonstrate relative empathy avoidance between their conditions. Any future study would benefit from such a control condition or by incorporating the original disparity statistics from the Benally, Ochai, Ciappetta & Soto, (2020) study. Additionally, any future studies of similar nature should ask participants about their awareness regarding the Washington team name change and their subjective thoughts about it.

Conclusion

Research on effective humanization strategies and empathy efficacy is becoming increasingly crucial in multicultural societies like the United States. Such studies demonstrate the importance of rhetoric in mainstream media, which is especially important to modern Native Americans who often suffer disproportionately compared to other Americans and continue to suffer in silence (i.e., 87% of American history books only indicate Native Americans as existing before the 1900s). The solutions to these modern problems are difficult to be fully addressed without acknowledgement of the historical wounds of Native Americans and empathy as they continue to heal. Studies like ours provide insight into potential obstacles that non-native members of society may have in empathizing with historical and present instances of Native American suffering. Without empathy, Native Americans will continue to see a decline in population and culture as tragedies like Covid-19 continue to devastate already disadvantaged communities.

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The Relationship Between Community Violence and Risky Drug Behavior

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Abstract

The purpose of this study is to explore how variations in a child's environment may moderate the relation between community violence and risky behaviors. As an initial test, the study explores the relation between rural, suburban, and urban communities and drug use at two selection points, 6th and 10th grade. The data indicate that while there are variations in drug use patterns across locations, conditioned by sex and age, in 6th grade, many of these differences disappear 4 years later. However, at both time points, the presence of heavy drug use is limited to a minority of participants, skewing patterns. Follow up work will incorporate variation in community violence into the analyses to see if we can further refine these relations.

The Relationship between Community Violence Across Communities and Risky Behaviors

Recent studies have shown that community violence can have a detrimental impact on children's development, causing increases in both internalizing and externalizing behaviors (Sullivan et al. 2007). Children can respond to experiences of community violence in various ways. Researchers have found main effects as a consequence of community violence such as aggression, PTSD and other psychiatric diagnosis. Community violence, as a term, has room for different interpretations regarding the subjective meaning from the point of view of individuals experiencing potentially negative events. The idea of community violence can have a wide range from homicide, murder, and rape, to robbery or theft.

This study is executed to build on the literature by assessing the connection between community violence in urban, suburban, and rural neighborhoods and patterns of externalizing risk behaviors in children. Although risky behaviors can encompass a wide range of behaviors, this research will focus on drug use, specifically the frequency and the variety of use reported by children. In doing so, this study will leverage the Pennsylvania Youth Survey (PAYS), which surveys children in schools across Pennsylvania every two years on a host of issues that impact the risk for, and emergence of, a number of risky behaviors.

Literature Review

Researchers have aimed to answer the question on how community violence can be detrimental on children's development many times and have received mixed responses. For instance, Lynch and Ciccetti (1998) studied children who experienced maltreatment and investigated subsequent adaptive behaviors. They found no significant increase in externalizing behaviors when community violence was defined as neglect and victimization in the community. In contrast, other researchers have found that community violence can lead to externalizing behaviors such as aggression and drug use. (Farrell and Sullivan 2004). Farrell and Sullivan (2007) studied four middle schools in separate rural counties and found that as all violence increased so did the aggression, especially in the boys. Others, in contrast, concluded that community violence affects internalized behaviors more, given links with post-traumatic stress disorder (PTSD) or depression (Lynch 2003). Overall, there is a big overlap between both externalizing and internalizing behaviors resulting from community violence. McGee and Baker (2003) highlight a study that surveyed approximately 300 African American adolescents and found elevated externalizing and internalizing behaviors as a result of living and experiencing a high level of community violence. Research has also shown that children experiencing a traumatic event before the age of 11 are more likely to experience psychopathology, such as post-traumatic stress disorder (PTSD; McGee and Baker 2003). While a lot has been learned concerning the effects of community violence on developmental outcomes, there is still a door open for more research.

There is a strong need for understanding how community characteristics, in this case, urban, rural and suburban, can have an effect on the impact community violence has on the presence and emergence of risky behaviors. With the escalation of violence including gangs and weapons in urban areas, it is beneficial to know how to intervene. Although typically more rural areas do not experience as much community violence the research is needed to explain the crucial effects it can have on individuals. Learning more about the causes and effects of community violence on diverse individuals in different types of communities will allow us to compare to the general population, with the goal of identifying effective interventions and therapies if needed. Furthermore, knowing the specific implications of geographic area on development will allow professionals to be able to have background knowledge to help access active developmental mechanisms. There is a strong need for this research to better focus on helping the upcoming generations, so they do not experience negative effects from early exposure, or subsequent risky behaviors.

Community Violence

The definition of community violence varies. It can range from something as tragic as homicide to something as minor as fighting. Individuals are impacted by community violence in different ways, which can in turn impact their development across a number of different trajectories. Some children may not experience any emotional effect from experiencing community violence while others can display internalizing and externalizing behaviors. In some communities witnessing or experiencing of violence cannot be avoided.

While community violence is more common in more populated areas of the state, it is still common in more rural areas. Farrell and Bruce (1997) found "In a representative study, 31% of urban 6th grade boys and 14% of girls had had someone threaten to kill them; 42% of boys and 30% of girls had seen someone shot; and nearly all had seen others beaten up, had witnessed arrests, or had heard gun fire, with frequencies ranging from 87 to 96%." (Youngstrom et al., 2003). Philadelphia, an urban city in Pennsylvania, reports 63,597

annual crimes while Centre County, which is rural, averages 725 crimes annually (NeighborhoodScout). Previous data suggest that small rural areas do not demonstrate as much community violence as large urban areas, but you do not find the absence of violence.

Drug Use

The current study will focus on drug use as a potential outcome of exposure to, or experience of, community violence. Within the last few years, the frequency of drug use has increased in the United States. Drug abuse is a problem that people of all ages have, and often first emerges in adolescents. Individuals use drugs as a coping mechanism for a number of social and emotional concerns. This research will focus on drug use as a potential effect of increases in community violence. Drugs can be sorted into seven distinct categories: depressants, stimulants, hallucinogens, dissociative anesthetics, inhalants, cannabis and narcotic analgesics (International Association of Chiefs of Police). In these various categories there are specific drugs such as alcohol, methamphetamine, crack, tobacco, cocaine, heroin and nicotine. Minor drug use can be expected from individuals depending on the environment and peers (Ramirez, 2012).

Adolescents frequently abuse tobacco and alcohol (DrugRehab.com). In the past few years vaping (nicotine) has also increased in frequency. The type of drugs that are available can vary in different communities. The National Drug Intelligence Center reports that Pennsylvania sees high levels of transit of drugs. Furthermore, Philadelphia has the highest transportation of legal and illicit drugs within its boundaries. In Reading, a more rural area of the state reports that the most common drug used is marijuana with smaller amounts of cocaine and heroin (National Drug Intelligence Center 2001). In today's society it is easy for teens to find marijuana, but it might be harder to find methamphetamine. Thus, the category of drug use may strongly impact the eventual developmental outcomes from adolescents. Certain drugs may be more addictive than others leading to different effects for broad patterns of development. This knowledge may help us with the understanding why individuals gravitate toward discrete patterns of drug use behaviors.

County Demographics

The classification of a county as rural, urban or suburban is based on population size. Pennsylvania is a state that is majority rural with a few urban spots, such as Philadelphia or Pittsburgh. The demographics of an urban neighborhood is classified by a city with a population of over 50,000, such as Allegheny county and Dauphin county. Furthermore, in a rural area the demographics are usually marked by populations with less than 50,000 individuals, such as Centre country and Cambria county. In between those two extremes are suburban areas. While these areas can have high populations, they tend not to be as developed as the urban area. Urban areas tend to have a main city and skyscrapers while the suburban is the area around the city which tends to be more residential.

Different counties are important to examine because they might have contrasting outcomes, both due to the everyday experiences of children and the general availability of drugs of abuse. Urban places have high populations which results in high violence, but even smaller populated places have violence. Thus, more populated places might have worse violence but it is possible that these individuals are immune to it so they do not have as many externalizing and internalizing results.

Adolescence

The term *adolescent* is typically used for the developmental window marked by the onset of puberty. The National Center for Biotechnology Information notes that this window includes the ages of 10 and 19 years old. During these years these kids go through many physiologically, socially and emotionally changes. Physiological changes include changes in the hypothalamus pituitary-adrenal axis that shows increased activity, leading to changes in both stress reactivity and basal activity (Gunnar et al., 2009). At the same time, adolescents are typically shifting schools going from middle to high school and friend groups are changing and simply growing as a person. The many changes in the age window may increase the impact of the environment and any negative effects. Finally, adolescence is marked by increases in both psychopathology (Costello et al., 2011) and drug use choosing this age range will allow my team and I to determine if violence can alter development. As an initial test of the relations noted here, I examined the relations between geographic location and drug use across six counties, chosen to represent urban, suburban, and rural areas. Child sex and race was also used to examine variation in patterns of interest. Future work will incorporate more targeted measures of community violence.

Methods

Participants

Pennsylvania Youth Survey (PAYS) is a survey sent out every two years to the students in the 6th, 8th, 10th and 12th grades in Pennsylvania. The participants in the current study are from the 2015 and 2019, using the 6th and 10th grade survey results. Although we cannot match individual children across the two time points, this approach allows us to examine patterns of change within the same cohort of children. The survey is optional but most schools across the state do participate in the survey. Other data used is from City-Data (http://www.city data.com), a website that takes data from government and private sources

Procedure

Participants were asked to complete the survey after receiving consent from their guardian at home. The survey is anonymous, voluntary, and confidential. The survey includes numerous questions that range from the topics of experiences, knowledge, attitudes and behaviors. The survey was given out in the classroom setting. Once completed the school sends them back to the administrators of the survey.

Measures

As an initial test of our research questions, I focused on six counties chosen to represent urban (Alleghany, Philadelphia), suburban (Delaware, Chester), and rural (Centre, Cambria) regions of the state. Within each county we also focused on race and lifetime drug use as our main measures of interest.

6ᵗʰ Grade

County. Children were selected for the analyses based on geographic location. As expected, there was an uneven distribution of respondents across Urban (N=342), Suburban (N=6,646), and Rural (N=1,964) counties.

Sex. Children were asked to report their sex as either male (N=4,399) or female (N=4,260).

Race. Children were asked to report their race across five categories. Based on my initial hypotheses, and the need to simplify the analyses, I focused on the two largest groups completing the survey, white (N=5,309) or African American (N=1,648).

Drug Use. Students (N=8,886) reported if they used substances on "0 Occasions", "1-2 Occasions", "3-5 Occasions", "6-9 Occasions", "10-19 Occasions", "20-39 Occasions", "40+ Occasions". The noted substances were Beer wine, or hard liquor, marijuana, sniffed or huffed substances, cocaine, crack, heroin, hallucinogens, methamphetamine, Ecstasy, metconazole, steroids, prescription pain relievers, tranquilizers, prescription stimulants, synthetic drugs, and over-the-counter medication. I created a composite score of drug use by averaging across the questions, with higher scores reflecting greater drug use. Scores ranged from 0 to 5.92, with a mean score of 0.03 (SD=0.13). This reflects the very low, and skewed, level of drug use in this cohort. As a result, I created two groups designating children who had never used any of the noted substances (N=7,104) versus children who had ever used any substance (N=1,782).

10ᵗʰ Grade

County. Children were selected for the analyses based on geographic location. As expected, there was an uneven distribution of respondents across Urban (N=2,137), Suburban (N=8,199), and Rural (N=1,665) counties.

Sex. Children were asked to report their sex as either male (N=6,024) or female (N=5,690).

Race. Children were asked to report their race across five categories. Based on my initial hypotheses, and the need to simplify the analyses, I focused on the two largest groups completing the survey, white (N=8,494) or African American (N=1,918).

Drug Use. Students (N=11,829) reported if they used substances on "0 Occasions", "1-2 Occasions", "3-5 Occasions", "6-9 Occasions", "10-19 Occasions", "20-39 Occasions", "40+ Occasions". The noted substances were Beer, wine, or hard liquor, marijuana, sniffed or huffed substances, cocaine, crack, heroin, hallucinogens, methamphetamine, Ecstasy, metconazole, steroids, prescription pain relievers, tranquilizers, prescription stimulants, synthetic drugs, and over-the-counter medication. I created a composite score of drug use by averaging across the questions, with higher scores reflecting greater drug use. Scores ranged from 0 to 6.00, with a mean score of 0.16 (SD=0.30). While levels of drug use had increased over the course of four years, the distribution was highly skewed. Again, I created two groups designating children who had never used any of the noted substances (N=5,394) versus children who had ever used any substance (N=6,435).

As such, while now the majority of students reported having used these substances, only a small minority were heavy drug users.

Results

Our first step examined the descriptive statistics for the student populations at each grade. This allowed us to characterize patterns of drug use across the urban to rural shift in our data. We then examined variations in drug use across counties overall, and then as a function of either sex or race. Chi-square analyses were used for the categorical drug use variable, when compared to race and location. A paired t-test was used to compare drug use category and gender. We then completed a univariate ANOVA to assess the interaction between geographic location, race, and sex to predict the continuous drug use score. The ANOVA was structured as a 3 (County) X 2 (Race) X 2 (Sex) analysis with the continuous score as the dependent variable.

6th Grade—2015 Cohort

As can be noted in Table 1, the majority of data were provided by Suburban students. In addition, as expected the Urban students were more diverse than the other locations, reflecting typical geographic distribution of minoritized populations. Finally, the large majority of students (> 79.6%) reported that they have never used any of the listed substances as 6th graders. We then examined if these patterns varied significantly across our measures of interest.

First, for the categorical drug use variable, we found a significant distribution of drug use endorsement across the county categories, $\chi^2(2) = 7.01$, $p = 0.03$. Although likely driven by the imbalance in the number of participants across locations, there is also the indication that drug use endorsement levels are higher in the Urban counties versus the other two locations. We then completed separate chi-squares per county comparing lifetime drug use and race. The distributions were not significant for the Urban, $\chi^2(1) = 0.05$, $p = 0.82$, and Rural, $\chi^2(1) = 0.52$, $p = 0.47$, students. However, for the Suburban students there was a trend such that fewer African American students were less likely to report less drug use (16.1%) than white students (18.5%), $\chi^2(1) = 3.23$, $p = 0.07$. A similar analysis with sex, found trends in Urban, $\chi^2(1) = 3.04$, $p = 0.08$, and Suburban, $\chi^2(1) = 24.12$, $p = 0.001$, counties for greater drug use among males. There was no difference in Rural counties, $\chi^2(1) = 0.07$, $p = 0.79$.

Second, the univariate ANOVA (Figure 1) found significant main effects for county, $F(2,5887) = 9.71$, $p < 0.001$, and race, $F(1,5887) = 7.46$, $p = 0.006$. In addition, there was a significant county by race interaction, $F(2,5887) = 7.63$, $p < 0.001$. Again, this reflects the uneven distribution of drug use across groups with very low levels of use, and a few children reporting high levels. This can be seen in the large error bars.

Table 1. Distribution of race, sex, and lifetime history of drug use (Yes/No) for the students assessed in grade 6 in 2015.

	Race		Sex		Lifetime Drug Use	
	African American	**White**	**Male**	**Female**	**Yes**	**No**
Urban	156 (55.1%)	127 (44.9%)	150 (45.0%)	183 (55.0%)	83 (24.8%)	252 (75.2%)
Suburban	1372 (27.0%)	37142 73.0%	3319 (51.5%)	3120 (48.5%)	1347 (20.4%)	5254 (79.6%)
Rural	120 (7.6%)	1468 (92.4%)	930 (49.3%)	957 (50.7%)	352 (18.1%)	1598 (81.9%)

Figure 1. Distribution of drug use score as a function of race, sex, and geographic location in grade 6.
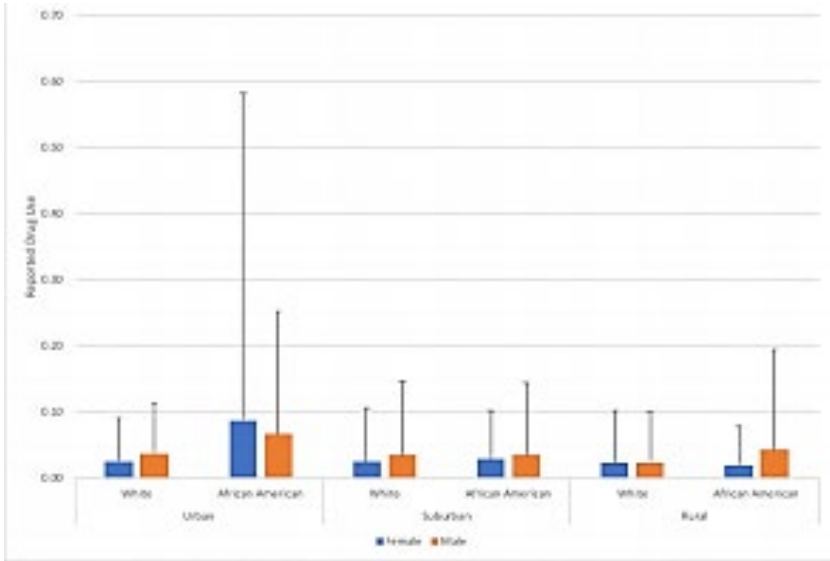
10th Grade—2019 Cohort

As can be noted in Table 2, the majority of data were again provided by Suburban students. Interestingly, there was a marked increase in the number of students from Urban counties, who were overwhelmingly white. Further examination suggests that this resulted from a large increase in Alleghany county. As such, the Urban and Suburban distribution by race was near parity. Finally, there was a shift over the course of the four years in testing, such that just over half of the students, across all counties, reported lifetime drug use as 10th graders. We examined if these patterns varied significantly across our measures of interest.

First, for the categorical drug use variable, we found no significant difference in the distribution of drug use endorsement across the county categories, $\chi^2(2) = 1.02$, $p = 0.60$. It appears that drug use levels have normalized over time. We then completed separate chi-squares per county comparing lifetime drug use and race. The distributions were not significant for the Urban, $\chi^2(1) = 1.45$, $p = 0.23$, and Rural, $\chi^2(1) = 1.19$, $p = 0.28$, students. However, for the Suburban students there was again a significant relation, such that fewer African American students were less likely to report less drug use (48.7%) than white students (58.2%), $\chi^2(1) = 35.02$, $p = 0.001$. A similar analysis with sex, found a trend in Urban, $\chi^2(1) = 2.02$, $p = 0.16$, and significant in Suburban, $\chi^2(1) = 5.68$, $p = 0.02$, and Rural, $\chi^2(1) = 5.34$, $p = 0.02$, counties for greater drug use among males.

Second, the univariate ANOVA (Figure 2) found no significant main effects for county, $F(2,8992) = 0.27$, $p = 0.77$, and race, $F(1,8992) = 0.43$, $p = 0.51$. In addition, there was no significant county by race interaction, $F(2,5887) = 1.02$, $p = 0.36$. Again, this may reflect the fact that drug use has increased and become normalized as students' progress in high school. Yet, it is still rare to see heavy drug use, as noted by the rather large error bars.

Table 2. Distribution of race, sex, and lifetime history of drug use (Yes/No) for the students assessed in grade 10 in 2019.

	Race		Sex		Lifetime Drug Use	
	African American	White	Male	Female	Yes	No
Urban	350 (17.9%)	1600 (82.1%)	1195 (56.8%)	908 (43.2%)	1157 (55.1%)	942 (44.9%)
Suburban	1475 (21.5%)	5395 (78.5%)	3995 (50.1%)	3981 (49.9%)	4374 (54.1%)	3713 (45.9%)
Rural	93 (5.8%)	1499 (94.2%)	834 (51.0%)	801 (49.0%)	904 (55.0%)	739 (45.0%)

Figure 2. Distribution of drug use score as a function of race, sex, and geographic location in Grade 10.
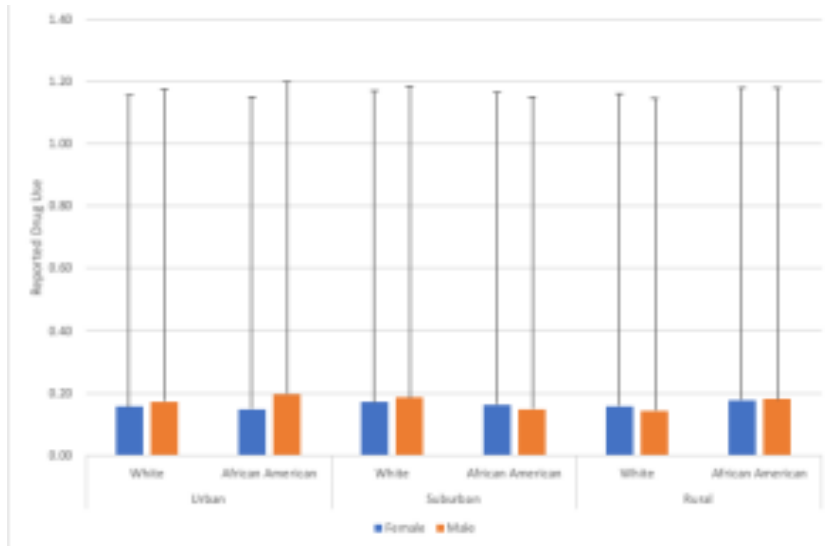
Discussion

This study builds on previous research examining the impact of community violence on adolescents to examine the effect patterns of having internalizing and externalizing behaviors. The specific externalizing behavior examined in this research was drug use. Based on overall statistics, the degree of the violence that these individuals likely experience varies with their geographic location. Generally, urban counties had a higher crime index, followed by suburban and rural counties, which had the lowest crime index in the years of 2015 and 2019. For instance, in 2015 urban areas averaged 27,030 crimes, followed by suburban areas averaging 3,178 crimes, and then rural areas at 874 (Open Data URC – Crimes) Across the cohorts there was a marked increase in drug use. However, only a small fraction of adolescents were heavy drug users. Future research will more directly highlight the change of adolescent drug use with a relation to community violence.

The findings from this research suggest there is an increase in drug use with age. Specifically, the urban areas rose from 24.8% to 55.1% of the participants acknowledging their drugs (Table 1,2). Furthermore, in the suburban areas there was also an increase jumping from 20.4% to 54.1% (Table 1,2). In the previous data, we notice that the rural counties had the biggest increase in drug use. In 2015 for rural areas only 18.1% of the participants reported using drugs while in 2019, drug use jumped up to 55%, more than half of the participants (Table 1,2). Furthermore, in the urban areas there was also an increase in drug use. In parallel, the data suggest shifts in crime in the same regions over this four-year window. In 2015, the 6 selected counties (Alleghany, Philadelphia, Delaware, Chester, Centre and Cambria) had lower crime rates recorded than in the year of 2019. In 2015, the cohorts of urban areas averaged 27,030 crimes annually (Open Data URC – Crimes). However, 2019 statistics show an increase to an average of 37,300 crimes (NeighborhoodScout).

These findings could potentially pair the increase of the drug use in urban areas with the increase in community violence. It is also important to note, however, that one may expect normative increases in drug use between 6th and 10th grades, as children shift from upper elementary/middle school into high school.

Thus, a limitation to the research may be a confounding variable of age that played a part in the increase of drug use. Typically, six graders are not engaging in drug use, but may expect that by tenth grade adolescents tend to start exploring and being influenced by peers' decisions (Steinburg & Monahan, 2007). Moving forward with research on the effect of community violence on externalizing behaviors, especially drug use, we need to research counties at different age points across the same year. In the hope that the different counties will experience different variance of crimes will show a more direct link between the two variables of interest. Therefore, this is a threat to the internal and external validity of the current study.

The results of this study should be interpreted carefully due to several limitations. The main variable of drug use was captured by self-report data and we could see maturation threats in which the participants either under or overestimate their drug use. However, Sullivan et al. (2007) suggest, "studies have revealed that adolescents are typically truthful when completing self-report measures of risk-taking behaviors such as drug use and aggression (e.g., Oetting & Beauvais, 1990). Furthermore, the data could lack reliability in the aspect that students could have moved in and out of the counties which could expose them to other community violence than what the community-level data suggest. We need to acknowledge the limitations so that moving forward in this research topic we know how to administer the research in the future. As we continue to research the impact of community violence on the development of externalizing and internalizing behaviors, we will expand and refine our targets measures of interest. The complex relation of these variables emphasizes the need for further research using stricter designs to identify the exact relation between community violence and externalizing behavior such as drug use.

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Relations between Maternal Stress and Attention to Emotion in Infancy

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Abstract

The purpose of this study is to examine the connection between infant attention to emotional faces and maternal stress associated with environmental factors. As an initial test, the study explores maternal stress with self-reported characteristics of their environment. We examined infants' emotional attention to angry, happy, and neutral faces captured via eye tracking at 4-, 8-, 12-, and 18- months. The data indicate that there were no significant effects independently due to emotion or stress at the younger ages of 4 or 8 months. However, by 12 months, infants with high stress mothers spent more time looking at the faces, across emotions. In addition, across the sample, infants spent less time looking at neutral faces, relative to happy and angry faces. At 18 months, infants looked the most at angry faces, versus happy and neutral. Over time, there is more attention specifically to angry faces. Follow up work will need to examine infants at a larger scale and across more trajectories to refine the potential relation between maternal stress and attention to emotion in infancy.

Introduction

Researchers have examined both typical trajectories, and individual differences, for recognizing and interpreting both threatening and non-threatening faces in the first years of life. Both humans and non-human animals use facial emotion to interpret their surroundings to determine if it is or is not harmful (Nystrom & Ashmore, 2008). Interpreting faces tends to emerge at an early age in humans. For example, infants as young as 6 six weeks begin to recognize and distinguish faces. Furthermore, around 6 months typically developing infants can start to recognize different emotions on faces (Charlesworth & Kreutzer, 1973; Grossmann, 2010). Infants learn from their surrounding environment, which is typically shaped by their parents beginning in the first year of life, happening in tandem with the development of facial emotions processing. This developmental window from birth to approximately 24 months can be sensitive to multiple factors, including parental emotions, health, and stress. The impact is particularly acute with respect to the influence of maternal characteristics and behaviors on infants. Early motherhood can be a stressful time and this stress can produce a spillover effect on the child. For example, the stress can overflow to the child in forms of anger or neglect (Williamson et al., 2013). The spillover may result in the infant processing emotional faces differently and paying more or less attention to threatening facial expressions.

Maternal stress can originate from multiple sources, including environmental stress. It is important to research the effect of maternal stress from environmental factors and how it can influence infant emotional facial attention and recognition. With better research in this domain, interventions can be put into place to benefit the mother and child. Stress is a mental or emotional tension resulting from adverse circumstances. Environmental factors such as socioeconomic status (SES), crime, discriminatory treatment due to race can have an effect on individuals in many ways. The pervasive impact of stress, in turn, may result in both physical and mental health issues for individuals (Yaribeygi et al., 2017). Conduits for the environment can be captured by characterizing the neighborhood. Neighborhoods can influence individuals functioning and development in both positive and negative ways. The various environmental factors of the neighborhood can lead to stress across individuals. Here, we focus on the specific impact on mothers and potential spillover on infant attention.

Environmental stressors experienced by pregnant women can place an added stress on the fetus resulting in, but not limited, to miscarriages, premature births, and low birth weight (Knackstedt et al., 2005). Postnatally, maternal stress also influences infant development across multiple domains. Studies have shown that mothers who report they have high stress from being mothers due to lack of social support, parenting competence, and depression also report that children rate lower on dimensions of mastery motivation (Sparks et al., 2012). Maternal traumatic experiences in pregnancy may impact their offspring's temperament, especially negative affectivity **(**Rodríguez-Soto et al., under review). At one extreme, Post-Traumatic Stress Disorder (PTSD) can arise when an individual is exposed to an extreme stressor or traumatic event (Yehuda, 2002). For example, Yehuda et al. (2005) found that mothers and babies who were exposed to elevated stress after the 9/11 attacks on the World Trade Center had lower cortisol levels. Cortisol is a hormone that is responsible for threat and fight or flight (Terburg et al., 2009), suggesting that these mother-child pairs had lower levels of arousal to threat.

Increased stress is also associated with substance use in pregnancy. Infants who were prenatally exposed to substances had worse birth outcomes followed by increases in both internalizing and externalizing behaviors by the age of 5 (Lin et al., 2018). These findings support the idea that maternal stress can have a direct effect on infants and their development. The current study will highlight the idea that maternal stress from environmental factors may be associated with infants' development, specifically patterns of attention to emotional cues in the first years of life. These environmental factors can be captured by characterizing the neighborhood a child is embedded in. There are many demographic and socioeconomic factors that contribute to maternal stress (Leach et al., 2018). For example, racial socialization is a neighborhood factor that captures "the nature of race status as it relates to: (1) personal and group identity, (2) intergroup and interindividual relationships, and (3) position in the social hierarchy" (Caughy et al., 2017). Caughy and colleagues (2008) studied neighborhood racial composition noting if the given area had over 80% of either African American or European American inhabitants. They found that high neighborhood economic disadvantage is correlated with poorer child behavioral and cognitive outcomes because of racial disparities.

Neighborhood-related factors such as childcare and family support, can also contribute to maternal stress. As noted above, maternal stress can have a wide-ranging impact on infant development. One core domain impacted by stress may be attentional patterns to emotion. Mothers handle stress in various ways, which can include visible hostility towards or around their children. Maternal stress can translate into the mother-child relationship and parental efficacy (Mi-Sook & Hyuk-Jun, 2005).

Currently, mothers still engage in the lion share of direct infant care in the first years of life, bridging the impact of maternal stress in pregnancy to the child's first years. When pregnant, mothers who report high levels of emotion dysregulation had newborns with lower attention and arousal levels (Ostlund et al., 2019). However, in the same study, infants who scored higher on the arousal scale were more sensitive to the environment. High levels of stress in parents are also associated with infants being less alert to angry faces (Burris et al., under review). The decrease in attention to the angry faces may be caused by the infants' conditioned response to repeated exposure to angry or distressed faces. Thus, maternal stress from possible neighborhood/environmental factors can contribute to patterns of attention to emotional faces by altering daily environmental input from caregivers.

The detection of facial emotion can be altered by the infant's environment. Infants with highly anxious mothers show greater attentional bias toward threat (Morales et al., 2017). This was evident in longer attention toward angry face stimuli. Mothers who have high stress are less interactive with their child (Feeley et al., 2011) and those interactions may take on a more negative tone. Infants may engage or disengage with certain stimuli based on what they are conditioned to seeing in their daily lives. Stable patterns of emotional facial attention may emerge as early as 6 months. (Charlesworth & Kreutzer, 1973). In the second half of the first year of life, babies are less likely to engage with happy and neutral faces compared to negative faces (Pérez-Edgar et al., 2017). However, when infants are conditioned to not experiencing happy faces, we predict they engage with happy faces more often. Infant attention patterns may also generalize beyond emotional faces. For example, threats represented by animals (e.g., snakes) also pull for greater attention. Thus, early patterns of attention may ripple across multiple domains of processing and impact multiple domains of functioning.

The purpose of the current study is to examine the connection between infant emotional facial attention and maternal stress associated with environmental factors. A diverse sample will be used to capture a wide range of individual experience and minimize potential bias due to homogenous samples. Specifically, we will look at infants' emotional attention to angry, happy, and neutral faces captured via eye tracking. We anticipate that infants who have mothers who are exposed to more environmental factors known to contribute to maternal stress will display less attention on angry faces vs. happy and neutral faces compared to infants with less stress exposure. We predict that infants in more stressful environments will have been exposed to angry emotions more often, which will lead to less interest in the negative emotions. These data could inform interventions to help decrease environmental and parental spillover effects on infant perceptual and socioemotional development.

Methods

Participants

Infant and caregiver pairs were recruited for a larger study of infant socioemotional development through various strategies including baby registers, database, visiting parenting class and word-of-mouth (Pérez-Edgar et al., 2021). In the end three hundred and fifty-seven infant and caregiver pairs were enrolled in the sample. Most of the infant and caregiver pairs were enrolled when the infants were 4-months. The majority were recruited from State College, PA (n=167), followed by Newark, NJ (N=109) and Harrisburg, PA (N= 81). Caregivers identified 180 of the infants as white, 58 as African American/Black, 9 as Asian, 78 as Latinx, 27 as mixed race and 5 declined to provide the information. For the current study, we will leverage data from the first 4 data collection waves: 4, 8, 12, and 18 months.

Measures

Infant Overlap. Infants completed a version of a classic overlap task to assess infants' ability to disengage from emotional faces. Consistent with the calibration procedure, stimuli were presented using the Experiment Center. Infants were presented with up to 30 experimental trials, ending either when all trials were completed or when the infant could no longer attend to the task. Each trial was initiated when the infant's attention was on a video clip presented centrally on the screen, which was triggered either when the infant fixated for at least 100ms or when the experimenter determined that the infant was looking at the video clip. If the participant did not attend to the center of the screen, the slide advanced after 10000ms. Following was a central face sampled again from the NimStim face set for 1000ms. Ten actors (5 male) provided neutral, happy, or angry, closed mouth images. Facial stimuli were approximately 12 cm x 8cm and the visual angle of each face was 11.42° (H) x 7.63° (W). Following the presentation of the face, a checkerboard stimulus then appeared in either the left or right periphery of the screen adjacent to the face (20.78° visual angle) for 3000ms. The checkerboard was 12 cm x 2.5cm, 11.42° x 2.39° visual angle. This progression of stimuli was concluded with a 1000ms ITI, which was a blank screen. No consecutive trials were identical in terms of face and probe placement.

Confusion, Hubbub, and Order Scale (CHAOS). The CHAOS is a 15-item survey designed to assess 'environmental confusion' (high levels of noise, crowding, traffic pattern) in the home. It was collected at the 4-, 8-, 12-, 18-, and 24-month time points. Each item is a statement (e.g., *There is very little commotion in our home*) with parents responding on a four-point Likert scale (1 = *Very much like your own home*, 2 = *Somewhat like your own home*, 3 = *A little bit like your own home*, 4 = *Not at all like your own home*). A total score is generated by summing all of the items.

Parent Daily Hassles Survey (PDHS-R). The PDHS-R is a 20-item survey designed to assess the frequency and intensity of daily hassles experienced by parents [47]. It was collected at the 4-, 8-, 12-, 18-, and 24-month time points. Each item describes an event that may routinely occur in families with young children (e.g., being nagged, whined at, complained to) and parents note the frequency (rarely, sometimes, a lot, or constantly) and then how much of a 'hassle' the events have been for them within the past 6 months using a 1 to 5 scale. Responses are not child-specific, and the survey is not designed to capture relational difficulties with any particular child. The hassles scale can be used in two different ways: totals of frequency and intensity scales, or by deriving 'challenging behavior' and 'parenting tasks' scores from the intensity scale. The challenging behavior total score is obtained by summing seven items from the intensity scale scores and the parenting tasks scale is obtained by summing eight items from the intensity scale.

Results

The current analysis focuses on the relation between maternal self-reported stress and infant attention to emotion faces at 4, 8, 12, and 18 months. In order to create stable measures of stress, each of the subscales for the PDHSR were standardized and then averaged into a single score for each time point. The CHAOS score was also standardized. The PDHSR and CHAOS were then averaged to create a single Stress score at each time point. As can be seen in Table 1, the sample size varied considerably across testing times. Missing data were due to either infant inability to complete the task, missing questionnaire data, or family study withdrawal. Table 2 presents the intercorrelations between the Stress scores and infant attention values.

Table 1. Mean, standard deviation (SD), and n u m b e r (N) for the maternal self-reported stress and infant attention to happy, angry, and neutral faces at 4-, 8-, 12-, and 18-months.

	Mean	SD	N
4 months			
Maternal Stress	0.0004	0.86446	241
Neutral	1476.26	716.98	116
Angry	1376.92	734.73	116
Happy	1402.57	731.07	116
8 months			
Maternal Stress	-0.0001	0.88854	205
Neutral	1499.16	544.72	173
Angry	1452.81	581.29	173
Happy	1508.13	586.57	173
12 months			
Maternal Stress	-0.0057	0.87839	165
Neutral	1269.41	542.41	131
Angry	1352.60	528.26	131
Happy	1358.43	552.84	131
18 months			
Maternal Stress	0.0033	0.89100	175
Neutral	1492.17	594.52	107
Angry	1646.81	574.73	107
Happy	1487.41	624.43	107

Table 2. Intercorrelations between maternal self-reported stress and infant attention to happy, angry, and neutral faces at 4-, 8-, 12-, and 18-months. Number (N) is reported in the parentheses.

	Stress4	Stress 8	Stress 12	Stress 18
Neu4	0.056 (87)	0.122 (61)	-0.025 (57)	0.017 (57)
Ang4	0.080 (87)	0.118 (61)	0.063 (57)	0.123 (57)
Hap4	-0.002 (87)	0.172 (61)	0.008 (57)	-0.040 (57)
Neu8	-0.03 (120)	0.146 (130)	0.110 (97)	-0.103 (105)
Ang8	0.043 (120)	0.227** (130)	0.120 (97)	-0.068 (105)
Hap8	-0.041 (120)	0.237** (130)	0.120 (97)	0.065 (105)
Neu12	0.177 (101)	0.260* (95)	0.315* (93)	0.167 (87)
Ang12	0.132 (101)	0.211* (95)	0.149 (93)	0.146 (87)
Hap12	0.227* (101)	0.218* (95)	0.262* (93)	0.080 (87)
Neu18	-0.086 (84)	0.127 (82)	-0.022 (79)	-0.039 (88)
Ang18	-0.023 (84)	0.131 (82)	-0.062 (79)	0.106 (88)
Hap18	-0.161 (84)	0.03 (82)	-0.059 (79)	-0.050 (88)

Initial inspection of the sample found that too many data points were lost in analyses that included all measures at each timepoint, due to list-wise deletion. Indeed, a full omnibus ANOVA with Age, Face Emotion, and Maternal Stress had only 19 degrees of freedom. As such, analyses were broken down into separate ANOVAs by age. Thus, each age had a 3 (Face Emotion) by 2 (Maternal Stress) interaction. Maternal stress was split into two groups based on a median split at each age.

4 months
Neither the main effect of Emotion, $F(2,170) = 1.25$, $p = 0.29$, the main effect of Stress, $F(1,85) = 0.37$, $p = 0.55$, nor the Emotion by Stress interaction, $F(2,170) = 0.86$, $p = 0.42$, were significant.
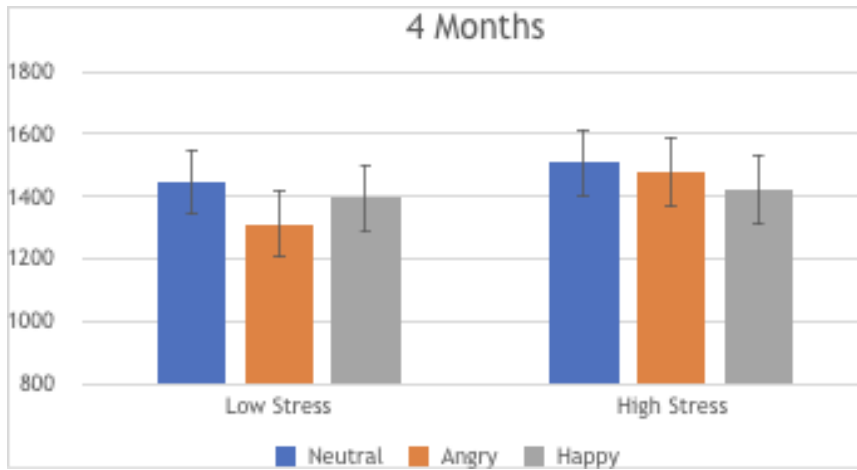
8 months
Neither the main effect of Emotion, $F(2,256) = 1.64$, $p = 0.20$, the main effect of Stress, $F(1,128) = 1.23$, $p = 0.27$, nor the Emotion by Stress interaction, $F(2,256) = 0.22$, $p = 0.80$, were significant.

The main effect of Emotion, $F(2,182) = 3.20$, $p = 0.04$, was significant, indicating that at 12 months the infants took longer to detach from happy emotions, followed by angry and neutral emotions. In addition, the main effect of Stress approached significance, $F(1,91) = 3.61$, $p = 0.06$, due to the slightly longer fixations to all faces in the infants of high stress moms relative to low stress moms. However, the Emotion by Stress interaction, $F(2,182) = 0.34$, $p = 0.71$, was not significant.

18 months

The main effect of Emotion, $F(2,172) = 9.47$, $p < 0.001$, was significant, indicating greater dwell time (more attention to) angry faces across all of the infants. Neither the main effect of Stress, $F(1,86) = 0.23$, $p = 0.63$, nor the Emotion by Stress interaction, $F(2,172) = 0.964$, $p = 0.39$, was significant.
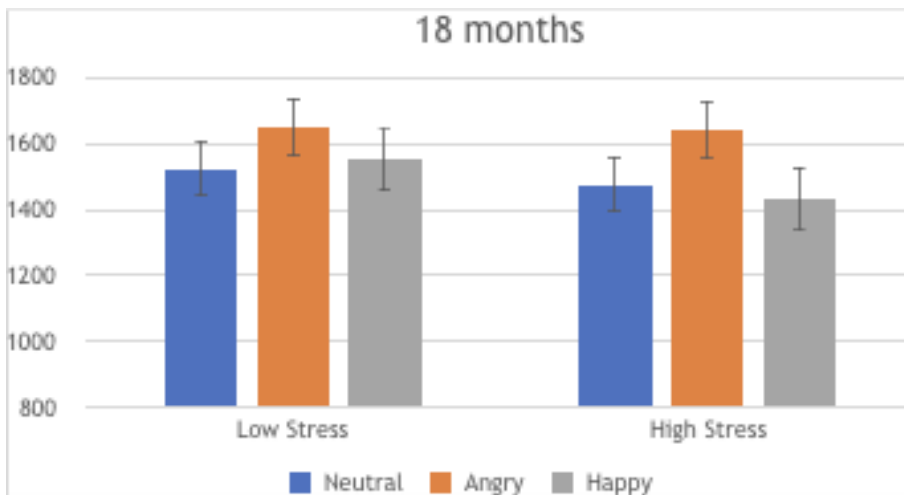
Discussion

The current findings indicate that the emotion by stress interaction was not significant at any of the time points measured. That is, from the age of 4 months to 18 months, differences in infants' dwell time across neutral, angry, and happy emotional faces are not directly associated with the influence of maternal stress. When looking at the variables of emotion and stress individually, findings emerged at different ages. For the variable of emotion, there was no significant main effect at ages 4- and 8- months. However, for the time points of 12- and 18- months, significant differences emerge indicating that as the infants aged, they paid more attention to angry faces compared to neutral and happy faces. The variable of stress did not have significant effects at any of the time periods, when examining across the emotion faces. Specifically looking at the 12-months data, stress was approaching significance, this indicated that there was a slightly longer fixation to all faces in the infants of high stress moms relative to low stress moms. However, Table 2 indicates significant positive zero-order correlations between maternal stress at 8 months and individual dwell times at 8 and 12 months. This suggests that a larger, more robust sample may have been able to detect significant patterns in the ANOVA that lagged from one age to the next.

The study suggests that within the first one and half years of life of infants, attention to emotional faces is not robustly associated with our specific measure of maternal stress. As infants age they tend to pay more attention to angry faces rather than happy and neutral ones. This can be caused by a number of reasons. For example, the simple physical structure of anger on a face might intrigue the infant (Lobue & Deloache, 2011). These findings align with Leppänen et al. (2018), which found that as infants age they dwell longer at angry facial emotions compared to happy. This change can be caused by the simple development of interest in different facial structures. At 8 months, infants did not dwell longer on the emotion of anger unlike the previous literature. Heck et al. (2016) found that by 7 months infants focus more attention on fear emotions rather than happy ones. Our study could have failed to replicate these findings because of the specific characteristics of the infants participating. For example, the infants might not be predisposed to experiencing a threatened environment. Threatening facial expressions can be a sign to potential danger (LoBue, 2009), if these infants are predisposed to high levels of anger, they may not be conditioned to looking at threatening stimuli.

Our findings add to the evidence that as infants develop, they dwell longer toward threatening stimuli--in particular, angry emotional faces. This bias is important because it allows infants to determine if their environment is potentially threatening. At the 12-month time period, the emotion by stress interaction approached significance, which indicates that there is an association between maternal stress and emotional attention that may be evident with a larger sample or more refined measures of stress. For example, prior work has used levels of the hormone cortisol to capture variations in stress levels (Bayazit, 2009).

Our findings also raise questions that require further investigation. First, the study used participants from a similar background with regards to demographics. If the study used a wider participant pool across various states, rather than states from the tri-state area there is potential room for a different outcome. If there was no access to participants across various locations, looking at each town (Harrisburg, State College & Newark) separately there might be an association of maternal stress to infant facial attention. Studies have shown that people from urban areas report more problems and conflict compared to rural areas (Elgar et al., 2003).

Newark is classified as an urban area, so the mothers from this location might have scored higher on the CHAOS and PDHSR leading to a difference in processing of emotions in the infants. Furthermore, the majority of the participants identified as white, if there was more of a divide in the ethnicity the maternal stress might be higher. That said, post-hoc analyses found that stress levels only differed by location at 18 months, with the highest levels at Newark. The study could be extended by not only examining infant and caregiver pairs from different towns but also looking at different ages.

While we did not incorporate maternal ages into the analysis, studies show that adolescent mothers experience more stress than non-adolescent mothers (Coll et al., 1986). Adolescent mothers tend to have less support from their environment which can also add additional stress. Younger mothers tend to be less responsive and use more punishment on their child (Coll et al., 1986).

In this current study we only examined trajectories up to 18 months. Future studies are needed to look at the individuals at an older age. It may be that the pattern of attention bias to angry faces, if maintained at later ages, could show signs of anxiety from maternal stress. Maternal stress during pregnancy is connected to internalizing behaviors (Park et al., 2014). However, internalizing behaviors typically emerge later in childhood (Van Zalk, 2020). Therefore, conducting this research at a later time point in infants could create a stronger association between maternal stress and development of things.

In conclusion, the results of the study indicate that as infants develop, they tend to dwell longer on the emotion of anger compared to neutral and happy emotions. There was no interaction between attention to emotions and maternal stress at 4-, 8-, 12- nor 18- months. However, we noted some indications of direct correlations. As we continue this research, there is a need for a larger participant pool examining across larger trajectories. This could allow for a stronger association between maternal stress and risk behaviors to emerge.

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Authentic Materials in the Korean Language Classroom: The Case of Korean and US American English Online Food Recipes

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Abstract

This paper analyzes the discourse present in online recipes on websites popular in Korea and America, focusing on the description of food, its taste, and how to prepare it. In doing so, we look at language choice and how the recipe author interacts with the reader. This offers a wealth of insight on how food is regarded, described, and the implications it makes about the respective country's cultural perception of food. Furthermore, the language choices made in recipes can serve as an excellent material for language learners, offering accurate looks into real-life use coming straight from authentic material. Alongside our analysis, we also consider how these findings could benefit students in the classroom.

1. Introduction

From the many facets of culture, we often pick food to be the most representative one. Food offers insight into a country's geography and culture; preparation methods can be representative of strong values and beliefs, shown through rituals such as tea ceremonies. Social norms surrounding appropriate times to prepare and consume the food, like eating seaweed soup on birthdays and eggs and bacon for breakfast, also come with cultural superstition and history. When talking about food, how to make it, how it looks and tastes, there is an innate representation of such value.

In this paper, we analyze this discussion of food through the genre of online recipes. In focusing on and talking about food and food preparation, there is a sizable amount of discourse related to preparation and presentation which provide sufficient material to work with. Korean recipes and food discourse are more so the main focus but can also serve as a representation of East Asian culture with its large wealth of popular representative foods both domestically and internationally. American recipes and food discourse come to serve as a sort of "control group," offering itself as a means for comparison. In these comparisons, we see both overt and covert discourse that can highlight cultural differences between the two countries which is represented in their language. In discussing the use of authentic Korean materials in teaching, we specify the language learners being English speakers and so using American recipes for comparison can better represent the cultural norms in talking about food preparation as American people, and better highlight differences that could be hard to teach otherwise.

In these analyses, we find unique forms of discourse that allow us to better understand a cultural understanding of food. The particular look into descriptors and taste and preparation terms show the minute differences and the overarching cultural differences that they are a part of. In these differences, we find demonstrations of these cultural views that can make an excellent learning resource for a language learner, the comparisons allowing us to put a spotlight on these concepts.

2. Literature Review

2.1 Korean Cuisine

Rice, vegetables, and fermented foods are key ingredients in modern Korean cuisine. In Kwon et al. 's (2016) "Seoul Declaration on the Korea diet," a Korean diet consists of "high consumption of vegetables, moderate to high consumptions of legumes and fish and low consumption of red meat." popular vegetables within Korean cuisine are garlic, green onion, red pepper, and ginger. Common aspects of the Korean meal include kimchi, soup, and various side dishes. According to the Seoul Declaration and listed into brief characteristics, Korean cuisine includes the likes of: (1) various recipes based on rice and grains; (2) more fermented foods; (3) more vegetables from wild landscapes and the seas; (4) more legumes and fish and less red meat; (5) more medicinal herbs; (6) more sesame and perilla oil; (7) limited deep-fat fried cooking; (8) more meals based on seasonal produce; (9) various local cuisines; and (10) more home-cooked meals.

Kim et al. (2016) further expands on the Korean diet, offering representative foods for each category while further expanding on the aforementioned set of characteristics. Rice-and-grain-based recipes are represented by 국밥 *kwukpap* 'hot soup with rice' and 비빔밥 *pipimpap* 'mixed rice dish.' Vegetables commonly present in Korean cuisine are carrots, cabbage, spinach, lettuce, cucumbers, and peppers, while mung beans, soybeans, cowpeas, and peanuts are common legumes. Both vegetables and legumes are seasoned or paired with fermented sauces such as 고추장 *kochwucang* 'fermented red chili paste' and 된장 *toyncang* 'fermented soybean paste.' The meat, most likely chicken or fish due to the rarity of beef, pork, or lamb in their environment are commonly seasoned or garnished with garlic, green onion, red pepper, or ginger.

As Korean cuisine began to take form and become an established palate in its own right, an aesthetic began to form. "What looks good tastes good" says an old Korean proverb provided by Chung et. al (2016). One aspect of this aesthetic is harmonization, portrayed by foods that show mixing such as pipimpap, a mixed rice dish with marinated meat and a colorful array of vegetables and legumes such as carrots, cucumbers, seaweed, and beansprouts. "Bibimbap, before mixing, looks like a well-maintained garden," says Chung et al. "Bibimbap is characterized by the fact that it's flowery beauty fades by mixing, giving birth to an even greater taste. Not only does mixing enhance its taste, bibimbap beauty is also typi-fied by each ingredient giving its distinct and exquisite taste upon the harmonization (mixing) of the ingredients." Other aspects can include patience, characterized by kimchi, kochwucang, and other fermented foods, and care, characterized by 죽 *cwuk* 'rice porridge' and 섭 산적 *sep sancek* 'beef skewers' a porridge and a traditional beef dish respectively prepared in a way that made it easier for the elderly to eat.

2.2 American Cuisine

American cuisine is marked by change, notably in the 20th century, notes Dyson (2000). Early on in the 1900s, the key ingredient was meat. Beef was the most popular option, and it was often eaten with potatoes (baked, fried, mashed) and other filling foods such cakes or pies with little attention to vegetables. This was a reflection of the health and beauty standard, where good health was shown through bigger bodies, and bigger bodies were attained through heavy, meat-centric meals.

A shift occurred in the 1920s as more and more nutritionists and food scientists began promoting vitamins and minerals. "The breakfasts that in earlier years were heavy on meat and breads became citrus fruit, dry cereal and milk, or eggs and toast. Lunches were light: sandwich, salad, soup. Dinners changed the least, but portions became smaller: roast or broiled meat, potatoes, vegetables, and dessert, with the latter often omitted," Dyson says. A decade later, yet another shift occurred when the Great Depression struck, which influenced portion sizes as rationing became common, and the subsequent Second World War had helped fix a spot for vegetables on the American plate, which then turned into a tray that one could heat up in a microwave for an easy TV dinner consisting of a meat, starch, and vegetable. As frozen, quick-to-prepare foods were slowly becoming commonplace in the American household, this gave way to the rise in mainstream popularity of fast-food restaurants.

2.3 Recipe Discourse

As recipes begin to be shared through mediums other than spoken word, it forms a new genre in which linguistic choices are made for a variety of reasons when describing food and how to prepare it. A rather basic and common format for the English written recipe is the title, the ingredients, and the instructions. However, rarely is any aspect of language ever that simply explained. Tomlinson (1986) expands on this, stating how titles in written English recipes often set an expectation, and are mainly maintained through marks of authenticity. There is the method of personalizing it to the author, giving titles such as "Grandma's cookies" or "Lucy's Casserole" in order to show that this recipe is dear to the author due to the personal connection between the author, the recipe, and the loved one who shared it with them, and the reader should expect to read a credible recipe that makes for a wonderful dish due to the author's personal connection to the food itself. There is also the act of linking a dish to its region of origin by stating the name of that region in the tile, e.g., "New York Pizza" or "Philly Cheese Steak," which adds authenticity. This personal touch, or touch of authenticity by linking foods to places or people, is a means to establish a relationship between the author and the reader.

Within the recipe genre, there are various ways to establish this relationship. The one that the reader might see first is the title. The recipe design might also come into play, which Fisher (2013) discusses, which can be altered to fit the desired audience. This can be shown through register, level of formality, word choice, the dish itself that the recipe is for, use of "you," etc. and in online recipes, the intended audience can even interact with the author and the recipe, and offer feedback on the design of the recipe. The readers' background knowledge is also taken into consideration, which can influence the presence of a recipe's instruction and description. The author cannot assume that everyone who reads their recipe will have experience and knowledge in things such as tempering chocolate or performing a julienne cut, or they might but simply not know the formal language describing it. This plays into the vague, open-to-all word choice that

might be used to attract a larger audience of all levels of expertise. Some assumptions about the audience are made regardless. Fisher (2013) points out those made in a cookbook for girls in order to define and cater to the intended audience, such as the suggestions to tie one's hair back and put on an apron, with pink ribbons decorating the page. In a cookbook for those with health issues, the relationship between certain foods and certain illnesses is highlighted.

Despite different audiences, common features were present in cookbooks in order to establish such a relationship with the reader. "Very common are introductory texts that provide background information on the recipes, procedures, customs, ingredients and the physical and chemical processes involved in food preparation," says Fischer (2013), but added features such as purposeful design, elaboration on the scientific processes behind food and its relation to health can be added and adjusted according to the intended audience.

Shifting into primarily online written recipes, the discourse alters itself a bit. Diemer & Frobenius (2013) analyze this, looking into the features of food blogs. The lexicon of food blogs is quite similar to written recipes, replete with food jargon and vocabulary specifying measurements, tools, ingredients, and preparation methods, but there is the added vocabulary specific to the blogging and the online space, such as "comment," and "post." This added, blog-specific vocabulary is key in establishing this genre. There is also the prominence of verbs of perception and emotion, such as "look," "feel", "want," or "find," and auxiliary verbs such as "should," "might," "may," "must," and "need," which emphasize and strengthen a personal connection and take small but noticeable steps away from conventional instruction present in older written recipes. There is also the deviation from the spelling standard or inclusion of topics surrounding lifestyle outside of food but still closely related, which all helped distinguish and establish the online recipe, specifically the food blog, as a genre of its own.

Within the genre of online recipes, Strauss et al. (2018) English recipes still tend to show high amounts of specificity when detailing preparation and measurements, and mainly focus on the food and preparation. Engagement is still present and encouraged, and commentary focuses on the preparation of the dish, the success or failure of the commenter in making the dish and detailing any changes that were made to suit their taste.

In Korean recipes, engagement and specificity go hand-in-hand, and online recipes can be equal parts instruction and personal narrative. Strauss et al. describe it as "a generic amalgam of graphics (photographs, emoticons, affective symbols), highly personal narratives, poetic musings, and instances of seemingly direct-address conversation."

2.4 Food, taste terms in English

In English, taste terms can be rather scarce. The standard four taste terms of English are "sweet," "sour," "salty," and "bitter" are often used to describe the flavor of food without incorporating texture. Ankerstein & Pereira (2013) best elaborate on this as such: "An apple has a specific flavor, but the description of that flavor in ordinary English vocabulary is "sweet" or "sour", depending on the type of apple. These terms do not describe the whole taste profile of an apple. Other descriptions for the flavor of an apple could be given, such as "crunchy" or "fruity", but these terms are texture related and attributive, respectively, rather than a gustatory description." Of course, there are many ways to describe an apple (or any food for that matter) in English but when it comes to focusing exclusively on taste, there is not much outside of "sweet," "sour," "salty," and bitter." This is not to say that these are the only taste terms. Outside of the four, there are several other taste terms, a significant amount of which derive from the name of

other foods or ingredients, e.g., "buttery," "sugary," "vinegary," etc. Many taste terms in English seem to be derivatives or terms describing quality, appearance, attributes of the food in order to describe its flavor.

2.5 Taste terms in Korean

Taste terms in Korean have some depth as they describe not just the flavor or texture, but other aspects of flavor such as "intensity, depth, purity and duration," Rhee & Hyun (2017) state. Aside from five terms "sweet," "salty," "sour," "bitter," and "umami," in Korean there are the additional three "pungent," "fishy," and "bland." An aspect of the "overwhelmingly large in size" paradigm of Korean taste terms comes from vowel symbolism. With Korean having negative, positive, and neutral vowels, the harmony, and polarity that comes from the use of these vowels in describing foods and their textures add a subtle yet telling layer through the use of onomatopoeic words. An example from Rhee & Hyun that illustrates this is the difference in tense vs non-tense when describing something boiling, here being 보글보글 *pokulpokul* which best describes plain water boiling in a pot, compared to 뽀글뽀글 *ppokulppokul*, which best describes a thick stew boiling and suggests friction among ingredients.

Taste terms can range from simply describing taste, to describing taste in conjunction with sensations in the mouth, describing events such as "burning," refreshing," or indicating that a food is lacking in purity or stimulation.

These words, which might seem to be describing sensations and not necessarily taste, do carry connotations of taste when being used. Jang et al. (2015) explore this with "refreshing" especially, which is 시원한 맛 *siwonhan-mat* in Korean. After having participants rate levels of *siwonhan-mat* and deliciousness with two common *siwonhan-mat* foods: 콩나물 국 *khongnamwul kwuk* 'bean sprout soup' and 황태북어 국 *hwangthaypwuke kwuk* 'pollock soup.' In the study, Jang et al. find the close relationship between food being delicious and refreshing, so close that both words are practically interchangeable when describing taste. "Ratings of deliciousness were correlated with ratings of *siwonhan-mat,* suggesting that *siwonhan-mat* may be a core element of pleasant taste in *kwuk* and 탕 *thang* 'stew.'"

2.6 Taste Terms in English, a Cross Comparison

Strauss' (2005) comparison between Japanese, Korean, and American recipes analyze the linguistic terms used to describe taste and texture of advertised foods. Strauss distinguishes the use of taste descriptors and their varying levels of intensity, with Japanese advertisements being rather generic while both Korean and American advertisements tend to use more hyperbolic terms.

2.7 Use of Authentic Learning Materials/Discourse in L2 Pedagogy

Within the discipline of second language teaching, there are many methods and factors of consideration that determine effective ways to teach second language learners. The method of using authentic learning materials in L2 teaching is rather popular and comes with mixed results, prompting the use and analyses of multiple methods in incorporating authentic materials.

Badger & MacDonald (2010) state that when using authentic materials, "the principle of authenticity for language samples is that we should use texts which are not designed for the purposes of language teaching." This is a break away from carefully curated textbooks and teaching materials and presents "a better representation of language use outside the classroom." While the principle is not necessarily problematic, it does come with its limits. The material itself might be authentic, but not completely suitable for teaching. What if one or both speakers and non-native speakers? If we step away from the usability of the material, how can we be sure that students will be more inclined to learn and retain the material better? "Authentic texts which are motivating for some users will be boring for others; authentic texts which are easy for some language learners will be difficult for others," Badger & MacDonald explain, "Authenticity says nothing about the motivational properties or the level of difficulty of a language sample."

There is also the factor of being able to successfully implement these materials into the classroom. Given that these materials were not constructed for classroom learning, it can be hard to collect if not be an incredibly time-consuming process for teachers, and even when collected, the ability to be able to best utilize these materials would take a sort of knowledge and familiarity that teachers might have the resources or time to obtain (Gilmore 2007). If teachers did have the time and expertise to collect and utilize these materials, there is not even the guarantee that it could prove effective in the classroom. Huang et al. (2011) discusses a survey study of authentic-material-based activities used in the classroom that teachers deemed to be successful. Activities included incorporating a range of authentic materials such as job listings, menus, maps, and schedules. Huang et al. found that the authentic materials themselves do not "necessarily result in appropriate, meaningful, and successful instruction," but nonetheless such activity ideas can still hold value in the classroom and can serve as a resource or a "springboard for generating new ideas."

However, it is worth noting that use of authentic learning materials is not entirely burdensome. In a study by Keshmirshekan (2019) looking at the effectiveness of authentic material use in teaching English learners in Iran, the results strongly favored using authentic materials as an effective method for "language learners to interact and improve their learning and the communicative aspects of language outside/inside classrooms whenever and wherever they desire." There is also Sundana (2017), where authentic materials were successfully implemented when teaching descriptive writing, but a part of its success came from student motivation and initiative. "They felt that the materials assist them in writing, they get many ideas to write, and it enhances their vocabulary as well, as a result, they were more interested in writing. In addition, the students were likely to utilize visual and interpersonal styles in learning since they were fond of learning to write descriptive paragraphs by using the visual materials, such as articles from magazines, newspapers as well as articles from the internet with their friends in the groups." While authentic materials can be hard to source and implement in some classrooms, it can definitely be a driving force in others, and is a matter of skillful and considerate collection and use, given the opportunity to be able to know how to properly utilize them.

Strauss and Eun (to appear) establish a foundation for the use of authentic discourse by Korean language instructors and learners of high-intermediate to advanced Korean. The study is based on a systematic analysis of a mini corpus of Trip Advisor and Mango Plate reviews, collectively yielding a robust set of context-specific lexical items, expressions, and grammatical constructions that commonly emerge in hotel and restaurant reviews--linguistic exemplars that are both natural and high frequency and that are conspicuously missing from traditional commercial textbook content.

3. Data and Methodology

The primary source of data for Korean recipes was 10000recipe.com. It attracts 5.1 million monthly visitors and hosts around 141,000 recipes. The primary source of data for American recipes was allrecipes.com. It consistently ranks as the top recipe website in the United States and garners approximately 1.5 billion annual visits across their 19 global sites. The high engagement numbers from both websites ensure accuracy in localizing popular and common dishes given the number of visitors that partake in creating, sharing and engaging with these recipes, which reflect in the number of recipes published and the number of views, ratings, and comments that they receive.

For this research project, we focused on recipes for popular dishes and recipes for common, traditional dishes. Of each website, we collected recipes for 15 different dishes, with two recipes per dish, equaling in 30 recipes per site and 60 recipes overall.

After deciding on the sources for recipes, further refining was done to ensure systematicity in collecting recipes. This involved setting up a set of criteria that each recipe must meet in order to be selected. We looked exclusively at dinner dishes, excluding any side dishes. We also set a minimum amount of engagement that each recipe must have in order to ensure that it is a popular or common dish.

For 10000recipe.com, views, comments and reviews were the only visible gauges of engagement. For this specific website, we decided to focus on views as the main determiner by setting a minimum of 100,000 views in order to be selected after meeting other criteria. Both recipes for one dish had to have garnered at least 100,000 views in order for the dish to be included in the database.

For allrecipes.com, recipe views were not visible. Instead, comments and ratings were the way to gauge engagement, so we decided to make ratings the main determiner and set a minimum of 1,000 ratings for a recipe to be included. Like for 10000recipe.com, both recipes for a dish had to have at least 1,000 ratings for the dish to be included in the database.

When looking for popular foods within the main dish dinner category on allrecipes.com, it showcases four recipes under the title "Most Made Today," alongside recommended and other popular recipes that vary in popularity and engagement. In collecting recipes for popular foods, we looked at the top four recipes made that day as stated by the website and further down the page of popular and recommended recipes to see which ones met the criteria and finding a second recipe for the dishes that also met the criteria in order to include them in the database.

As for 10000recipe.com, there is a page that ranks recipes based on popularity on a daily, weekly, and monthly basis. With the site filters set in place to show only main dishes and dinner recipes, it was a matter of looking through each dish recipe to see if it met the criteria and finding a second recipe for the dish that also met the criteria to ensure it could be included in the database.

The Korean recipes appear in Figure 1.

Popular Dishes
- 오징어 볶음 *ocinge pokkum* 'stir-fried squid'
- 닭볶음탕 *talkpokkumthang* 'braised spicy chicken'
- 부대찌개 *pwutay ccikay* 'spicy sausage stew'

- 제육볶음 *ceyyuk pokkum* 'pork stir fry'
- 콩나물국 *khongnamwulkwuk* 'bean sprout soup'
- 간장갈비 *kancang kalpi* 'soy sauce ribs'
- 비빔국수 *pipim kwukswu* 'cold spicy noodles'
- 참치마요덮밥 *chamchimayotephpap* 'tuna mayo rice bowl'

Common Cuisine
- 삼겹살 *samkyepsal* 'grilled pork belly'
- 잡채 *capchay* 'stir-fried glass noodles'
- 김치찌개 *kimchi ccikay* 'kimchi stew'
- 불고기 *pwulkoki* 'marinated beef'
- 비빔밥 *pipimpap* 'mixed rice'
- 김치볶음밥 *kimchi pokkumpap* 'kimchi fried rice'
- 수제비 *swuceypi* 'korean style pasta soup'

Figure 1. Korean recipes from 10000recipe.com

The American recipes appear in Figure 2.

Popular Dishes
- Lasagna
- Chicken Parmesan
- Meatloaf
- Stuffed Peppers
- Pot Roast
- Chicken Cordon Bleu
- Cajun Chicken Pasta
- Prime Rib

Common Cuisine
- Salisbury Steak
- Macaroni and Cheese
- Barbecue Ribs
- Roast Chicken
- Chicken Noodle Soup
- Pulled Pork
- Fried Chicken

Figure 2. American recipes from allrecipes.com

4. Analysis

4.1 Titles

4.1.2 Korean

The titles below show common yet dynamic use of adjectives, names, and other means of description to catch the reader's attention to describe not just the quality of the dish, but also the

quality of the recipe. Authors don't shy away from using "I" to establish themselves as a presence in the recipe, and almost simulate a conversation with titles including phrases such as "I like the spicy taste!" or "I'll tell you the real golden recipe…."

There is also the presence of this "golden recipe" that shows up throughout recipe titles. When a recipe is deemed "golden," it conveys the idea of the being of high, or "gold," quality or standard. Recipes being touted as "golden recipes" come with the idea that the recipe that "never fails" and is the best for its coordinating dish, sure to taste good every time to anyone that tries it. Other ways to try and describe the recipe in appealing matter include saying the kind of occasion the recipe fits ("perfect for eating alone!", "perfect for a rainy day!"), using choice adjectives like "tempting" or "refreshing," the latter of which holds its own presence in the list of Korean taste terms as its own distinct term.

A lot of the dynamic title usage tends to be used for the more novel recipes that are trending, and while the recipes are a part of Korean cuisine and its common ingredients and cooking methods, they are not necessarily staple or representative meals like 비빔밥 *pipimpap* 'mixed rice,' 삼겹살 *samkyepsal* 'grilled pork belly,' or 김치찌개 *kimchi ccikay* 'kimchi stew.' Titles for trending recipes tend to be slightly longer as they include more adjectives and/or utterances, most likely in an attempt to use language that attracts website visitors, thus clicking on it and ensuring a "trending recipe" status through high but steady levels of views, comments, and likes. Recipes for more established dishes do not need such a description, given that the dishes are already well-known by the Korean general public and any exaggerated expression in reference to these dishes might be marked. So *"the golden recipe for spicy stir-fried pork that never fails. I like the spicy taste!"* is fitting for the recipe author sharing a recipe for a popular dish that many visitors are looking to try and make most likely for the first time, while *"Making pipimpap~"* or *"Grilled pork belly with stir-fried mung bean sprout and green onion, more delicious"* is the recipe author's choice in titling a recipe for a common, representative dish that the reader has probably both made and eaten before.

4.1.3 American

The American online recipe title is succinct and to the point. For both trending and common dishes, oftentimes the recipe titles are simply the name of the dish. Some added descriptors include the method or style that the dish is cooked in (*Slow Cooker Barbecue Ribs*), choice adjectives such as "awesome" and "perfect," or "quick" and "easy" to highlight either the delicious flavor or the convenience of the recipe, both of which are common factors in selecting and recreating a recipe. Any further elaboration on the recipe quality or any mention of the recipe author is usually relegated to the brief description written in rather plain language before sharing succinct recipe instructions.

4.1.4 Korean and American

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Korean recipe titles are vastly more dynamic in language use than American recipe titles. With more instances of adjectives, utterances, and novel language concepts to describe food and recipe quality, Korean online recipes tend to offer a bit more insight on the dish, its recipe, and even the author, while American recipe titles are usually concise and to the point with adjectives coming in conservative amounts to describe the flavor or preparation method and quality. Both Korean and American recipes tend to invoke the names of people, such as Korean chef Baek Jung Won or American chef John Mitzewich in their recipes to specify a certain style or technique employed by each chef when making the meal. However, it seems that while Korean online recipes tend to include Chef Baek Jung Won almost exclusively, American recipes utilize all sorts of names ranging from Chef John to Chuck or Grandma to invoke a personable quality in the recipe that makes it seem like it's a recipe made by family just for you.

4.2 Taste Terms

4.2.2 Degrees of Taste

Alongside--or incorporated into--most taste terms in recipes are terms meant to distinguish the degree to which the dish tastes good, or how present certain ingredients or flavors are within the dish as a whole. These instances are more common and quite varied within Korean recipes, but still common within American recipes. Throughout American recipes, common taste terms include delicious, tasty, or good, but it is worth noting that they can be often preceded by terms such as "quiet," "very," or "so," e.g., "quite good," "very good" or "so tasty." It can even be taken further to create descriptors such as *fall-off-the-bone good* (used within the context of ribs).
 If such terms are not used, it is also common for adjectives to jump from moderate to high in terms of describing degrees of taste. This is exemplified by the use of taste terms such as exceptional. This is also present within titles ("Awesome Slow Cooker Pot Roast," "World's Best Lasagna") as a way to describe and highlight the dish and the recipe used to make the dish. Delicious is often left alone, but it is worth noting how saying something is delicious with no added adverbs can already signify a high degree of taste. Within American recipes, very rarely is flavor downplayed. It can be neutral at best and simply be savory or yummy, but it seems that terms like exceptional and the addition of terms like "very," "quiet," and "so" help in describing the high degree of taste.
In Korean recipes, 너무 *nemwu* 'very' and 진짜 *cincca* 'really' serve to raise the degree of taste described in recipes, but 맛있다 *masissta* 'delicious' is the standard, common way of describing a generally delicious dish or flavor.
Alongside neutral or high degrees of flavor described through appropriate terms, Korean online recipes also tend to use infixes to lessen the degree of taste present in the dish. This can be often used for describing specific tastes within the recipe or of a certain ingredient but is also commonly used to describe dishes that are slightly spicy by use of the term 매콤하다 *maykhomhata* 'to be slightly spicy.'. Another popular use of this infix is in 달콤하다 *talkhomhata* 'to be slightly sweet.' There is also the practice of duplication for emphasis, e.g., 칼칼하다 *khalkhalhata* 'to be sharp, spicy."

4.2.3 Terms Within and Outside the Universally Accepted Tastes

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Across languages and cultures, the widely accepted five basic tastes are sweet, spicy, bitter, salty, and umami. When describing foods, utilizing these basic flavors can offer a more precise flavor profile that goes beyond the standard "delicious" or "tasty." Within American recipes, using basic flavors when describing foods is not so common aside from using terms like savory. Interestingly, terms that fall outside of the basic five used in order are also used for an accurate description that draws upon expectation and assumption, for example a Salisbury steak that tastes like it took hours to make. It doesn't emphasize savoriness or saltiness, but rather draw upon the flavor of something that was cooked for a long time, ultimately sketching the expectation of richness and a generally delicious, well-made dish while still going outside the convention of "delicious" or "savory." This is present in "fall-off-the-bone good" as well.

In Korean online recipes, universal taste terms are commonly present. Four out of the five (salty, sweet, spicy, and umami) make frequent appearances, and are further specified in degree of saltiness, sweetness, etc. through the use of adverbs and infixes. Alongside the use of universally accepted, basic taste terms, Korean recipes also tend to describe flavor by richness. Two terms that exemplify this are 진하다 *cinhata* 'thick, strong, heavy' and 깊은 맛 *kipun mas* 'deep flavor.' Both describe flavor in terms of richness and is usually used for dishes such as stews and particularly spicy and savory foods.

There is also the presence of taste terms that relate to bodily experiences or emotions. For example, 홀릭되는 *holliktoynun mas* 'tempting taste,' and 개운하다 *kaywunhata* 'to feel refreshed.' It describes nothing specifically about the flavor of the dish, but rather how it makes the eater feel, and can oftentimes be synonymous with "delicious."

4.3 Appearance Terms

4.3.2 The Role of Color

When talking about how the food looks (or is supposed to look), color is often used in both Korean and American recipes as markers of doneness or at least as an indicator of when to continue onto the next step of the recipe. In American recipes, a common example of this is cooking until chicken is no longer pink in the center and when juices run clear. Here, pink signifies incompletion. In these recipes, the color of completion is brown. Cooking until your meat is well-browned, evenly browned, browned on all sides, or golden brown means it has been cooked long enough and is most likely done. Brown also tends to signify doneness in Korean recipes, even the color yellow in specific recipes that include bean sprouts, but pink or any other colors indicating rawness or something that is not yet cooked is rarely mentioned.

4.4 Cutting Terms

More present in Korean recipes are terms that specify the way that meat or vegetables are cut. The terms aren't used exclusively in the context of describing preparation methods but provide a description of how it contributes in terms of flavor. Specifically, specific meats that are cut too thinly are said to upset the overall flavor of the dish, as shown in excerpt (1:)

(1) 스팸은 반드시 얇게 잘라주세요. 두꺼우면 국물 맛이 제대로 안 배고 맛이 따로 놀아요.
"Be sure to cut spam thinly. If it's thick, the soup doesn't taste well."

캔햄은 너무 얇으면 아쉬우니 도톰하게!
"It'd be a shame if the canned ham were thin, so make it thick!"

4.5 Making the Food Pretty

Almost exclusively within Korean recipes is the notion that food be prepared neatly and prettily. Yeyppukey 'prettily, neatly' is a common appearance term used in recipes, and it appears towards the end when the author instructs the reader to plate and serve the dish neatly.

There is also the notion of beauty coming from the various colors of the dish, and even the idea of not having the right amount of variety--whether too little or too much--possibly compromising the beauty of the dish. Excerpt (2) shows how this approached:

(2) 제육볶음에는 야채를 여러가지 넣으면 지저분해 보여서 양파 고추 파 이렇게 간단하게만 넣어주시는게 좋답니다~!!
"For stir-fried spicy pork, it looks messy if you add various kinds of vegetables, so it's good to put in onions, peppers, and green onions~!!"

5. Using Authentic Materials to Teach Korean

Reviewing the analysis of the data collected from these recipes, there is a lot of material that can be worked with and become a valuable resource for classroom use. Alongside vocabulary, examples of the "Korean" way of discussing food can be taken from the recipes to provide something above simple vocabulary and grammar. Through these recipes, we see what is emphasized, what is not, and what is valued about food in a manner that best subscribes to Korean norms, both societal and cultural. It might be difficult to introduce and explain how food looking good can be just as important as tasting good, or the Korean taste terms that are rich in describing texture, flavor, and preparation method unless it is exemplified through discourse. In providing this unregulated, authentic language use there is a sense of legitimacy. This is how those born and raised in Korea and well-socialized into the culture discuss food, and so there is the added layer of not just being grammatically correct, but culturally competent.
There is more than enough benefit to outweigh any possible complications when it comes to using authentic materials, such as what was analyzed today, in the classroom for better understanding of the Korean language. Alongside the legitimacy of the material, it offers accurate language replete with subtle but noticeable language use that better fits the genre of food discussion in Korean. This might help with achieving "native-like" fluency that might be hard to capture within manufactured examples and conversations. Of course, these slightly awkward albeit correct textbook readings might forgo authenticity in order to really emphasize

certain grammar points and construction and focus more on the teaching of correct grammatical use before looking into how "authentic" it sounds (Gilmore 2004). The aim might seem considerate; focusing on establishing a certain level of comprehension and literacy before moving onto using authentic materials if the teacher chooses, but it might serve students better to work with authentic materials more often.

In using these materials, not only is there introduction to material that is presented in a way that textbooks might have a hard time exemplifying, but in their use, there is an opportunity to critically engage with the material in figuring out their meaning(s) and use within context (Strauss and Eun to appear). In working with the material, students parse grammaticality and the sociocultural implications of such language use. Aside from being grammatically correct, it can provide insight on how to be correct both technically and socially. Different areas of language and language use come into play within the teaching of authentic materials, providing a richer learning experience if used correctly.

6. Conclusion

In exploring the genre of online food recipes, a rich source of food discourse was found through the discussion and description of popular and common foods on commonly visited recipe websites of their respective country. Alongside food descriptions, we analyzed the choices that the recipe authors make in discussing the food. This includes their way of establishing a connection to the reader, seeming personable, or adding a sense of personality or authority to the dish akin to how a close friend or relative would. While arguably a bit distant from food or recipes, it still holds its own suggestions on not just how food is talked about, but how we talk to each other about it. Exploring this rich concept, we also looked into the benefit of using authentic materials, whether it be online recipes or not, in the classroom and their possible added benefit to the Korean language learning experience.

Through the analysis of about 60 recipes total, we have gotten a closer look at how food is described and how the food preparation process is viewed in both Korea and America. Looking at both popular dishes and common cuisine, their recipes demonstrated different perspectives and values concerning food. Concepts such as visuals, efficiency, variety, and harmony on the plate, as well as giving an accurate flavor profile of the food were prevalent throughout numerous recipes and showed what the importance and value, or lack thereof, of these concepts in preparing food. As language and language teaching continues to evolve, it is key to acknowledge that further analysis and discussion is a must. Not only within the genre of food discussion, but within the discussion of how to implicate authentic materials in the classroom learning experience. This can make for better understanding of subtle but significant language use in discussing something as universal, yet personal, as food.

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Examining How Perceptions of Family Cohesion and Organization Effect Children's Psychological Functioning

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Objectives: This study aimed to look at (1) Are parent-child reports of organization and cohesion in family environment associated with parent-child reports of psychological functioning of child? (2) Are lower levels of parent-child agreement about the family environment associated with worse psychological functioning? We hypothesized that higher levels of cohesion and organization in family would be associated with lower levels of total psychological problems. We hypothesized that lower levels of agreement between parent and child reports on family environment would be associated with worse psychological functioning of child. **Methods:** The study sample included 101 low income, ethnically diverse (59% Black, 43% Hispanic, 15% White, 58% Female, 42% male) youth between the ages 10-12. Youth and a guardian completed interviews and measures on family environment and psychological wellbeing. **Results:** The results support the hypothesis that higher levels of cohesion and organization are associated with lower levels of total problems. The results supported the hypothesis that lower levels of agreement are associated with worse psychological functioning. **Discussion:** Overall, the findings support that family environment is important to children's psychological well-being and provide implications for future directions.

Keywords: [Adolescence, Psychological well-being, Family environment]

Examining How Perceptions of Family Cohesion and Organization Effect Children's Psychological Functioning

Family environment plays a significant role in children's formative years. The family is one of the first support systems that children rely on to get their basic needs met. A positive family environment can serve as a protective factor for stress, especially during adolescence when stress is heightened (Burt, 1988). This protector factor can maintain a healthy family environment and foster healthy development. Adolescents are going through rapid changes in emotion, behavior, cognition, and biology which can affect many areas of their life (Burt, 1988). These rapid changes can be a significant stressor in the family environment. There is a lot of confusion that surrounds this development period and can affect their relationships. Having strong relationships and an organized family can support adolescents when they are going through these rapid changes in life.

A chaotic home environment marked by lack of organization can cause disruptions in the family environment which can lead to further stress for adolescents (Wachs, 2010). These disruptions in the family environment can heighten the stress adolescents are already facing. Organization can be defined as routines, responsibilities, and rules in the family. Low-income parents tend to have higher stress and fewer resources than non-poor families have, which can limit their ability to maintain cohesion and organization within the home (Evans, 2010). As a result, children who live in a low-income household are more likely to be exposed to chaos and instability which can have negative developmental outcomes (Evans, 2010).

Two important aspects of the family environment—organization and cohesion--are captured by the Family Environment Scale (FES; Lanz, 2014). Family organization includes things such as how the family is structured, rules, responsibilities, and routines (Lanz, 2014). Behere (2017) found that children who come from an intact family (higher family structure) were less likely to be exposed to adverse childhood experiences compared to disrupted families. Family cohesion is measured by looking at the interpersonal relationships in the family, especially the level of conflict and expressiveness (Lanz, 2014). Kliewer (1998) found that cohesion mediated the relationship between stressors and maladjustment, showing that lower levels of cohesion were predicted by stress and served as a risk factor for internalizing and externalizing behaviors.

Prior research has used parent reports or external observer ratings of family environment and has failed to consider the child's experiences (Slesnick, 2004). A child may not understand the struggles of the family which can make them perceive their family environment differently than the parent might. If they do not understand their situation, they might have trouble understanding why their parents do certain things and have a biased attitude towards their family. Berkien et al., (2012), for example, found that when a child perceives that their parents treat them with different levels of emotional warmth, children were more likely to have behavioral problems. While Burt (1988) found that positive family environment was related to positive psychological functioning, their findings did not support the hypothesis that positive family environment would serve as a stress mediator. The current study was therefore designed to examine the perceptions of both parents and young adolescents on structure and organization in the home, and how each perspective is associated with emotional/behavioral problems in the youth.

Furthermore, we know even less about how well parent and youth ratings of the home environment would correspond to each other. Studies have either obtained the parent's or child's perception of family environment but very few studies have obtained the perceptions of both parents and children (Slesnick, 2004). Even fewer studies have examined parent-child correspondence (or lack thereof) and its implications for child mental health (Berkien et al., 2012). Past literature on family environments has also mainly focused on Caucasian youths and most studies have very few participants that are of other races. Therefore, a second aim of this study is to examine the degree of correspondence between parent and child reports of structure and organization in the home and how (non-)correspondence is associated with emotional/behavioral problems in a racially and ethnically diverse sample of youths with high stress exposure levels.

In this study, we plan to examine (1) Are parent and child reports of organization and cohesion in family environment associated with psychological functioning of child as reported by both parent and child? and (2) Are lower levels of parent-child agreement about the family environment associated with worse psychological functioning?

Based on prior research, we hypothesized that when higher levels of cohesion and organization were reported, lower levels of child's total psychological problems would be reported. We also hypothesized that when lower levels of agreement between parent and child reports on family environment, higher levels of child's total psychological problems would be reported.

Methodology

Parent study. Data for the current study were drawn from the Building a Strong Identity and Coping Skills (BaSICS) intervention clinical trial conducted by Martha Wadsworth, Ph.D. The parent study recruited low-income families with middle-school aged youth residing in neighborhoods in central Pennsylvania with elevated levels of poverty and violence to participate in the BaSICS clinical trial. The children in the study were age 10-12 at pre-test assessment, and were 59% Black, 43% Hispanic, 15% white, and 58% female. Children were randomly assigned to either receive the intervention or to a control group. Assessments occurred at four timepoints: pretest, posttest, 6-month follow-up, and 12-month follow-up. The assessments were conducted at community agencies local to the neighborhoods and happened outside of school hours. The parents were able to complete measures either in person or online, and the children's assessments were in person. At assessments, the families participated in interviews and completed questionnaires.

Current study. The current study used data from the BaSICS pre-test assessment. The current study used a cross-informant correlational design where the association between levels of organization/cohesion in family environment and psychological functioning of child was examined. The association between parent-child disagreement on organization/cohesion in family environment and psychological functioning of child as reported by both the parent and child was also examined. The measures included in the current study were child and parent report on organization/cohesion from the Family Environment Scale (Lanz, 2014) and total problem scores on the Child Behavioral Checklist (Achenbach and Rescorla, 2001). Parents completed the Child Behavior Checklist and the children filled out Youth Self Report. Both parents and youth completed the Family Environmental Scale.

Measures. The Family Environment Scale measures perceptions of cohesion within the family (e.g., "There is a feeling of togetherness in our family") and the emphasis on structure in the home (e.g., "Each person's duties are clearly defined in our family") (Lanz, 2014). To confirm internal reliability, an exploratory analysis was conducted for the subscales of the Family Environmental Scale and the subscales were adjusted based off the data for cohesion (4 items each, αs =.62-.63) and organization (5 and 8 items, αs =.63-.65) (Joos et al., 2019). The items removed from the subscales were primarily reverse scored items that might not have been clear to participants. The Child Behavioral Checklist yields a total problem score which is calculated from 112 and 113 items that are rated from 0 (never true) to 2 (very often true) about internalizing (e.g., depression, anxiety) and externalizing (e.g., delinquency, aggression) behaviors (αs = .90-.93) (Achenbach and Rescorla, 2001; Joos et al., 2019).

Data Analysis. To examine aim 1, within person and cross-informant correlations between organization and cohesion in family environment and total problems from the Child Behavioral Checklist and Youth Self-Report (Achenbach and Rescorla, 2001) were examined. To examine aim 2, a residualized, non-correspondence score was created by regressing parent FES scores onto child FES scores and saving the residual score. Second, I have examined correlations between the calculated correspondence score and total problems from the Child Behavior Checklist and Youth Self-Report.

Results

Within person and cross-informant correlations between organization and cohesion in family environment and total problems from the Child Behavioral Checklist and Youth Self-Report were conducted (Achenbach & Rescorla, 2001). Parent report on cohesion and parent report on organization was significantly correlated ($r=.399$, p<.001). Parent reports on cohesion and child reports on cohesion are negatively correlated but the correlation did not reach statistical significance ($r=-.179$, $p=.055$). Parent report on cohesion in family environment and parent report on child total problem score were significantly negatively correlated ($r=-.281$, $p=.003$). Parent report on organization in the family environment and parent report on child total problems score were negatively correlated ($r=-.228$, $p=.015$). Child report on organization and child report on total problem score were significantly negatively correlated ($r=-.285$, $p=.003$). Parent report on organization and total problems score reported by child were correlated but not statistically significant ($r=-.175$, $p=.080$). There was a significant correlation between parent report on child total problems and child report on child total problems ($r=.245$, $p=.015$). A residualized correspondence score was created by regressing parent FES scores onto child FES scores and saving the residual score to measure agreement in reports of family environment. There was a significant negative correlation between the agreement cohesion score and parent report on child's total problems ($r=-.276$), $p=.003$). There was a significant negative correlation between the agreement organization score and parent report on child total problems ($r=-.226$, $p=.017$). A regression model was run using the agreement scores for cohesion ($p=.53$, $B=.07$, $t(100)=.63$) and organization ($p=.11$, $B=.18$, $t(100)=-1.62$) and children's total problems score reported by child which was not significant ($R^2=.026$, $F(2, 98)=1.31$). A regression model was run on the agreement scores and children's total problems reported by parents which was significant for the cohesion residual score ($p=.03$, $B=-.22$, $t(110)=-2.2$) but not for the organization ($p=.18$, $B=-.14$, $t(110)=-1.36$) residual score ($R^2=.92$, $F(2, 108)=5.44$).

A regression model was run with the dependent variable being total problem scores reported by parents and reports of cohesion and organization by parent and child ($R^2=.95$, $F(4,106)=2.77$). Parent organization ($p=.19$, $B=-.13$, $t(110)=-1.3$), child organization ($p=.8$, $B=-.03$, $t(110)=-.251$) and cohesion ($p=.89$, $B=.014$, $t(110)=.14$) were not significant in this model. Cohesion reported by parent and children's total problem score reported by parent was the only significant relationship in this model ($p=.035$, $B=-.22$, $t(110)=-2.14$). A regression model was run with the dependent variable being total problem scores reported by child and the reports of cohesion and organization by parent and child ($R^2=.108$, $F(4, 96)=2.92$). Child cohesion ($p=.65$, $B=-.045$), parent organization ($p=.097$, $B=-.18$, $t(100)=-1.68$) and cohesion ($p=.38$, $B=.095$, $t(100)=.88$) were not significant in this model. Within this model, the child report organization was the only significant relationship to total problems reported by child ($p=.02$, $B=-.24$, $t(100)=-2.36$).

Discussion

This study aimed to examine if reports of family cohesion and organization are associated with children's psychological functioning. The study also aimed to examine if lower levels of agreement on family environment is associated with children's psychological functioning. Both hypotheses were supported by the data analysis, though within person effects were stronger than cross-informant effects. The hypothesis that family environment reports would be associated with psychological functioning was supported by the results. The hypothesis that lower levels of agreement would be associated with worse psychological functioning was also supported by the results.

This study helped fill in some of the gaps from previous research which has relied almost completely on reports from only one informant and on samples lacking in socioeconomic and racial diversity. This study used both parent and child reports for family environment and psychological functioning. Our participants were ethnically diverse as well as low income. Further, there is a dearth of research on parent-child agreement on family environment, and hence, examining parent-child agreement was one of the aims for the study. Since the design of the study was cross-sectional, we are unable to determine the direction of the correlations. The results of this study suggest that parent FES reports are not associated with children's FES reports. This was especially true for reports of organization in the home as correlations were quite small. This could be because children may feel differently about things such as rules and responsibilities than their parents do. The negative relationship between parent-reported cohesion and child-reported cohesion approached significance. Since the cohesion relationship is negative, this could mean that their opinions of cohesion in the home differ vastly. Children may be better raters when it comes to cohesion in the home. If the sample size were larger, this correlation would likely have been significant and would help inform the research more. Consistent with our hypothesis, we did see that the parent reports of FES were correlated with parent reports on total problems.

The positive correlation between parent reports on organization and cohesion infers that there is overlap on agreement of these two variables and that parents are consistent in their reports of family environment. The negative correlation between parent reports of cohesion and parent reports on total problems means that when parents reported a higher level of cohesion, they reported lower total problem scores. This supports the hypothesis that higher levels of cohesion would be associated with better psychological functioning. The correlation between parent organization and total problems reported by children was close to significance. This negative relationship could mean that when families have more structure, the psychological functioning of the child improves. Cohesion seems to be the more crucial factor in predicting psychological functioning of children in this model. The negative relationship between parent organization and total problems reported by parent could mean that higher levels of organization benefits children's psychological functioning. This relationship supports the initial hypothesis that higher levels of family organization would be associated with better psychological functioning. This relationship could mean that parents are more reliable when it comes to levels of organization in the home and how they affect children's behaviors.

The relationship between child reports of organization and child reports on cohesion were positive which infers that child are consistent when reporting on these variables. Child report on organization was negatively associated with total problems reported by child which infers that high organization levels are associated with lower total problems.

This relationship could be because things such as routines and responsibilities help maintain structure in the home which can improve psychological functioning. Children may also be better raters of their psychological functioning than parents as they are the ones experiencing symptoms. The positive relationship between parent reports on total problems and child reports of total problems may infer that typically, they agree on the child's psychological state. The reason we believed this is that it can be hard for a parent to truly know how their child is doing as sometimes psychological problems are internalizing symptoms. The child may also not be comfortable telling their parents about their struggles.

The agreement regression model was positively correlated with parent cohesion and organization. The agreement score for cohesion was negatively correlated with parent reports of total problems which infers that cohesion is an important predictor of child total problems; When agreement is low on this variable, levels of total problems will be high. The agreement score for organization was also negatively correlated with total problems reported by the parent. This suggests that low parent-child agreement on family will be associated with higher total problems. These correlations help inform us that how well parents and children agree on family environment can affect psychological functioning. The regression model that used the agreement scores and total problems reported by child was not significant which lines up with the correlation table as it was not significant in the table. This could be that child reports are not as reliable as parent reports. It could also be that our sample size was low.

The regression model showed that parent-child agreement on family cohesion was more strongly associated with children's emotional and behavioral functioning than was agreement about family organization. This could be due to several factors. This could mean that cohesion is a more reliable predictor of psychological functioning. It could also be that cohesion is easier to report rather than the different variables involved in organization. Parent and children could also disagree more on organization as it has to do more with rules and routines. Similarly, parent-reported cohesion was the only variable out of the full set of family environment variables that significantly predicted parent-reported total problems. This pattern of findings suggests that strong relationships among family members can foster a positive environment and help children be emotionally healthy. In the regression model containing all the family environment variables to predict child-reported total problems revealed that child-reported family organization was the only significant predictor in the model. This could reflect that when children feel like there is more structure in the home it can buffer psychological symptoms. This is consistent with existing research showing that children from highly organized homes have better psychological health.

This study had a few limitations. Since I used existing data, I did not get to conduct my own experiments and had to adapt to what was available. The data I used was collected during pre-test for the BaSICS intervention. In the future, analyzing the post-test and follow-up assessments could lead to better understanding of the direction of the correlations. We would be able to make more inferences with longitudinal data. In future research, it will be important to include covariates such as race and ethnicity to understand the effects of these important demographic factors on the results. Another limitation of this study is that the children themselves were reporting on family environment and psychological functioning. While it is good to have their point of view, children are not the most reliable reporters. Furthermore, self-report measures can contain biases. Future research should examine the extent to which these findings would be similar when examining other psychological outcomes.

To conclude, family environment is associated with children's psychological functioning. Cohesion seems to be more significant when looking at total problems reported by parents whereas organization seems to be more significant when looking at total problems reported by child. Further, the extent to which parents and children agree about the quality of their home environment appears to be a phenomenon worthy of continued study.

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Tables
Table 1. Within Person and Cross-Informant Correlation

	1	2	3	4	5	6	7	M(SD)
Parent re Cohesion	-							6.94(1.57)
Parent re Organization	.399**	-						6.06(2.13)
Kid re Organization	.033	.098	-					6.19(1.84)
Kid re Cohesion	-.179	-.052	.341**	-				6.94(1.57)
Total Problems K re K	.022	-.175	-.285**	-.146	-			53.37(10.78)
Total Problems P re K	-.281**	-.228*	-.043	.054	.245*	-		56.28(12.52)
Standardized Residual C	.984**	.403**	.097		-.002	-.276**	-	
Standardized Residual O	.404**	.995**		-.086	-.149	-.226**	0.395	

Note: Correlation is significant: p<0.01**, p<0.05*

The Real Stressors of College Students: Factors Predictive of Academic Engagement

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Abstract

Stress is known to be a pressure many college students experience, likely impacting their success. However, little is known about the types of stressors experienced and how stress relates to academic engagement. The purpose of this study is to explore stressors students experienced during an average school week and how factors such as stress, morning outlook, and personal resources predicted studying behavior. Using Ecological Momentary Assessment, college students (N= 108) provided daily information about their stress experiences and studying routines. Students experience an average of two stressors a day, and the most reported stressors were school and time pressure. A positive relationship was found between stress and studying, and morning outlook was predictive of studying behavior. Results provide information applicable to student supports.

When examining students' relationship with stress, academics are automatically involved, particularly academic engagement —the dedication and commitment a student prescribes to their studies. Every student commonly has one objective, to learn and obtain knowledge. Mitchell et al. (2005) stated that students who are focused on education believe that their focus will propel their learning ability. No matter how dedicated and committed students may be, it is likely that stress may find its way into the equation. The stress of academics, new social climates, and living environments are always present (Leppink et al., 2016). There are also work, time, and money pressures that may cause students to lose focus and feel stressed. It is up to each student to use their resources to overcome stress and focus on their studies.

Student Stress

In 2019 alone, more than half of college students reported "overwhelming anxiety and tremendous stress." One year later, students' stress levels surged with the presence of the global pandemic (Hoyt et al., 2020). The understanding of student's experiences and relationship with stress was described by Krypel and Henderson-King (2010) as perceived stress, "a person's perceptions of the stress than by objectively measured stress in the situation" (p. 411). How a student experiences their stress and identifies with it is one of the main components for identifying the scenarios stemming from their stress.

It is helpful to understand why some individuals are more resilient to stress than others, particularly to advise students on effective stress management and academic engagement strategies. It was argued that optimism is a resource that may be utilized to combat the adverse effects of stress. Optimistic students are defined as students who have "positive expectations for the future" (Krypel & Henderson., 2010).   Remaining optimistic in stressful situations as a student means there is almost always a presence of a positive outlook. Krypel and Henderson (2010) stated that Optimists are believed to experience fewer burnout symptoms and combat educational challenges encountered.

It is also helpful to understand why some individuals are more resilient to stress than others, particularly to advise students on effective stress management and academic engagement strategies. Initial findings shared by Maykrantz and Houghton (2020) examined self-leadership as "a process of self-influence through which individuals lead themselves" as a possible distinguishing factor for those who were successful in managing their stress and anxiety (p. 81). Amanvermez et al (2019) conducted a study to examine the effects of stress management interventions in reducing stress, depression, and anxiety among college students. The study participants were students with high stress/ anxiety levels, which were described as high levels of cortisol or high scores on stressful event evaluation and checklist. The results from the study indicated that stress management interventions might be effective in reducing distress among college students. Understanding sources of stress and the role of stress in academic engagement can help inform stress management interventions with greater precision.

Academic Engagement

In the 1980s, the projected time to complete a college degree was four years. Since the early 2000s, the same degree is projected to take six years (Moody et al., 2020). There have been many questions around why undergraduate degrees have become more time-consuming. One possible answer is student engagement. A student engagement study conducted by Mitchell and co- contributors' objective was to increase the quality of the courses offered at their university. They believed that a student's engagement might vary depending on the course, so two studies were developed to examine that theory. The first study theorized that "student engagement measure would be related to two types of self-reported engagement: (a) absolute engagement in their present course and (b) relative engagement, a judgment of how engaged students are in a particular course compared with how engaged they are in other courses. The second portion investigated the utility of the Student Course Engagement Questionnaire by testing it concerning grades. Mitchell et al (2005) hypothesized that more focused students would do better in class than those who were not. Both studies discovered four dimensions of college student engagement —skill engagement, participation/ interaction engagement, emotional engagement, and performance engagement.

Academic Psychological Capital

Some students have higher levels of psychological capital (PsyCap) which are the "positive psychological resources of hope, efficacy, resilience, and optimism" (Luthans et al., 2014, p. 191), simply a skill that may help a student better face adversity, such as stress. A person with higher psychological capital levels has a better chance of work-based positive outcomes (Luthans et al., 2016). Avey et al (2019) conducted a study that described PsyCap as a "positive strength" to combat career stressors (p. 680). Academic psychological capital is not only a construct that describes attributes that may have some advantages in certain situations. It

goes beyond what someone may know or whom they know but is more about who they are and the potential for greatness within that individual (Luthans et al, 2016).

There is reason to believe that PsyCap makes students more successful. The presence of positive psychological resources such as efficacy is a positive predictor of academic performance for a college student (Luthans et al., 2014, p. 193).

A study conducted by You (2013) discovered that PsyCap has a meaningful relationship with learning empowerment and academic engagement. His findings went on to imply "PsyCap promotes an individual's motivation for learning and ultimately enhances learning engagement" (You, 2013, p. 22)

While there is abundant research surrounding the validity of college students' stress, there seems to be a deficiency in literature in the type of stressors students are experiencing and how stress relates to academic engagement. This study will analyze the relationships among stress, academic engagement, morning outlook, and academic psychological capital. The following research questions will be addressed:

Research Question 1: What is the relationship between stress and academic engagement?
Research Question 2: What kind of stressors were reported by students, and with what frequency?
Research Question 3: What is the relationship between Stress, Morning Outlook, PsyCap, and Academic Engagement?

Method

Participants and Procedures

The data from the ENGAGE study was conducted by Dr. Allison Fleming and her co-investigators during the 2018- 2019 academic year. One hundred eight students were enrolled and registered as participants in the study. Females comprised 72.2% of the sample, and 26.9% were male. Fourteen students were first year, 25 were second year, 36 were third year, 30 were fourth year, and three were fifth or more. The data was collected using the Ecological Momentary Assessment (EMA) method, asking questions in real-time and within respondents' natural environment allowing greater response accuracy.

Measures

Demographics: Participants were asked to disclose their gender, race/ ethnicity, age, and grade level.

Phone Ambulatory Assessment: The participants carried a lab-owned smartphone and were expected to respond to six surveys 7 days of the week. The questionnaire was divided into three sections wake up survey, Mid-day survey, and nighttime survey. The wake-up survey was expected to be completed upon waking up. The mid-day surveys were randomized with two-hour intervals. The final set of questions, the nighttime survey, was completed before bed after the last randomized mid-day survey.

The morning survey targeted uncovering data about forecasting, sleep, and cognition. The mid-day beeps target was feelings, cognition, time pressure/ distraction. Finally, the nighttime survey focused on feelings, cognition, time pressure/ distraction, behavior ratings, and stressors recap. Some sample questions asked in the survey were "How stressful do you expect today to be?", "What is your level of worry?" "Has anything stressful happened to you since the last beep?" and "How much did stress interfere with your schoolwork today?" The majority of the answers were provided using a scale ranging from *not at all* to *extremely*, and some questions prompted participants to specify their answer themselves or answer with a simple yes or no.

Results

The correlations between various variables were examined to approach the first research question, what is the relationship between stress and academic engagement? The data (Table 1) indicated that when students were more stressed, they tend to have a higher rate of studying when they have the opportunity (r=.218). There was also a positive correlation between stress and stress interference throughout the participant's day (.811*).

Table 1.

Correlations among Attended Class, Studied, Stress Now, and Stress Interference variables.

	M	sd	1	2	3	4
1. Attended Class			X			
2. Studied			.216*	X		
3. Stress Now			-.089	.284**	X	
4. Stress Interference			-.153	.127	.811**	X

*=p<.05
**=p<.01

The second question, "What kind of stressors were reported by students, and with what frequency?" was examined by looking closer at the responses from the behavior wrap up questions asked. During the night questionnaire, the students were asked about the stressors they experienced. Students could select all that applied, or "none." The participants reported a total of 593 stressors throughout the study. The participants experienced an average of two stressors a day (Table 2). In the order of School (56.3%), Time Pressure (43.8%), Personal Arguments (26%), Money (22.8%), Work/Romantic relationship (18.5%), Discrimination/ Other (2.7%), and Bullying (1.3%).

Table 2. *Frequency of Student Stressors*

	N	Mean *(sd)*
Personal Argument	154	.26 *(.439)*
Romantic	110	.19 (.389)
School	334	.56 (.496)
Work	110	.19(.389)
Money	135	.23(.420)
time	260	.44(.497)
Discrimination	16	.03(.162)
Bully	8	.01(.115)

Other	97	.16(.370)
Total	593	2.07(1.634)

To address the third question, what is the relationship between stress, morning outlook, PsyCap, and academic engagement? - a closer look was taken at variables stress now, academic PsyCap, and forecast optimism. It was discovered that Stress and Morning Outlook both predicted studying, but Academic PsyCap did not. Academic PsyCap was found to only have a correlation to the total study quality variable, which was readiness to study, organization for studying, and remaining up to date with studying.

Table 3. *Regression among Variables*

Predictor	B(SE)	p-value
Stress Now	.315(.005)	.001
Academic PsyCap	.000(.000)	.996
Forecast Optimism	.255(.005)	.012

    a. *Dependent Variable: studied mean (Adjusted R= .118)*

Discussion

To sum up the findings, stress was positively related to academic engagement, as operationalized as studying. This finding makes sense within the context of the types of stressors reported. The most common stressors were school and time, indicating that students' most significant stressors were school-related. The way to address this kind of stress is to engage academically, as these behaviors (studying, attending class) will make success more likely. The predictors of studying behavior also included optimism but did not include academic PsyCap.

      The study results indicated that how a person approaches their day could serve as a precursor for how that day goes. The students who answered positively to the question "today is going to be a good day" were more likely to have a good day, simply the self-influence instilled by students may have the potential to control many other factors. Luthans et al (2014) defined optimism as an expectation of future success. Students with a positive outlook are more motivated to achieve goals at a higher rate. Our findings also indicated that stress is a potential motivator, as stress was positively related to studying behavior. The main stressors discovered, school and time pressures, were both related to school. Even though stress is seen as having a positive relationship with academic engagement in this study, moderation is also vital to help students have a healthy balance. Chiauzzi and colleagues (2008) developed an intervention named MyStudentBody—Stress to boost stress management skills and healthy behaviors for U.S. college students. MyStudentBody—Stress was a website that prompted students to answer a five-question questionnaire about their stress levels. After submitting responses, the student would receive a report that featured positive affirmations, among other things. Chiauzzi et al (2008) observed that their intervention could decrease anxiety levels and increase the use of specific stress management skills. Interventions such as Chiauzzi et al could be the answer to healthy intervention to help moderate the levels of stress college students experience.

There were some limitations encounter during this study. First, this study was a secondary data analysis, meaning that questions were constrained to the information available. The data collected was self-reported, and we are assuming that students reported their activities and feelings accurately and honestly. A third limitation was the collection of our data. The observations were limited to one week. We assumed that we were catching a typical week, but there is a chance that participants provided data during an abnormal week that was not representative of their normal habits.

Implications for Student Support

The study provides additional understanding of student experiences with stress in a daily context. Understanding that stress is a potential motivator offers an opportunity for University's administration and faculty to approach the topic differently. A perspective that makes moderation their focal point. The Pew Research Center stated that the purpose of a student is to "grow personally and intellectually" (Heimlich, 2011). Many forget that there is more to a student than being a student. There is a personal aspect to their lives, which should not be forgotten to pursue a degree.

There is space and opportunity for interventions such as MyStudentBody that helps record and assess stress levels so students and faculty can realize and intercept themselves whenever their levels may seem too high. Aside from the top two stressors being school and time pressures, other stressors demand just as much attention, such as personal arguments, money, and work. Policies that focus on supporting students outside lives stressors could effectively balance the level of stress students experience every day. Something as simple as introducing daily mindfulness routines could be a great introduction to the new approach.

Many institutions have programs that focus on the well-being of a student's mental health. The problem is that many students have no knowledge of their resources, especially following a year impacted by COVID-19, where much of the on-campus presence and experience was altered or missing. There can be much more done to make students aware of what their schools have to offer. Even though universities may have such resources, there is always space for improvement. The students' voices are essential and should be listened to because the resources offered are outdated and may need updating. In conclusion, conversations between administrations and the communities they serve maybe the key to may forward more positively.

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COVID-19 Awareness Variance
Among Black Americans and Healthcare Workers

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<u>Abstract</u>

Background: This study examines differences in COVID-19 awareness among Black Americans versus those of other races as well as healthcare workers versus non-healthcare workers. COVID-19 awareness is also assessed based on sociodemographic factors including gender, age, level of education and social standing.
Methods: Data from a cross sectional online survey sent out by Pennsylvania State University's College of Medicine was utilized. The sample of American adults (n=1583, Black=76, non-Black=1507, mean age= 48.2) responses to 7 true/false COVID-19 knowledge questions and self-report demographic information was analyzed.
Results: Lower levels of COVID-19 awareness and social standing were observed in Black Americans compared to those of other races, even after adjusting for other demographic information. Higher perceived social standing and higher levels of education were also uniquely associated with higher levels of COVID-19 awareness. Healthcare workers also tended to have higher levels of COVID-19 awareness regardless of professional role.
Conclusions: Based on these results, there are disparities in health awareness, which can influence health behaviors and status. More research is needed to determine causes (e.g., access to health information resources) and address gaps in public health messages.

<u>Introduction</u>

The COVID-19 pandemic has further amplified health inequities within the Black population in the United States. Systematic racism has resulted in decreased access to quality healthcare, lower socioeconomic status, increased risk for chronic diseases and lower quality of education in Black communities (Perry et al., 2020; DiMaggio et al., 2020). These factors pose a disproportionate risk for COVID-19 infection and death for African Americans. Studies on the COVID-19 data have reinforced this inequity as African Americans are at a 5 times greater risk of contracting COVID-19 and also have higher death rates at 40% while African Americans make up 14% of the population (Souza et al., 2020; DiMaggio et al., 2020). Thus, the purpose of the study is to examine the relationship between Black race and the amount of COVID-19 awareness.

Previous studies have found a causal relationship between level of health literacy and health behaviors in patients with Diabetes, as well as other chronic diseases (Kim et al., 2010; Chollou et al., 2020). Based on this, an individual's education level may play a factor in the amount health knowledge and the precautions engaged in during the COVID-19 pandemic, such as social distancing and wearing a mask. There is also evidence of poor quality of education within public school systems in predominantly Black areas, exemplified by achievement gaps reflected in data reported by the U.S. Department of Education (Brey et al., 2019). This may contribute to the comprehension of medical jargon surrounded COVID-19 and understanding how to navigate health services (Brey et al., 2019). However, limited literature has explored racial differences in COVID-19 awareness, which could be useful in understanding racial disparities in COVID-19 cases and deaths.

Prior health disparities literature has indicated that race does not entirely explain disproportionate rates of adverse health outcomes, such COVID-19 deaths (Khariton et. al., 2018). Sociodemographic factors such as social standing, age, gender, and type of employment (e.g., medical/health occupation) have also accounted for health disparities (Ezeamama et al., 2016; Roberts et al., 2021). For example, previous studies have found that higher perceived social standing is associated with better health outcomes in HIV patients (Ezeamama et al., 2016). In addition, minorities have also been found to have more chronic conditions and behavioral risk factors in Prostate Cancer survivors (Roberts et al., 2021). With social status implicating health status, it can also be hypothesized that employment within the medical field may play a pertinent role in accessing health information (Hossain et al., 2021), which may not be readily communicated in the public section. For example, high levels of knowledge have been reported in Healthcare workers (Hossain et al., 2021). Furthermore, levels of health literacy/awareness may also vary depending on the role within the medical field, such as Physicians or Nurses. Currently, Black Americans account for 11.6% of the US Workforce, while only representing 5.7% of Advanced Practice Nurses and 4.8% of Physicians (US Department of Health and Human Services, 2011-2015). However, there is greater representation of Black Americans in Technologist/Technician roles and support roles (e.g., Home Health, Nursing Aides, and Medical Assistants), which tend to have lower salaries (US Department of Health and Human Services, 2011-2015). Thus, the association between sociodemographic factors (e.g., race and socioeconomics) and health literacy awareness may vary by medical employment status. By examining the knowledge levels of Black Americans and other sociodemographic factors on COVID-19 protocols, this association between health literacy and behaviors may also address some of the disparities in health promotion campaigns.

Thus, the current study will explore the following aims. The first aim will examine whether awareness of COVID-19 varies between Black adults and adults of other races. The second aim will examine how demographic factors (age, level of education, perception of social standing, race) relate to COVID-19 awareness. The third aim will examine the relationship between COVID-19 Awareness and healthcare employment and whether this association varies by demographic factors (race, levels of education, and social standing).

Methods

Participants

The data used for this research was collected from a cross-sectional online survey that occurred from April 9 to July 12, 2020. A total of 5,005 people completed the survey. Participants were recruited through snowball sampling. Snowball sampling is a recruitment process that used press releases from Penn State University College of Medicine and shareable social media links.

Measures and Procedures

This survey was adapted from another survey in partnership with the College of Healthcare Information and Management Executives (CHIME). To assess COVID-19 knowledge, responses to the 7 true/false questions about social distancing and COVID transmission will be analyzed in terms of sum of correct responses. Social standing was assessed from the responses to the MacArthur Scale of Subjective Social Status. This scale asks participants to rate their social status from 0 (low) -10 (high). Demographic data, such as race, gender, age, and levels of education (0 (did not finish high school/secondary school) – 5 (graduate degree)) were gathered through self-report from participants.

Statistical Analyses

For the research methods, a statistical analysis of data from a cross-sectional survey will be conducted using SPSS. An ANOVA or t-test will be used to assess for differences in knowledge by race. In order to examine the influence of demographic factors, correlation between these factors and COVID-19 awareness will then be computed. A regression model will then be utilized to determine the relationship of age, social standing and race on COVID-19 knowledge. Correlation and a regression model will also be computed to determine the relationship between employment in healthcare and COVID-awareness. This will also be analyzed to identify how race, age and social standing interact with this relationship. For the final research question, a regression model was conducted and included interaction terms (e.g., medical profession*Black race; medical profession*levels of education; medical profession*social standing) to explore whether the association between medical profession status and COVID-19 awareness varied by demographic factors.

Results

The current study included 1,583 participants with complete data across the measures of interest. The total sample had a mean age of 48.2 years (SD=15.67, range=18-97; see Table 1 for demographic characteristics of the sample). A majority (n=1178; 74.4%) of the participants were female. The participants' average social standing was 7.07 (SD=1.55), which suggests a relatively high perceptions of social standing. Approximately, 20.3% (n = 322) reported working in a medical profession (Nurses n = 43, Physicians n = 59, Nurse Practitioners n = 12, Physician Assistants n = 4, Administration n = 36, other clinical staff= 64 or non-clinical staff n = 43). Significant racial differences were observed strictly for age and social standing (see Table 1). Specifically, non-Black participants reported being an average of 48.2 years as compared to 39.19 years for Black participants (t(1535) = 5.15, p < .001). Perceived social standing was also significantly lower for Black participants with scores averaging 6.37 (1.84) as compared to 7.11

(1.52) for non-Black participants (t(1523)= 4.06, p < .001). There was not a significant difference in level of education or gender between Black and non-Black participants.

COVID-19 Awareness Survey Descriptive Observations

On average, the sum of correct responses on the COVID-19 awareness survey was 4.24 (*SD*=1.16, range=0-6; see Table 2). Significant racial differences were also observed for the sum of correct responses on the COVID-19 awareness survey (Table 2). Black participants had an average score of 3.74 (SD=1.49) while non-black participants had a mean score of 4.27 (SD=1.13; t(1581)= 3.90, p < .001), which suggests knowledge gaps about COVID-19 between Black adults and other racial/ethnic groups. To delve further into possible reasons for this significantly lower score, frequencies of participants who reported correct responses to each question was estimated by racial groups (Black vs. Non-Black participants). Out of the 7 questions, 2 questions indicated significant racial group differences (Table 2). Specifically, a lower percentage of Black adults (61.9%, n = 47) reported correct responses to Item 3, "A vaccine for COVID-19 is available in some countries", compared to non-Black adults (80.0%, n = 1206; X^2(1) = 14.5, p < .001). Additionally, a lower percentage of Black adults (77.6%, n=59) reported correct responses to Item 7, "Most people who get COVID-19 will survive", compared to non-Black adults (91.6%, n = 1385; X^2(1) = 18.4, p < .001).

Significant differences in correct responses on the COVID-19 awareness survey were also observed between healthcare workers (employed in a medical profession) and non-healthcare workers (employed in non-medical profession; see Table 3). On average, healthcare workers (*M* = 4.43, *SD* =1.08) tended to have more correct responses than non-healthcare workers (*M* = 4.21, *SD* =1.14; t(1581)= 3.904 p < 0.001). Significant differences in terms of correct responses were observed between healthcare professionals and non-health professionals for 2 out of the 7 survey question items. Specifically, a larger percentage of healthcare workers (43.5%, n = 140) reported correct responses to Item 4, "The World Health Organization, European Commission, and U.S. Centers for Disease Control and Prevention all have the same public health recommendations to reduce the spread of COVID-19", compared to non-healthcare workers (33.4%, n = 405; X^2(1) = 11.31, p < 0.001). Likewise, a larger percentage of healthcare workers (57.1%, n = 184) reported correct responses Item 5, "Treatments for mild symptoms of COVID-19 are available without a prescription", compared to non-healthcare workers (47.5%, n = 576; X^2(1) = 9.49, p=0.002). While significant differences were observed between healthcare workers and non-healthcare workers, there was no significant differences on the COVID-19 awareness survey across medical professional roles (Nurses, Physicians, Nurse Practitioners, Physician Assistants, Administration, or non-clinical staff).

Demographic Characteristics associated with COVID-19 Awareness Responses

Pearson correlations suggested that Black race is negatively correlated with COVID-19 awareness based on survey responses, meaning Black race is significantly associated with a decrease in sum of correct responses (r = -0.1, p<0.001). Employment in the medical profession was also found to be positively correlated with COVID-19 awareness survey scores, meaning employment in healthcare is associated with an increase in correct responses to the survey (r = 0.08, p = 0.002). In addition, level of education is also positively associated with an increase in COVID-19 awareness survey scores in a significant manner (r = 0.18, p<0.001). Gender and age were not significantly correlated with COVID-19 awareness and were excluded from the regression model.

Unique Correlates of COVID-19 Awareness Responses

A linear regression model was conducted to determine specific associations between demographic factors and COVID-19 awareness survey responses after adjusting for other demographic characteristics that were also significantly associated with the COVID-19 awareness survey responses (Table 4). Black race was negatively associated with the sum of correct responses even after adjusting for other covariates (β = -0.09, *SE* = 0.15, *p<0.001*). Compared to other racial/ethnic groups, Black adults tended to have lower total correct responses on the survey. In contrast, social standing, level of education and medical employment are positively associated with COVID-19 awareness. Thus, higher social standing is uniquely and significantly associated with a higher sum of correct responses on the COVID-19 awareness survey (β = 0.18, *SE* = 0.02, *p<0.001*). Higher levels of education are also positively and significantly associated with COVID-19 awareness (β = 0.18, *SE* = 0.03, *p<0.001*). Similarly, healthcare employment is associated with a higher sum of correct responses on the COVID-19 awareness survey (β = 0.08, *SE* =0.07, *p<0.002*).

In a second regression model that included 2-way interactions (Table 4), a significant 2-way interaction was observed between social standing and healthcare profession status (β = -0.10, *SE* = 0.05, *p<0.01*). As illustrated in Figure 1, an increase in total correct responses on the COVID-19 awareness survey was associated with a higher social standing, particularly for non-healthcare workers *(b = 0.13, p < .001)*. Non-significant results were found for the other interaction terms (Back race* medical employment; level of education*COVID-19 awareness).

<u>Discussion</u>

In this study, Black Americans were found to have significantly lower average correct responses about COVID-19 awareness. Specifically, Black Americans scored lower on the COVID-19 awareness questions regarding availability of the COVID-19 vaccine and likelihood of COVID-19 survival. Since this study's survey was sent out many months before a vaccine became available, it is unclear whether knowledge levels improved over time. Still, these observed racial differences in COVID-19 awareness support other studies that have observed similar racial differences in COVID-19 knowledge, particularly between Black adults and non-Black adults (Shafiq et al., 2021; McCormack et al., 2021). These trends point towards greater social inequalities in health knowledge, which has been exemplified in the COVID-19 pandemic. It speculated that these racial differences can be attributed to social inequalities with health promotion campaigns. Thus, this finding highlights a potential need to tailor health promotion campaigns to be culturally sensitive to Black communities. This can be achieved through implementing community outreach programs where Black Americans can interact with health professionals about important information regarding their health and safety. This may combat misinformation about COVID-19 and overall medical mistrust which contributes to issues such as vaccine hesitancy and increased rates and deaths from COVID-19 in Black Communities. There have also been studies which have found that experiencing discrimination in any form can lead to increased mistrust of industries, including the medical industry (Williamson et al., 2019). This study also found vicarious discrimination (e.g., watching others experience discrimination) also breeds mistrust (Williamson et al., 2019). For this reason, it is the responsibility of the public health field to advocate for change in not only eradicating health disparities, but also police brutality, disproportionate imprisonment of Black individuals and poverty. It is not until

this, and many other systematic problems are addressed that the health status and knowledge of Black Americans will improve.

Level of education was found to be significantly and uniquely associated with increased level of COVID-19 awareness. On average, our sample of Black adults had a bachelor's degree/4-year degree, and no significant racial differences were observed between Black and Non-Black participants in levels of education. Thus, despite levels of education increasing the likelihood of COVID-19 awareness, it does not appear to explain the lower levels of COVID-19 awareness observed among our Black participants. A possible explanation may be that Black Americans in this sample also reported a statistically significant lower perceived social standing. Other studies have found that social standing is related to health outcomes and behaviors, which may explain why Black Americans having a lower perceived social standing may contribute to decreased knowledge levels and increased COVID-19 cases/death (Ezeamama et al., 2016). As for other sociodemographic factors examined, age and gender were not found to significantly correlate with COVID-19 awareness. A possible explanation for observation regarding age is that early in the COVID-19 pandemic, older adults were one of the first demographic groups identified in public health to be at-risk for adverse outcomes from COVID-19 (Betti et al., 2021). Thus, COVID-19 information may have targeted to older adults through several outlets, such as family, friends, medical healthcare providers, and general media. The lack of findings regarding gender could be due to our unbalanced sample size across our gender categories with a larger percentage of females representing our total sample.

Unlike much of the prior published literature on COVID-19 awareness, this study has strived to unveil how healthcare employment may further contribute to COVID-19 knowledge gaps, specifically among Black Americans. Healthcare employment was hypothesized to be an important influence on COVID-19 awareness levels given the increase likelihood healthcare workers would be exposed to information which pertains directly to the pandemic but may not be clearly and consistently communicated to the general public. For the results on healthcare employment, significant results were found regarding increased COVID-19 awareness of healthcare professionals as compared to non-healthcare professionals. More interestingly, there was not a significant difference in awareness levels based on the role within the healthcare field. Meaning simply being employed in a healthcare setting, even in non-clinical roles leads to greater knowledge about COVID-19. As for the specific questions with the most significant difference, one was asking whether there was a difference in COVID-19 recommendations based on different organization. This reflects adequate education provided to healthcare professionals about the pandemic and different health entities, such as the Center for Disease Control versus the World Health Organization. The second question which healthcare professionals answered more correctly was whether there are treatments for mild symptoms of COVID-19 available without a prescription. This observation reflects increased knowledge about over-the-counter medications to help symptoms such as ibuprofen.

While these results seem promising, there is a decrease in the entrance of Black Americans and other minorities into the healthcare field (Salsberg et al. 2021). Thus, the opportunity to obtain health information privy to healthcare professionals may be restricted from minorities, as they are underrepresented in this sector. As such, this may exacerbate the already existing knowledge gaps regarding recognizing adverse health symptomology and seeking trustworthy healthcare. Finally, it is warranted to note that despite healthcare workers tending to have higher COVID-19 awareness than non-healthcare workers, the sample of healthcare workers, on average, correctly answered approximately 4 out the 7 COVID-19 awareness questions correctly.

In particular, less than 50% correctly answered questions regarding the "Virus can be transmitted if asymptomatic" and "Public health recommendations are same by organization". Although it was surprising to observe these findings among healthcare workers, it is possible that these observations may be a result of the timing of the survey, as the survey was distributed during the early height of the pandemic. At this time health providers and researchers were still grappling with to understand the underlying mechanisms and transmission of the virus.

To further analyze the trends, interaction terms were also utilized to understand how sociodemographic factors impact COVID-19 awareness more specifically. Of these interaction terms, the only one which was significant was the 2-way interaction between social standing and healthcare profession status. For non-healthcare professionals, increasing social standing was associated with increased COVID-19 Awareness (Figure 1). Whereas social standing did not impact COVID-19 awareness for healthcare professionals, meaning there are no racial barriers to obtaining information for medical workers based on these results. The other interactions terms medical profession*Black race and medical profession*levels of education did not significantly interact with COVID-19 awareness levels.

A few limitations of the study are worth mentioning that could further explain the current observations. The sample of Black participants was generally small at 76 people, as compared to the 1,507 non-Black participants. While significant results were still found, greater diversity of the sample may have given more insight to the heterogeneity of COVID-19 awareness that may be observed with Black participants as observed for other health factors (Khariton et al., 2018). Particularly more diversity in regard to socioeconomic status (e.g., income and financial strain) measures, which were not included in this study, as well as level of education and race, would have been more representative.

As many health disparities exist within the COVID-19 pandemic, exploring the variance of knowledge levels particularly among groups at risk for inequitable health resources and adverse health outcomes is vital. While racial differences in COVID-19 cases, deaths, and resources have been documented (Souza et al., 2020; DiMaggio et al., 2020), the current study is one of the few studies to explore and observe that the relationship of COVID-19 awareness levels across several sociodemographic factors (e.g., age, race, gender, level of education, social standing). As suggested in prior literature, health inequalities in COVID-19 (including awareness) are not fully understood given increased rates of chronic diseases and environmental factors (e.g., population density) has not been found to fully explain these disproportionate trends (DiMaggio et al., 2020). Understanding the relationship between COVID-19 health knowledge and sociodemographic will allow for insight on potential reasons for health disparities within the pandemic and assist in developing methods to combat these disparities.

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Table 1

Participant Characteristics & Racial Differences in Characteristics

	Total Sample (n = 1583)		Black	Non-Black	
	n(%)	Mean (*SD*)	(n = 76)	(n = 1507)	P-value
Age	-	48.20 (15.67)	39.19(13.18)	48.66(15.65)	**0.001**
Level of Education[a]	-	4.14 (1.15)	3.95 (1.21)	4.15 (1.14)	0.137
Gender					0.316
Female	1178(74.42)	-	55 (72.4)	1123 (81.54)	
Male	337 (21.29)	-	20 (26.31)	317 (21.04)	
Non-binary	5 (0.32)	-	0 (0.00)	5 (0.33)	
Refused to Answer	15 (0.95)	-	1 (1.32)	14 (0.93)	
Social Standing	-	7.07 (1.55)	6.37 (1.84)	7.11 (1.52)	**0.001**
Medical Professional	322 (20.34)	-	18 (23.68)	304 (20.17)	0.552

Note. **Bold** terms indicate significant findings. [a]Total sample, Black sample, and Non-Black level of education means reflects at least at bachelor's degree/4-year degree.

Table 2

COVID-19 Awareness Correct Responses in Total Sample and By Race (Black vs. Non-Black)

	Total Sample	Black	Non-Black	P-value
Gathering outdoors is safer (Item 1)[a]	1448(91.5)	71(93.4)	1377(91.4)	0.533
Virus can be transmitted if asymptomatic (Item 2)[a]	81(5.1)	1(1.3)	80(5.3)	0.123
A vaccine is not available (Item 3)[a]	1253(79.3)	47(61.8)	1206(80.0)	**<0.001**
Public health recommendations are same by organization (Item 4)[a]	1024(35.3)	28(36.8)	531(35.2)	0.775
Treatment for mild COVID-19 symptoms available over the counter (Item 5)[a]	780(49.3)	31(40.8)	749(49.7)	0.129
Positive antibody test does not determine date of contraction (Item 6)[a]	1147(72.5)	47(61.8)	1100(73.0)	0.034
Most people who get COVID-19 will survive (Item 7)[a]	1444(91.2)	59(77.6)	1385(91.9)	**<0.001**
Sum of correct responses[b]	4.24(1.7)	3.74(1.5)	4.27(1.1)	**0.003**

Note. [a]Numeric values reflect frequency count (percentage). [b]Numeric values reflect mean (standard deviation).

Table 3

COVID-19 Awareness Correct Responses in By Medical Profession Status

	Non-Medical Profession (n = 1213)	Medical Profession (n = 322)	P-value
Gathering outdoors is safer (Item 1) [a]	1113(91.8)	293(91.0)	0.661
Virus can be transmitted if asymptomatic (Item 2) [a]	65(5.4)	14(4.3)	0.466
A vaccine is not available (Item 3) [a]	970(80.0)	249(77.3)	0.298
Public health recommendations are same by organization (Item 4) [a]	405(33.4)	140(43.5)	**<0.001**
Treatment for mild COVID symptoms available over the counter (Item 5) [a]	576(47.5)	184(57.1)	**0.002**
Positive antibody test does not determine date of contraction (Item 6) [a]	876(72.2)	242(75.2)	0.292
Most people who get COVID-19 will survive (Item 7) [a]	1104(91.0)	305(94.7)	0.031
Sum of correct responses [b]	4.21(1.14)	4.43(1.08)	**0.002**

Note. [a]Numeric values reflect frequency count (percentage). [b]Numeric values reflect mean (standard deviation).

Table 4

Linear Regression Models to Explore the Association between COVID-19 Awareness Correct Total Responses and Demographic Characteristics

	Model 1 β (SE)	Model 2 β (SE)
Black race	-0.47(0.15)***	-0.39(0.15)**
Social standing	0.11(0.02)***	0.13(0.02)***
Level of education	0.13(0.03)***	0.13(0.03)***
Employment in Healthcare	0.21(0.07)**	1.00(0.37)**
Black race*Medical employment	-	-0.38(0.31)
Social standing*Medical employment	-	-0.10(0.05)**
Level of education*Medical employment	-	-0.01(0.06)
R^2	0.939	0.940
F-Ratio	4673.63	2918.75
p-value	0.000	0.000

Note. Asterisks indicate level of significance as follows: *$p < .05$. **$p <.01$. ***$p <.001$.

Figure 1. Two-way Linear Interaction Model between Social Standing and Healthcare employment
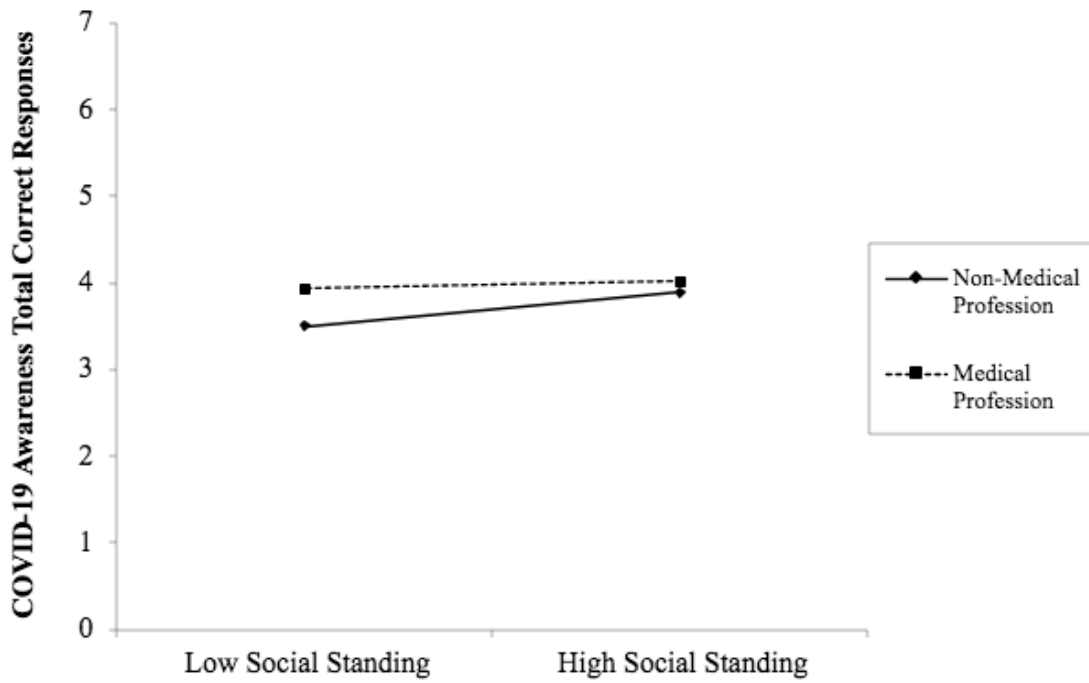
Examining the Risk and Protective Factors of School Behavior Problems and the Consequences for Black Girls

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Abstract

Black girls are disproportionately affected by harsh school disciplinary action and the school-to-prison-pipeline. While previous studies have focused on Black boys, Black girls are a fast-growing, yet overlooked population in the juvenile justice system whose voices and experiences are often muted (Morris, 2012). The purpose of the current study is to investigate if perceived discrimination, parenting, and ethnic-racial socialization (ERS) act as protective or risk factors for school behavior problems and the consequences of suspension/expulsion in Black girls. The Maryland Adolescent Development in Context Study (N_{girls}=410) was used to test the following research question: How do perceived discrimination, parenting, and ERS act as risk or protective factors for school behavioral issues and the consequences in Black girls? More specifically, the study focused on understanding (1) the associations that discriminative experiences, ERS, and parental warmth, monitoring and school-based involvement have with school behavior problems and suspension/expulsion, and (2) whether ERS and other parenting practices moderate the association between discrimination and Black girls' school behavior problems and disciplinary action. Linear and logistic regressions were conducted to investigate the relationship between the variables of interest. Results showed that there was a significant relationship between racial discrimination, parental warmth, and the interaction between both of those variables on school behavior problems. Parental warmth was also significantly associated with suspension/expulsion. Findings additionally revealed that socioeconomic status was significantly associated with both school outcomes.

Black girls are approximately 8% of the K-12 enrollment, yet they make up 13% of all suspended students (Epstein et al., 2017). Previous studies have primarily focused on the racial disparity in disciplinary action for Black boys and relatively, in this domain, more research exists on Black boys than Black girls (Ispa-Landa, 2013; Morris, 2012; Morris and Perry, 2017). This focus is expected, as negative stereotypes of Black boys can contribute to the disproportionate rates of harsh school discipline—which is associated with their overrepresentation in the juvenile justice system (Morris, 2012). Yet, Black girls are the fastest-growing population in juvenile detention centers and still overlooked in the pipeline discussion (Morris, 2012). Between 2002 and 2006, the suspension rate of Black girls increased 5.3%, compared to a 1.7% increase for Black boys (Morris, 2012). Furthermore, research has shown that there is a greater disparity in office referrals between Black girls and White girls than between Black boys and White boys (Morris and Perry, 2017). Black boys are 1.5 times more likely to be disciplined for disobedience and disruptive behavior than White boys (Epstein et al., 2017). In contrast, Black girls are 2.5 times more likely to be disciplined for disobedience and 3 times more likely to be disciplined for disruptive behavior than White girls (Epstein et al., 2017) suggesting that school behavior problems are perceived and handled differently by teachers based on race and gender.

Black girls are not more deviant than other girls, but they still get in trouble at school and are punitively disciplined at higher rates than other girls (Epstein et al., 2017). This disparity could be due to the fact that parents of Black girls are socializing their children to be more aware of racially discriminatory experiences in school, and the girls respond to these experiences out of frustration or anger (Morris and Perry, 2017). Teachers may perceive this behavior to be disobedient or defiant and punish girls instead of acknowledging the discrimination—contributing to their school pushout (Morris and Perry, 2017; Morris, 2012). The concept of parents teaching their children about ethnic and racial identities is called ethnic-racial socialization (Hughes et al., 2003). When parents have conversations regarding race and ethnicity with their children, those discussions could potentially include ways to combat discriminatory experiences. Black youth who have a positive relationship (including parental warmth) with their parent are more likely to experience ethnic-racial socialization in the form of preparation for bias and cultural socialization (McHale et al., 2006). Preparation for bias is how parents make their child aware of discriminatory experiences and identify strategies to cope with it, while cultural socialization is the way that parents discuss cultural values and beliefs with their children. Ultimately, when youth—specifically Black adolescents—experience more ethnic-racial socialization, they perceive more racial discrimination (Cheeks et al., 2020).

However, Black boys and girls have distinguishable school experiences, as Black girls also face gender discrimination. In Western culture, female gender norms include being submissive, fragile, and soft-spoken (Arnull, 2019). Yet, these normative feminine behaviors may not capture the cultural nuance nor the experiences of Black girls. Black girls are often socialized to be independent and strong in order to survive the White and male dominated society that they must navigate (Skinner et al., 2018). Nevertheless, this disposition can also be misinterpreted as "inadequately feminine" by teachers and school administrators (Archer-Banks and Behar-Horenstein, 2012).

Common racial stereotypes like being "loud" and "aggressive" could negatively influence a teacher's perception of a Black girl in the classroom (Archer-Banks and Behar-Horenstein, 2012). When Black girls exhibit defiant or disobedient behavior by their teachers or school administrators, they are also challenging normative feminine roles (Epstein et al., 2017). Studies have shown that Black girls tend to respond to perceived mistreatment by their teacher—either racial or gender discrimination—in the form of "talking with an attitude" and other subjective behaviors (Morris and Perry, 2017). This response can be inaccurately (or inappropriately) perceived as misbehavior by teachers and may result in an office referral followed by other forms of discipline like suspension or expulsion (Morris, 2012).

According to the theory of social reproduction, the design, structure, and practice of educational institutions are intentionally created to reproduce social hierarchies (Morris, 2012). This means that Black youth are more likely to experience (un)intentional discrimination in the classroom by teachers, because schools teach and reinforce the ideas of race, class, and gender (Morris, 2007). The current study will examine how perceived discrimination in the classroom may act as a risk factor for school behavior problems and the consequences of suspension and expulsion in Black girls. In addition, the current study will investigate if parenting and the practice of ethnic-racial socialization could act as protective factors against these outcomes.

Theoretical Frameworks

The current study is guided by several conceptual frameworks and theories which propose that there are both protective and risk factors that can contribute to school behavior problems and the consequences (i.e., suspension/expulsion) among Black girls. Garcia-Coll and colleagues (1996) theorized that incorporating "essential factors" into research for marginalized children will permit a better understanding of their growth and development. The Integrative Model is relevant, as this study will focus on four of the eight constructs from the framework: social position variables, promoting and inhibiting environments, family, and developmental competencies (Garcia-Coll et al., 1996). The Integrative Model (Garcia-Coll et al., 1996) demonstrates how the experience of being a Black girl often includes experiences of discrimination and situates these youth in contexts (i.e., classrooms) that may either promote or constrain their development. Experiences in school may impact how families engage and communicate with each other, particularly impacting socialization, involvement, and parenting style. Overall, the Integrative Model is critical for the framing of this study, as it identifies the necessary factors in understanding the development of Black girls during adolescence. This knowledge, in turn, will aid in evaluating the risk and protective factors of school behavior problems and the consequences for Black girls.

Although the Integrative Model is necessary in understanding the development of Black girls, it does not completely encompass the experiences that Black girls have while in the promoting or inhibiting environment of school. Critical Race Theory (Delgado and Stefancic, 1998) and Critical Race Feminism (Evan-Winters and Esposito, 2010) articulate why Black girls could view school as a promoting or inhibiting environment. Although both Critical Race Theory and Critical Race Feminism include five main components, the most important aspects of the theories are the focus on how race and racism impact the functioning of US society and particularly how the experiences of Black women are inherently different from White men and women (Evan-Winters and Esposito, 2010). United States laws and policies reinforce Whiteness as the norm, and when people of color defy the "normalcy" of Whiteness, they are inherently

punished (Christian et al., 2019), which is reflected in how schools protect Whiteness, more specifically in their codes of conduct.

Many White teachers assert that race is not a contributing factor when they are disciplining their students, but they systemically punish subjective school behavior problems that they associate with African American youth (Serpell, 2020). This colorblind ideology is dangerous, because it disregards the potential, repetitive discrimination that occurs in classrooms when teachers discipline their Black students. Ultimately, Critical Race Theory and Critical Race Feminism are essential to the framework of this study, as they describe why the racial disparity in disciplinary action may exist for Black girls and how discrimination is a risk factor for school behavior problems and suspensions/expulsions.

Given disciplinary action disparities, Black girls may not be as attached to school settings. Weak bonds with prosocial systems, like schools, could create room for deviance to emerge (Hirschi, 1969). Poor relationships, potentially due to perceived discrimination and unintentional bias, between teachers and students could also be linked to school behavioral problems through decrements in teacher-student relationships (Morris and Perry, 2017). Understanding the factors that contribute to school behavior problems and the consequences of suspension and/expulsion in Black girls is imperative to understanding how the school context is either promoting or inhibiting to their development.

Historical Stereotypes of Black Women

The implicit bias that teachers and school administrators have of their Black girls could be rooted in the depictions of Black women through the historical stereotypes of Jezebel, Sapphire, and the Welfare Queen (Epstein et al., 2017; Annamma et al., 2019). **Jezebel** is the hypersexualized and seductive Black woman—which could be a potential reason why many Black girls are frequently punished for violating a school dress code (Epstein et al., 2017). **Sapphire** is the loud and angry Black woman—which could explain why many Black girls are punished for being loud or disruptive in the classroom (Epstein et al., 2017). **The Welfare Queen** is loud and defies authoritative figures (Annamma et al., 2019). This stereotype could explain why Black girls are systematically punished for "talking with an attitude". In a phenomenological study evaluating Black girls "talking with an attitude", it appeared that teachers ultimately responded to Black girls' attitudes with office referrals for being defiant and disobedient (Morris, 2007). It is important to consider this construct, because historically, Black women have been stripped of their femininity in society and upheld a different standard of what it means to be a woman (Morris, 2007; Ricks, 2014). So, when Black girls emulate any of these negative, anti-feminine behaviors in the classroom from the teacher's perspective, they could be viewed as problematic and therefore punished harshly in the form of suspension or expulsion for these subjective offenses.

Adultification in Black Girls

These stereotypes could also contribute to Black girls being perceived as older and less innocent than they truly are (i.e., adultification) (Epstein et al., 2017). Research shows that White women perceive Black girls, especially during early adolescence, as needing less protection and nurturing from adults and taking on adult roles and responsibilities (Epstein et al., 2017). This perception may be related to the fact that Black girls tend to start puberty earlier than other girls, (Carter et al., 2017). More recent studies suggest that earlier onset of puberty is not directly related to deviancy, yet teachers and school administrators still may excessively punish Black

girls because they view them as less innocent and more accountable for their actions than other racial groups (Carter et al., 2017).

Using the Integrative Model, Critical Race Theory/Critical Race Feminism, historical stereotypes and adultification as guiding frameworks and constructs for the current study, it can be implied that there are various factors that inhibit or promote the development of Black girls in the school context. More specifically, there should be a closer examination as to why school behavior problems in Black girls exist. Parents who are aware of potential (un)intentional bias and unfair treatment by teachers and school administrators may proactively engage in practices such as monitoring, school involvement and ethnic-racial socialization to protect their girls from entering the school-to-prison pipeline. With a better understanding of the various contributors to the perceived school misbehavior of Black girls, there may be a decreased likelihood of Black girls entering the school-to-prison pipeline through suspension and expulsion. Below, the extant literature related to the association of Black families and girls' school discrimination experiences, parent-child relationship quality and ethnic-racial socialization on school behavior problems and the consequences of suspension/expulsion is reviewed.

Perceived Racial and Gender Discrimination in School

Discriminatory experiences in school are associated with school behavior problems in Black girls. Research suggests that Black girls may be treated unfairly by their educators, and instead of succumbing to an unsupportive or hostile environment, they respond by speaking up for themselves, which could be perceived as noncompliance (Murphy et al., 2013). Teachers may identify this frustration as misbehavior and punish the girl for acting out. Feelings of unfairness also contribute to Black girls' feelings of alienation in the classroom, where they are likely to perceive discrimination (Gibson et al., 2019).

As previously suggested, this misinterpretation of behavior could be related to the cultural difference between teachers and students (Morris and Perry, 2017). If teachers are unable to connect with their Black female students, they could unintentionally act on harmful biases that make Black girls feel mistreated and unsupported. Therefore, when Black girls perceive discrimination, they may feel the need to defend themselves, which could be interpreted by teachers as disrespect. Studies revealed that Black girls may be disciplined if their teacher feels disrespected by their attitude (Koonce, 2012). Moreover, teachers have been observed to demonstrate less interest in Black girls who are "loud" or "argumentative" further perpetuating the cycle of discrimination and misbehavior (Archer-Banks and Behar-Horenstein, 2012).

In contrast, research has shown that Black girls report fewer disciplinary problems when they have positive relationships with their teachers (Murphy et al., 2013). Studies have also shown that students who perceive their school to be a positive place were less likely to engage in deviant behavior (Griffin et al., 2020). This suggests that while Black students may not be more deviant than their peers, they may not feel as connected or engaged with their school. Discrimination could be a factor in why Black youth could view school as a negative environment (Griffin et al., 2020).

Perceived school discrimination is also associated with higher rates of suspension and expulsion. In a comparative study between African American girls and Caribbean Black girls, it was found that African American girls were more likely to perceive discriminatory acts in school and be suspended/expelled more frequently (Butler-Barnes and Inniss-Thompson, 2020). If a Black girl perceives discrimination from her teacher, she might adopt an "attitude" as a defense mechanism, which may result in her teacher referring her to the office to be disciplined (Koonce, 2012).

Research is limited on how perceived discrimination and school behavior problems, including the consequences of suspension/expulsion, are associated in Black girls, however this study aims to add to this topic of growing interest.

Undeniably, school behavior problems and the consequences of suspension/expulsion appear to be related to discrimination. While Black girls do not necessarily exude higher rates of delinquent behavior, they may be more likely to be perceived as "troublemakers" in the classroom by their teachers if they are perceived to be acting out. Therefore, they experience higher rates of office referrals (Rocque, 2010). Higher rates of office referrals are associated with higher rates of suspension/expulsion (Rocque, 2010; Epstein et al, 2017).

Parenting: Warmth, Monitoring, and School Involvement

While perceived school discrimination could potentially be a risk factor for Black girls' school behavior problems and their consequences, the relationship that parents have with their children could be protective factor. Out of the six dimensions of parenting, parental warmth and control were found to be negatively related to delinquent behavior and school behavior problems (Bean et al., 2006). Researchers have additionally found that positive parent-child relationships are associated with fewer delinquent behaviors; while a lack of parental monitoring is associated with higher rates of delinquency (Hair et al., 2008; Steinberg et al., 2004). Even though these studies were not exclusively with Black girls nor did it discuss suspensions/expulsions, it suggests that adolescents who have positive relationships with their parents are less likely to get in trouble at school and exhibit delinquent behavior.

Parental school involvement may also be related to a child's behavior at school, and the outcomes that follow. In one study with African American parents and students, parental school-based involvement seemed to be an important point of intervention for disciplinary action. (Serpell, et al., 2020). The findings from this study showed that increased parent involvement was positively associated with more academic achievement and less problem behavior (Serpell et al., 2020). Research has also shown that parental school involvement is a significant predictor of suspension (Marcucci, 2020) In one study, school-based involvement was positively associated with discipline referrals (Hayes, 2012). These findings may suggest that parents who are more involved in school may be doing so to combat or respond to their youth's perceived problem behaviors or academic problems. Out of the different forms of parental involvement, school-based involvement seems to have the strongest impact on the discipline gap, which could imply that parents become more involved in their child's school once school behavior problems are identified or after suspension occurs for those infractions (Marcucci, 2020). From these studies, it is unclear if Black girls are more impacted by parental school involvement than Black boys; however, the current study additionally aims to add to this body of literature.

Ethnic-Racial Socialization

Another way that parents may protect their children from discriminative experiences could be through ethnic-racial socialization. There are various ways that parents can have conversations to socialize their children, and this current study will examine preparation for bias and cultural socialization. Research has shown that cultural socialization was positively associated with academic and behavioral outcomes, while prep for bias was negatively associated with academic outcomes (Hughes et al., 2009). This study focused on White and African American children but was not specific to Black girls. Despite Black girls being victims of racism and sexism, a study showed that they are most resilient when they have been taught about their identities (gender, race, class), the oppression that they may face due to those identities, and how to combat it (Archer-Banks et al., 2012). There have been limited studies that critically examine the impact of

ethnic-racial socialization on school behavioral problems and the consequences of suspension/expulsion on Black girls; but academic outcomes and school behavior problems have been found to be negatively associated (Palcic et al., 2009). Studies have shown that academic outcomes and suspension/expulsion are also negatively associated (Martirano et al., 2014).

Demographic variables

Findings from the studies previously discussed additionally found that age and socioeconomic status are related to school behavior problems and suspension/expulsion rates in Black girls. Higher SES was negatively associated with the suspension/expulsion of Black youth, but not significantly related to school behavior problems (Marcucci, 2020). In addition, older girls were more likely to be suspended/expelled (Butler-Barnes and Inniss Thompson, 2020). Literature also suggests that older youth are more likely to engage in riskier, and potentially deviant behavior (Steinberg and Morris, 2001). Therefore, these demographic variables will be included as covariates in the study.

Current Study

The current study examines the relationship of perceived discrimination, parenting, and ethnic-racial socialization with Black girls' school behavior problems and suspension/expulsion. This study is important because it places an emphasis on Black girls' experiences and may reveal if these factors impact Black girls' school behavior and explain their disproportionate rates of suspension/expulsion. Furthermore, this study may have implications for how teachers can better understand their Black female students and create more positive environments centered around collaboration between parents and schools—which could reduce the racial and gender disparity in disciplinary action. Based on the previous literature, the goal of the current study is to evaluate the following research question: How do perceived racial and gender discrimination, parenting (i.e., parental warmth, parental monitoring, and parental school involvement), and ethnic-racial socialization (i.e., preparation for bias and cultural socialization) act as risk or protective factors for school behavioral issues and consequences of Black girls? More specifically, the current study (1) explores the associations that discrimination experiences, ethnic-racial socialization, and parental warmth, monitoring, and school involvement have with school behavior problems and suspension/expulsion, and (2) determines whether ethnic-racial socialization and other parenting practices moderate the association between discrimination and Black girls' school behavior problems and disciplinary actions.

Study hypotheses are as follows:
1. There will be a positive correlation between perceived discrimination (i.e., racial and gender discrimination) and school behavior problems and suspension/expulsion.
2. There will be a negative correlation between parenting (i.e., parental warmth, parental monitoring, and school-based involvement) and school behavior problems and suspension/expulsion.
3. Parenting (i.e., warmth, monitoring and school-based involvement) will reduce the negative impact of racial discrimination on school behavior problems and suspension/expulsion.
4. Ethnic-racial socialization (i.e., preparation for bias and cultural socialization) will reduce the negative impact of discrimination on school behavior problems and suspension/expulsion.
5. Gender discrimination will increase the negative impact that racial discrimination has on school behavior problems and suspension/expulsion.

6. All of these associations will account for age and socioeconomic status, suggesting that SES will be negatively associated with outcomes, whereas age will be positively associated with outcomes.

Methods

The current study will use data from the Maryland Adolescent Development in Context Study (MADICS), conducted between Fall 1991 and 2012 (Eccles, 1997). This longitudinal study included six waves of data and had two primary goals 1) to focus on the influence of social context on adolescent behavior and 2) to illustrate the developmental trajectories from middle school through high school and young adulthood (Eccles, 1997). The sample was drawn from Prince George's County, Maryland, and had IRB approval (Eccles, 1997). According to the 2000 U.S. Census Bureau, 63% of Prince George's County is Black or African American and 27% White (Maryland National Capital Park and Planning Commission, 2004). At Wave 1, participants included 1482 families, (61%) being African American.

Participants

The sample for the current study only focuses on the African American families with a Black or African American girl (N_{girls}=410; 46% of the total sample). The family socioeconomic status was a standardized composite of the highest level of education completed by the caregiver, highest occupational status of the caregiver and family income. The median family income was between $40,000-$49,000, and the majority of caregivers were mothers (93.5%). On average, adolescent girls were 12 years old (SD=0.55). Of the parent population, 87.6% had a high school diploma or GED equivalent.

Procedure

After receiving IRB approval, four waves of data were collected from the youth, parents (both primary and secondary caregiver), older siblings, school records, and 1990 census data banks through middle school and high school (Eccles, 1997). Two additional waves of data were collected after the child finished high school, one and three years out, with self-administered questionnaires (Eccles, 1997). In home and telephone interviews were conducted and distributed while adolescents were in middle and high school (Eccles, 1997). For data collection, children and caregivers completed self-questionnaires and face to face interviews. The current study only uses the baseline Wave 1 sample from 7th grade.

Measures

Perceived Racial Discrimination. Perceived racial discrimination by Black girls was assessed with the Wave 1 youth scale (Eccles, 1997). Youth responded to one item from the youth self-administered questionnaire (e.g., "Do you think it will be harder for you to get ahead in life because you are Black/African American?") on a 2-point scale: 1=yes; 2=no. This scale was recoded: 1=yes; 0=no.

Perceived Gender Discrimination. Perceived gender discrimination by Black girls was assessed with the Wave 1 youth scale (Eccles, 1997). Youth responded to one item from the youth self-administered questionnaire (e.g., "Do you think it will be harder for you to get ahead in life because you are a boy/girl?") on a 2-point scale: 1=yes; 2=no. This scale was recoded: 1=yes; 0=no.

Parenting.

Parental Warmth. Parental warmth was assessed with the Wave 1 youth scale (Eccles, 1997). Youth responded to four items from the youth self-administered questionnaire (e.g., "My parents encourage me to do my best at everything I do") on a 5-point scale: 1=almost never;

2=once in a while; 3=sometimes; 4=often; 5=almost always. The reliability for this scale was good (α = 0.67).

Parental Monitoring. Parental monitoring was assessed with the Wave 1 parent scale (Eccles, 1997). Parents responded to 2 items (e.g., "How often do you know where child is in the course of the day?") on a 5-point scale: 1=almost never; 2=occasionally; 3=about ½ of the time; 4=sometimes; 5=almost always. This scale showed moderate reliability (α = 0.56).

School-based involvement. School based involvement was assessed with the Wave 1 parent scale (Eccles, 1997). Parents responded to 6 items (e.g., "Last year did you act as…paid school staff—working in the school as an aide, parent educator, assistant teacher, assistant librarian, or other such jobs") on a 2-point scale: 1=yes, 2=no. This scale has been recoded: 1=yes; 0=no and shows good reliability (α = 0.61).

Ethnic Racial Socialization.

Preparation for Bias. Preparation for Bias was assessed with the Wave 1 parent socialization scale created by Banerjee (n.d.). Parents responded to 7 open-ended items from Wave 1 (e.g., "How often do you suggest to your child that good ways of dealing with discrimination he/she might face are to do better than everyone else in school?") on a 4-point scale: 1=none; 2=a little; 3=somewhat; 4=a lot (α = 0.82).

Cultural Socialization. Cultural socialization was assessed with the parent socialization Wave 1 scale created by Banerjee (n.d.). Parents responded to 4 open-ended items from Wave 1 (e.g., "How often do you talk in the family about your racial background?") on a 4-point scale: 1=none; 2=a little; 3=somewhat; 4=a lot (α = 0.77).

Outcome Variables.

School behavior problems. School behavior problems was assessed with the Wave 1 parent scale (Eccles, 1997). Parents responded to 1 item (e.g., "In comparison to other 7th graders, how much trouble does your 7th grader get into?") on a 7-point scale: 1=much less trouble; 7=much more trouble.

Suspension/Expulsion. Suspension/expulsion was assessed with the Wave 1 parent scale (Eccles, 1997). Parents responded to 1 item in the interview (e.g., "Has child been suspended, excluded, or expelled from school or has child cut class in the past two years?") on a 2-point scale: 1=yes; 2=no. This scale was recoded: 1=yes, 0=no.

Covariates. Demographic information was reported by parents and youth. This information includes youth reported age and SES (i.e., parent education and family income). Parent education was determined if they received their high school diploma or GED with 1=yes; 2=no. Parents also reported if they had a post high school education with 1=yes; 2=no. Annual family income was coded on a 21-point scale ranging from 1=less than $5,000 to 21=more than $100,000.

Analytical Plan

After the variables were finalized, descriptive statistics were examined, reliability tests were conducted to determine internal consistency reliability, and then scales were created. Bivariate correlations were then used to determine associations between the variables of interest. Descriptive statistics were examined for all substantive variables. Two hierarchical regression models (a linear regression for school behavior problems and a logistic regression for suspension/expulsion) were conducted with SPSS 26.0 to test the study hypotheses. Age and SES were entered at step 1 as covariates. Parental warmth, parental monitoring, and parental school-based involvement were included in step 2 to explore their association with school behavior problems and suspension/expulsion. Racial discrimination and gender discrimination were entered at step 3 and cultural socialization and prep for bias were entered at step 4. Two-

way interactions were entered at steps 5-8: 5) interaction between racial discrimination and parental warmth, 6) racial discrimination and prep for bias 7) racial discrimination and cultural socialization, and 8) racial discrimination and gender discrimination. Hierarchical regressions analyses were conducted in SPSS.

Results

Preliminary Analyses

Means, standard deviations, and bivariate correlations for study variables are presented in Table 1. Results showed significant relationships between racial discrimination, parental warmth and parental monitoring and school behavior problems. Additionally, results showed a significant relationship between parental warmth and suspension/expulsion. There were no significant relationships between gender discrimination, ethnic-racial socialization variables, and school involvement on either outcome variable. Furthermore, results showed significant relationships between SES and school behavior problems and suspension/expulsion. Age was significantly associated with suspension/expulsion.

Substantive Results

Regressions are presented in Tables 2 and 3. Overall, results showed a significant relationship between SES, perceived parental warmth, perceived racial discrimination and the moderation of parental warmth on racial discrimination and school behavior problems. Similarly, results showed a significant relationship between SES and perceived parental warmth for suspension/expulsion of Black girls. Specific findings are reported below.

School Behavior Problems. SES was negatively associated with school behavior problems (B= -0.207, p<0.05), suggesting that Black girls in lower SES groups were getting in trouble at school more often, or that Black girls in higher SES groups were not getting in trouble as frequently. Age was not significantly associated with this outcome. Racial discrimination was positively associated with school misbehavior (B=0.430, p<0.05), suggesting that Black girls who perceived more racial discrimination were more likely to get in trouble at school. Parental warmth was negatively associated with school behavior problems (B=-0.250, p<0.05), suggesting that Black girls who received more parental warmth exhibited fewer school behavior problems. Parental monitoring, school-based involvement and gender discrimination were not significantly associated with school behavior problems. Parental warmth moderated the effect of racial discrimination on school behavior problems (B=-0.352, p<0.05). Simple slope analyses were conducted to plot this interaction (displayed in Figure 1). Analyses showed that Black girls who perceived high levels of racial discrimination also experienced more school behavior problems. However, parental warmth appears to alleviate the negative effect that racial discrimination has on school behavior problems. Preparation for bias, cultural socialization and gender discrimination did not moderate the effect of racial discrimination on school behavior problems.

Suspension/Expulsion. Results showed that SES was associated with suspension/expulsion (B=-0.546, p<0.05), suggesting that Black girls in lower SES groups were getting suspended or expelled more often than Black girls in higher SES groups. Age was not significantly associated with this outcome. Parental warmth was negatively associated with suspension/expulsion (B=-0.471, p<0.05), suggesting that Black girls who received more parental warmth were not as likely to be suspended or expelled from school. Parental monitoring, school-based involvement, racial discrimination, and gender discrimination were not significantly associated with suspension/expulsion. Parental warmth and prep for bias did not moderate the association between racial discrimination and suspension/expulsion. We were not

able to investigate the effects of cultural socialization and gender discrimination on racial discrimination and suspension/expulsion in this model, because our models would not converge. The final model only included parental warmth and prep for bias as moderators for racial discrimination.

Discussion

This current study was primarily conducted with an intersectional focus on Black girls to obtain a stronger understanding of the factors that contribute to the racial and gender disparity in disciplinary action. Previous literature revealed that Black girls are more likely to get in trouble than other girls in school, especially for subjective behaviors (Epstein et al., 2017). To contribute to this limited body of literature, we examined parenting practices including ethnic-racial socialization and perceived racial and gender discrimination to determine how those variables impact the school behavior problems and suspension/expulsion of Black girls. The overall findings from this study demonstrate that there could be some protective and risk factors for the perceived school behavior problems of Black girls and the consequences.

School behavior problems. Research revealed that there is an association between perceived discrimination and school behavior problems (i.e., "talking with an attitude") for Black girls (Koonce, 2012; Morris and Perry, 2017). It was hypothesized that there would be a positive correlation between perceived racial and gender discrimination on school behavior problems, and the current study partially supported this hypothesis. Results showed that racial discrimination was positively associated with school behavior problems. This finding aligns with the Integrative Model, which asserts that Black girls may find certain contexts (i.e., classrooms) to be promoting or inhibiting to their development (Garcia-Coll et al., 1996). Perceived racial discrimination can be a factor that could inhibit a Black girl's development, and "talking with an attitude" could be a byproduct of discrimination that teachers may perceive as problematic or defiant (Morris and Perry, 2017). There was no significant relationship found between gender discrimination and school behavior problems. This lack of finding could suggest that race, instead of gender plays a larger role in the discriminatory experiences of Black girls. Critical Race Theory asserts that Black girls experience society differently from Black boys and White girls due to the intersections of race, gender, and class (Evan-Winters and Esposito, 2010). Additionally, Blackness challenges the normalcy of Whiteness, which could potentially explain the racial disparity in disciplinary action for Black youth (Delgado and Stefancic, 1998).

It was also hypothesized that there would be a negative correlation between the parenting variables (i.e., parental warmth, parental monitoring, and school-based involvement) and school behavior problems. Results showed that parental warmth was significant, and negatively associated with school behavior problems. Parental monitoring and school-based involvement were not significantly associated with the outcome. Research has shown that parental warmth is associated with less problem behavior in adolescents (Bean et al., 2006). Since the findings did not support a relationship between parental monitoring and school involvement with school behavior problems, this could imply that parents are monitoring their children more and getting involved with the school after they get in trouble (Marcucci, 2020).

Furthermore, it was hypothesized that the parenting variables (i.e., parental warmth, monitoring and school-based involvement) would reduce the negative impact of discrimination on school behavior problems. Results showed that parental warmth moderated the effect of racial discrimination on school behavior problems. Specifically, for Black girls who perceived high amounts of racial discrimination, they also were more likely to experience school behavior problems. Yet, parental warmth appeared to serve as a buffer for this association. Therefore, it is

plausible to assume that the parent-child relationship has some impact on how Black youth internalize discrimination and the behavioral response they have to discrimination.

This partially supports hypothesis 3 and is consistent with the Integrative Model revealing that families may socialize their children based on promoting or inhibiting experiences that they could have (Garcia-Coll et al., 1996).

While it was also hypothesized that ethnic-racial socialization variables (i.e., prep for bias and cultural socialization) would reduce the negative impact of discrimination on school behavior problems, results were not significant, and therefore hypothesis 4 was not supported. This could be because the way that Black girls are socialized is not as important as the way that they interact with their parents. There was not a lot of literature which examined the relationship between ethnic-racial socialization and school behavior problems, so this lack of finding reflects the uncertainty shown in limited research studies (Bean et al., 2006).

Additionally, results showed that there was no significant interaction between racial and gender discrimination on school behavior problems. This finding did not align with hypothesis 5, which predicted that gender discrimination would increase the negative impact that racial discrimination had on school behavior problems. Despite Critical Race Theory (Delgado and Stefancic, 1998) and Critical Race Feminism (Evan-Winters and Esposito, 2010) suggesting that Black girls challenge both racial and gender norms and therefore have a different discriminatory experience than Black boys, it is likely that there were not enough measures for racial and gender discrimination in this study.

Finally, it was hypothesized that SES would be negatively associated with school behavior problems, while age would be positively associated with the outcome. Results showed that SES was significant and negatively associated with school behavior problems. Age was not significantly associated with school behavior problems. The relationship between SES and school behavior problems was expected, as literature shows that children from low SES are more likely to display problem behavior in schools as perceived by teachers (Jensen, 2009). This lack of finding between age and school behavior problems was surprising, considering research revealed that adultification was a contributing factor to Black girls being held accountable for their behavior more than other girls in the form of punitive punishment (Epstein et al., 2017). Since age was unrelated to school behavior problems, it is possible that future studies need to look at a wider range of ages, as most girls in this study were on average 12 years old. Overall, these findings revealed the importance of parenting on the development of Black girls, specifically indicating that warmth could be a protective factor against the negative affect that racial discrimination has on school behavior problems.

Suspension/Expulsion. Literature also suggested that perceived discrimination would be related to suspension/expulsion in Black girls (Butler-Barnes and Inniss-Thompson, 2020). It was hypothesized that there would be a positive association between perceived racial and gender discrimination on suspension/expulsion, but the current study did not support this hypothesis. Despite Critical Race Theory (Delgado and Stefancic, 1998) and the historical stereotypes indicating that there would be an association between perceived discrimination and suspension/expulsion, it could be that the lack of variability in discrimination and suspension/expulsion variables influenced this lack of finding. Future studies should examine several items for racial and gender discrimination, as the current study only used one item per measure.

It was also hypothesized that there would be a negative correlation between the parenting variables (i.e., parental warmth, parental monitoring, and school-based involvement) and

suspension/expulsion. Results showed that parental warmth was negatively associated with suspension/expulsion, which supports the Integrative Model (Garcia-Coll et al., 1996) in that certain contexts like a school environment could impact how families engage and interact with their Black girls. Research also shows that children with a positive parent relationship were also found to have better academic outcomes and were less likely to be suspended (Moore et al., 2004). However, parental monitoring and school-based involvement were not significantly associated with the outcome, which was inconsistent with the literature (Marcucci, 2020). As suggested with school behavior problems, this lack of finding could suggest that parents monitor their children and get more involved in school after their child is suspended or expelled. It is also important to note that the suspension/expulsion variable included children who cut class or were excluded, so the measure was limiting in this study.

　　　While it was also predicted that the parenting variables (i.e., parental warmth, monitoring, and school-based involvement) and ethnic-racial socialization (i.e., prep for bias and cultural socialization) would reduce the negative impact of racial discrimination on suspension/expulsion, results showed that neither interaction was significant. This might be because there are other protective factors besides parenting and the way that parents socialize their Black girls which could reduce the disparity in suspension/expulsion. It was difficult to explore other interactions in the current study because our models did not converge. Therefore, conclusions could not be drawn for all of our interactions.

　　　Lastly, it was hypothesized that SES would be negatively associated with suspension/expulsion, while age would be positively associated with the outcome. Similar to school behavior problems, results showed that SES was negatively associated with suspension/expulsion and age was not statistically significant. The current study findings were consistent with previous literature that found a negative correlation between SES and suspension/expulsion (Marcucci, 2020). Since age was not significant with this outcome either, future studies could examine another age range of girls, as adultification indicates that Black girls receive harsher discipline because they are perceived to be more mature (Epstein et al., 2017). Ultimately, these findings suggest that the relationship Black girls have with their parents could be important to explore in future studies, especially in terms of suspension/expulsion.

Limitations and Future Directions

　　　There were a few limitations for this study. First, there was only one item each to measure perceived racial discrimination, perceived gender discrimination, school behavior problems, and suspension/expulsion. As a result, there was a lack of variability for what this study considered to be discrimination, school behavior problems or suspension/expulsion. Future studies should include more questions per measure. The suspension/expulsion variable also did not indicate which outcome (i.e., suspension, expulsion, cutting class or exclusion) happened to the child. In the future, studies should use a variable that clearly assesses the suspension/expulsion of the child.

　　　Another limitation was that the number of Black girls in this sample who had school behavioral problems or were suspended/expelled from school was extremely low. With low base rates, there is likely a floor effect due to limited variability in the sample. Future studies should investigate a larger sample size of Black girls who reported school behavior problems or who were suspended/expelled from school.

　　　Moreover, this study did not use parent and youth scales together, which created mono-reporter bias. Perceived discrimination and parental warmth were only measured using the youth scales, while parental monitoring, parent school involvement, ethnic-racial socialization (prep for

bias and cultural socialization), school behavior problems and suspension/expulsion were measured using the parent scales. It is important to note that some of the scales used in the current study had acceptable reliability but still were considerably low. Future studies should use multiple reporters on variables of interest. Furthermore, teacher/school reports of youth behaviors should be included in order to examine the relationship between Black girls and teachers and identify where the discriminatory experiences are rooted.

This study also used cross-sectional data, and therefore only focused on these girls at one point in time (Wave 1 only looked at 7th graders). It would be valuable to look at these associations over time to see if and how these correlations vary in a longitudinal study. There might be some merit in examining older adolescents, as they could be more likely to engage in risky behaviors, which could potentially be associated with school behavior problems and suspension/expulsion from school (Steinberg & Morris, 2001).

Lastly, MADICS only studied adolescents in Prince George's County, Maryland, creating a limitation to external validity. These associations could vary based on geographic location. The socioeconomic diversity is a strength to the dataset; however, these families are different from the national average African American/Black family during this time period. Work should be conducted in different regions of the United States, perhaps in areas with different school practices and family structures.

Conclusion

The voices of Black girls need to be centered more in our discourse about Black youth. This is especially critical when it comes to their school experiences, which seem to be overwhelmingly characterized as a constraining environment—considering how racism, sexism, discrimination, and oppression are all influential factors on school behavior and the consequences of suspension and expulsion. This research fills some of the gaps existing in literature mentioned earlier. The interaction between parental warmth on the association between racial discrimination and school behavior problems has an impact on the development of Black girls, and further research should continue to investigate this relationship. This study has implications for how teachers can work to better understand Black girls and create more positive environments focused on family-school collaboration, which may help reduce racial disparities in school disciplinary actions. Hopefully, more research can be done to identify protective and risk factors of school behavior problems and suspension/expulsion, so that Black girls can be better understood and supported in their academic settings.

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Table 1 Correlations and Means

	1	2	3	4	5	6	7	8	9	10	11	Mean (SD)
1. Racial Discrimination	1	0.399**	-0.041	0.131**	0.084	0.038	0.037	0.102*	0.016	-0.081	0.100*	0.24 (0.43)
2. Gender Discrimination	0.399**	1	-0.039	0.070	-0.001	0.023	0.055	0.004	0.006	-0.098*	-0.007	0.17 (0.38)
3. Cultural Socialization	-0.041	-0.039	1	0.036	-0.024	0.045	0.126*	-0.053	-0.052	-0.020	0.170**	0.14 (0.45)
4. Prep for Bias	0.131**	0.070	0.036	1	0.070	0.048	0.048	0.013	-0.011	-0.142**	0.139**	0.59 (0.93)
5. Parental Warmth	0.084	-0.001	-0.024	0.070	1	0.160**	0.174**	-0.217**	-0.170**	-0.017	0.276**	4.00 (0.83)
6. Parental Monitoring	0.038	0.023	0.045	0.048	0.160**	1	0.112*	-0.107*	-0.080	-0.091	0.134**	4.85 (0.43)
7. Parental School Involvement	0.037	0.055	0.126*	0.048	0.174**	0.112*	1	-0.033	-0.084	-0.088	0.265**	0.21 (0.20)
8. School Behavior Problems	0.102*	0.004	-0.053	0.013	-0.217**	-0.107*	-0.033	1	0.350**	0.017	-0.129**	1.68 (1.24)
9. Suspension/Expulsion	0.016	0.006	-0.052	-0.011	-0.170**	-0.080	-0.084	0.350**	1	0.123*	-0.129**	0.10 (0.30)
10. Youth Age	-0.081	-0.098*	-0.020	-0.142**	-0.017	-0.091	-0.088	0.017	0.123*	1	-0.144**	12.34 (0.55)
11. SES	0.100*	-0.007	0.170**	0.139**	0.276**	0.134**	0.265**	-0.129**	-0.129**	-0.144**	1	-0.16 (0.84)

Correlations between variables of interest
$p<0.05$, **$p<0.01$

Table 2 Results of hierarchical regressions for Black girls' school behavior problems

Variable	School Behavior Problems	
Step 1. Covariates	*B*	*SE*
SES	-0.207**	0.076
Age	-0.090	0.122
Step 2. Parent-Child Relationship		
SES	-0.137	0.080
Age	-0.085	0.122
Parental Warmth	-0.250*	0.080
Parental Monitoring	-0.140	0.149
Parental School Involvement	0.215	0.328
Step 3. Perceived Discrimination		
SES	-0.152*	0.080
Age	-0.070	0.122
Parental Warmth	-0.264**	0.079
Parental Monitoring	-0.145	0.148
Parental School Involvement	0.228	0.326
Racial Discrimination	0.430**	0.157
Gender Discrimination	-0.149	0.179
Step 4. Ethnic-Racial Socialization		
SES	-0.145	0.081
Age	-0.063	0.123
Parental Warmth	-0.270**	0.080
Parental Monitoring	-0.142	0.149
Parental School Involvement	0.251	0.328
Racial Discrimination	0.417**	0.158
Gender Discrimination	-0.154	0.179
Cultural Socialization	-0.102	0.136
Prep for Bias	0.030	0.069
Step 5. Racial Discrimination x Parental Warmth		
SES	-0.122	0.082
Age	-0.063	0.122

Parental Warmth	-0.194*	0.088
Parental Monitoring	-0.149	0.148
Parental School Involvement	0.273	0.327
Racial Discrimination	0.449**	0.159
Gender Discrimination	-0.190	0.179
Cultural Socialization	-0.112	0.136
Prep for Bias	0.036	0.068
Racial Discrimination x Parental Warmth	-0.352*	0.177

Step 6. Racial Discrimination x Prep for Bias		
SES	-0.113	0.082
Age	-0.062	0.122
Parental Warmth	-0.198*	0.088
Parental Monitoring	-0.149	0.148
Parental School Involvement	0.282	0.327
Racial Discrimination	0.459**	0.159
Gender Discrimination	-0.177	0.180
Cultural Socialization	-0.114	0.136
Prep for Bias	0.072	0.080
Racial Discrimination x Parental Warmth	-0.337	0.178
Racial Discrimination x Prep for Bias	-0.129	0.151

Step 7. Racial Discrimination x Cultural Socialization		
SES	-0.113	0.082
Age	-0.056	0.122
Parental Warmth	-0.199*	0.088
Parental Monitoring	-0.146	0.148
Parental School Involvement	0.281	0.327
Racial Discrimination	0.472**	0.159
Gender Discrimination	-0.160	0.180
Cultural Socialization	-0.184	0.145

Prep for Bias	0.074	0.080
Racial Discrimination x Parental Warmth	-0.328	0.178
Racial Discrimination x Prep for Bias	-0.147	0.152
Racial Discrimination x Cultural Socialization	0.533	0.393

Step 8. Racial Discrimination x Gender Discrimination

SES	-0.116	0.082
Age	-0.051	0.122
Parental Warmth	-0.201*	0.088
Parental Monitoring	-0.126	0.149
Parental School Involvement	0.285	0.327
Racial Discrimination	0.573**	0.185
Gender Discrimination	0.030	0.253
Cultural Socialization	-0.184	0.145
Prep for Bias	0.075	0.080
Racial Discrimination x Parental Warmth	-0.346*	0.179
Racial Discrimination x Prep for Bias	-0.134	0.152
Racial Discrimination x Cultural Socialization	0.505	0.394
Racial Discrimination x Gender Discrimination	-0.387	0.362

Note: * = p $\leq$ 0.05;** = p$\leq$ 0.01

Table 3 Results of hierarchical logistic regression for Black girls' suspension/expulsion

Variable	Suspension/Expulsion		
	B	*SE*	*Exp(B)*
Block 1. Covariates			
SES	-0.546*	0.216	0.579
Age	0.192	0.328	1.211
Block 2. Parent-Child Relationship			
SES	-0.350	0.233	0.705
Age	0.170	0.339	1.185
Parental Warmth	-0.471*	0.216	0.624
Parental Monitoring	-0.140	0.363	0.869
Parental School Involvement	-0.762	1.103	0.467
Block 3. Perceived Discrimination			
SES	-0.342	0.233	0.710
Age	0.185	0.339	1.203
Parental Warmth	-0.472*	0.217	0.624
Parental Monitoring	-0.149	0.364	0.862
Parental School Involvement	-0.790	1.111	0.454
Racial Discrimination	0.092	0.465	1.096
Gender Discrimination	-2.061	4.640	1.194
Block 4. Ethnic-Racial Socialization			
SES	-0.323	0.235	0.727
Age	0.197	0.346	1.218
Parental Warmth	-0.501*	0.219	0.606
Parental Monitoring	-0.130	0.365	0.878
Parental School Involvement	-0.767	1.134	0.464
Racial Discrimination	0.054	0.469	1.056
Gender Discrimination	0.165	0.516	1.180
Cultural Socialization	-0.680	0.683	0.506
Prep for Bias	0.164	0.194	1.179

Block 5. Racial Discrimination x Parental Warmth			
SES	-0.345	0.241	0.708
Age	0.195	0.347	1.215
Parental Warmth	-0.556*	0.249	0.574
Parental Monitoring	-0.125	0.365	0.882
Parental School Involvement	-0.774	1.129	0.461
Racial Discrimination	0.109	0.479	1.116
Gender Discrimination	0.192	0.516	1.211
Cultural Socialization	-0.674	0.683	0.510
Prep for Bias	0.158	0.195	1.171
Racial Discrimination x Parental Warmth	0.225	0.474	1.252
Block 6. Racial Discrimination x Prep for Bias			
SES	-0.338	0.244	0.713
Age	0.196	0.347	1.216
Parental Warmth	-0.559*	0.249	0.572
Parental Monitoring	-0.126	0.365	0.882
Parental School Involvement	-0.768	1.129	0.464
Racial Discrimination	0.117	0.479	1.124
Gender Discrimination	0.200	0.517	1.222
Cultural Socialization	-0.672	0.681	0.511
Prep for Bias	0.179	0.223	1.196
Racial Discrimination x Parental Warmth	0.241	0.480	1.273
Racial Discrimination x Prep for Bias	-0.084	0.446	0.919

Note: * = p < 0.05

Figure 1: *Association between Racial Discrimination and School Behavioral Problems Moderated by Parental Warmth*

Association Between Racial Discrimination and School Behavioral Problems Moderated by Parental Warmth
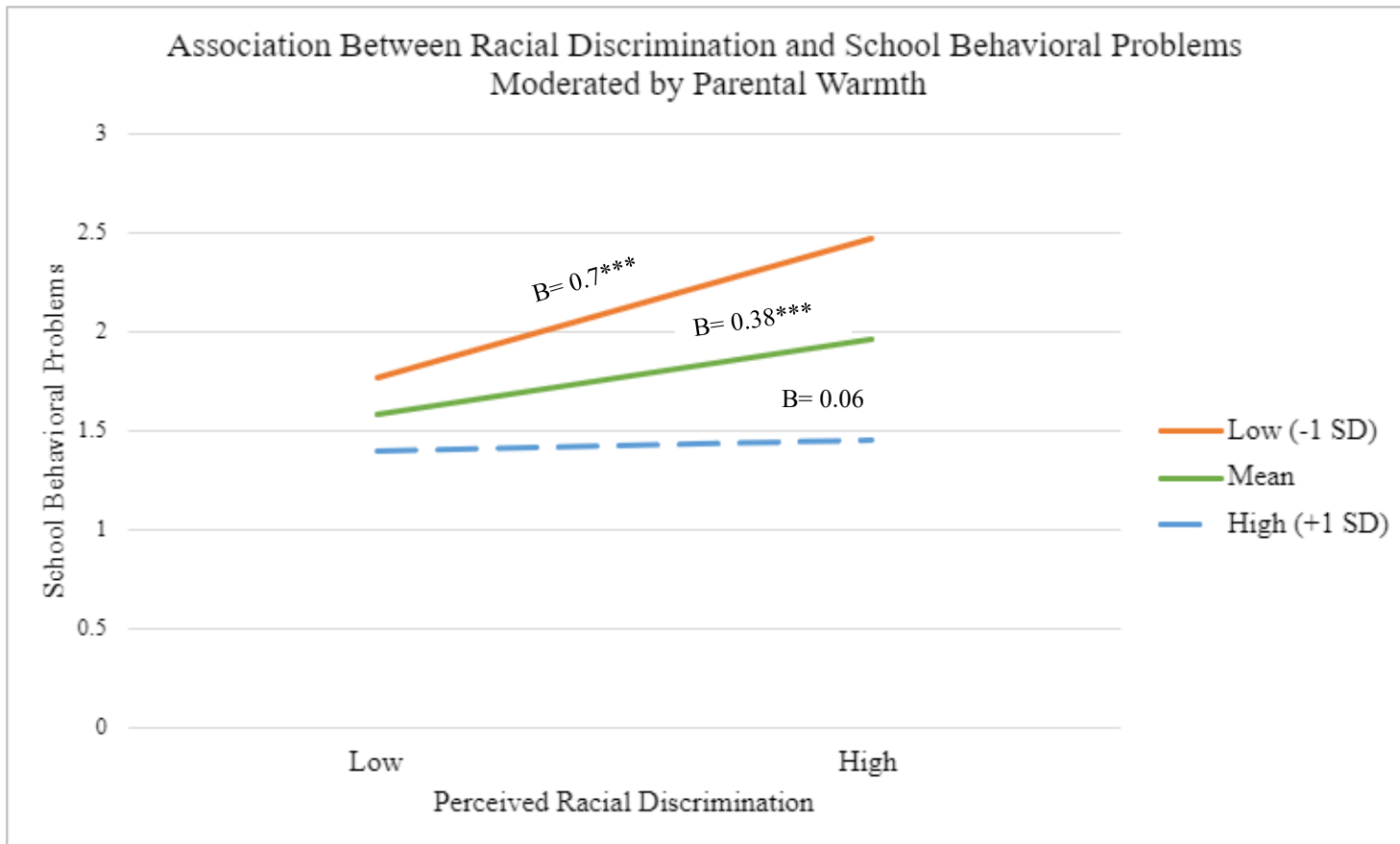
*p <.05. **p < .01. ***p < .001. †.05< p <.10

Amygdala Connectivity in Patients with Depression After Traumatic Brain Injury

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Abstract

Depression is a common symptom of Traumatic Brain Injury, injury to the brain due to external force. In this study, we analyzed network connectivity of the amygdala and the Default Mode Network (DMN) in patients with depression after TBI. We hypothesized that as the severity in depression of TBI patients increases, there will be an increasing number of alterations in the amygdala connectivity. We also hypothesized that as the severity in depression of TBI patients increases, there will be decreased DMN connectivity within the amygdala region. Using Power 264, we divided the brain into networks: Amygdala-Amygdala, Amygdala-DMN, Amygdala-Else, DMN-DMN, DMN-Else, Else-Else. Using graph theory, a discrete area of mathematics, we were able to visualize the connections that were found statistically and observe if or how network connections were altered.

Introduction

The neurological correlation of depression after Traumatic Brian Injury provides serious complications on patients that could prove to be life altering or threatening. Traumatic Brain Injury (TBI) is- physical injury to the brain tissue that causes temporary or permanent functional damage to individuals (Ghajar, 2000). Due to alterations of area and network connectivity caused by TBI, the development of depressive symptoms in TBI patients is-common. Such symptoms could significantly reduce the ability of individuals with TBI as depression comorbid of TBI results in poor cognitive function, lower quality of life that is health-related, increased functional disability, greater suicide attempts, increased sexual dysfunction, decreased social and physical activity, and more insufficient recovery and rate.

With depression, there is abnormal functionality in the amygdala (Han et al., 2015). The amygdala, part of the brain's limbic system, is known to be the emotional center of the brain, associating with memories and responses to emotion. The part consists of several regions in a connection of the cortical-striatal-pallidal-thalamic circuit, also known as the core neural system in mood disorders (2015). A subgroup of networks divides the amygdala, but three have been studied in particular to psychiatric illness.

These networks are listed as the first one preferentially correlating to -the default mode network (DMN), the second preferentially correlating to the dorsal attention and frontal-parietal network, and the last one, with no preference in what it is correlated to in relativity to the first

two subdivisions. In a resting-state fMRI study, Helm et al. (2018) observed a decrease in DMN connectivity of patients with mood depressive disorder (MDD) compared to healthy controls. Associating the connections between the DMN and the dorsal subdivision is likely to provide information of contributing patterns that ultimately lead to depression. As for the connection in TBI, connecting a part of the DMN with regions of the salience network (SN) shows that the amygdala also holds alterations of the connectivity in the DMN and SN with TBI individuals. There is importance in understanding how the amygdala connectivity is a potential neuroimaging biomarker for patients with depression after TBI. Looking at the DMN may prove to be useful in discovering how severity of depression after TBI affects overall regions of the amygdala, leading to linked symptoms.

Further understanding the neural mechanisms between TBI and depression, as a result of depression after TBI, can help find treatments for the significant symptoms and better understand the clinical outcomes of TBI comorbid with depression severity. In this study, we will utilize fMRI at resting-state to research depression after TBI as depression involves neural processes that occur over more extended periods (minutes or hours) (Han et al., 2015). Using the power 264, we will correlate the activity between the DMN and the Amygdala, which a collection of nodes and edges will then map out to represent the relationship between the nodes, a process of -graph theory (Wang et al., 2010). We hope to examine the strength of the left and right amygdala bilaterally as well as analyze the DMN area of the amygdala to understand what it is doing to modulate the bilateral behavior and if the DMN does predict depression after TBI. We hypothesize that as the severity in depression of TBI patients increases, there will be an increasing number of alterations in the amygdala connectivity. We also expect that as the severity in depression of TBI patients increases, there will be decreased DMN connectivity within the amygdala region.

Materials and Methods

Procedure
This study involved the use of an existing archival dataset, initially collected from functional imaging techniques and neuropsychological testing to analyze. In gathering fMRI data, participants were involved in resting state scan and a block design one-back task. A traditional neuropsychological battery outside of the scan was then administered. A Philips Achieva 3T scanner at Hershey Medical center or a Siemens Magnetom Trio 3T whole-body scanner at the Department of Radiology at Hershey Medical Center, or either a Siemens Magnetom Trio 3T whole-body scanner or a Siemens Prisma 3T whole-body scanner that are both at the Social, Life and Engineering Sciences Imaging Center at The Pennsylvania State University, University Park were used to collect imaging data. The data was gathered and organized in an onsite HW and SW designed to support researchers at The Pennsylvania State University called ICS-ACI.
The data used from this study included 14 individuals with moderate to severe TBI, determined by a Glasgow Coma Scale score of 3-12 (Teasdale and Jennet, 1974) or found by MRI or CT of those who were injured at least approximately a year prior. The ages range from 18-55 years old causes of injury listing as MVC, fall, assault sports, or other.
The participants were recruited as either a cross sectional study after injury or a longitudinal study that examined recovery three months after TBI. In addition, they were informed of the studies prior to consenting, and Penn State IRB approved of the consent form used. Participants were also compensated for participating in the study.

Table 1
Demographics

Sample Size (n)	Age; mean	Gender	BDI-II; mean	GCS; mean	HVLT; mean	Education; mean
13	31.07	3 females 10 males	8	7.83	6.79	12.5

Resting State Scans

For the resting-state scan, all subjects were asked to focus on the white cross at the center of the screen while being reminded to not fall asleep. Data collection included 34-35 slices for whole-brain coverage resulting in 3mm x 3mm x 4mm voxels and taken with a TR of 2,000 ms and a TE of 30ms. After removing the first 3 volumes for T1 equilibration effects, 145 volumes were left for analysis.

Beck Depression Inventory-II (BDI-II)

Participants self-administered a series of 21 items on a survey that measured the existence and severity of depressive symptoms. Each item was scaled from 0 to 3, and the final scores were calculated to determine the measures for each participant.

Data Preprocessing

All of the participants' data were preprocessed using SPM8. Data from resting-state were adjusted and normalized to fit a standard T1 template from the Montreal Neurological Institute and to limit the signal-to-noise ratio. Motion from the scans were examined with the Artifact Repair toolbox to identify large motion and correct any in BOLD signal.

Network Brain Parcellation

The brain is observed through a large-scale network perspective. Through parcellation, pieces of the brain are divided into nodes and analyzed in a network. This methodology assists in the methodology of graph theory, where we studied a graph of functional areas in 264 nodes, or regions of interests. Further, the 264 nodes from the Atlas-Based approach Power 264 were broken into specific nodes for the areas of interest, including the amygdala and the Default Mode Network.

Graph Theory

Graph theory is an area of discrete mathematics that graphs the brain as a complex network. In neuroscience, graph theory can be applied to either functional or effective connectivity (Farahani et al., 2019). A graph is a diagram made up of coordinates that represent relation. In graph theory, these graphs represent the networks through a collection of nodes and edges. Nodes demonstrate the anatomical elements of the brain while the edges show the relationships between the nodes (Wang et al., 2010). In Figure 1, a sample of nodes are pointed at by arrows, representing specific brain regions of interest. A sample of edges is also pointed at in this figure, showing particular connections between nodes.

The degree of a node is the number of edges connected to a node; for example, node D has a degree of three while node C has a degree of two. Figure 2 highlights modules, a cluster of nodes; two clusters are circled in a gold color in Figure 2. Additionally, in this figure, node A is labeled to illustrate a hub, which is a node with a high degree. Compared to the other nodes in

this figure, node A has the highest degree, that being four and therefore a hub of this network. Given these components, graph theory can show the relationship of network connectivity within or across brain regions.

Figure 1
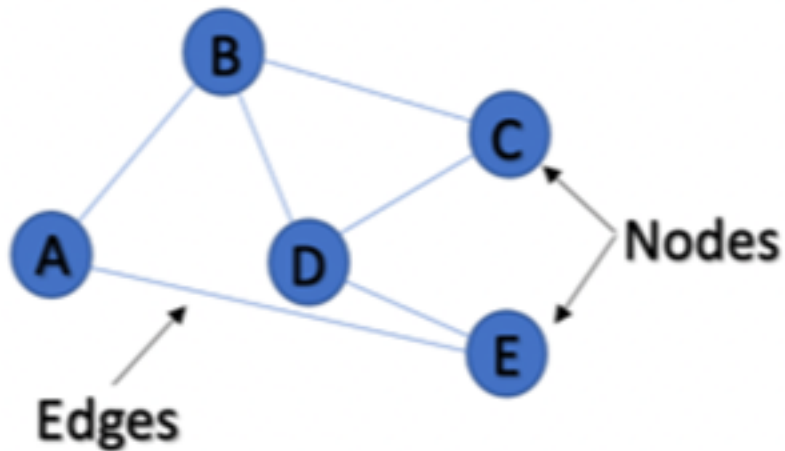A diagram demonstrating edges and nodes, components seen in graph theory-based approaches.
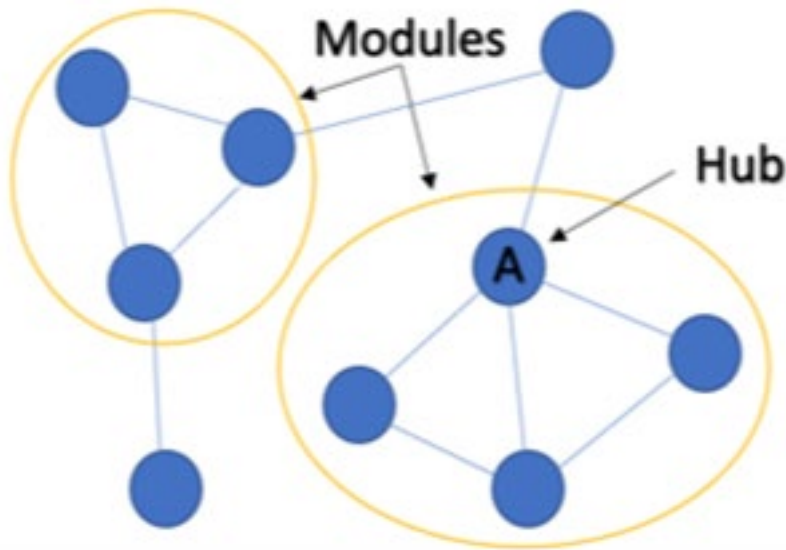
Figure 2
A diagram demonstrating and highlighting modules and hubs, components seen in graph theory-based approaches.

Network Analysis
MNI coordinates for the left and right amygdala were run through the ACI system provided by Penn State. The coordinates used were (right amygdala, 27, 5, −17; left amygdala, −15, −1, −14)

(Feng et al., 2016), and nodes 265 and 266 were added to include the left and right amygdala, respectively. The nodes for the DMN and the rest of the brain were arranged in their respective networks. After the run, we received the strengths of the connections.

Results

Amygdala Connectivity
Amongst the 13 patients totaled, the strength of the network connectivity associated with the amygdala all held a value of 0.00, indicating no connection between each network shown in Table 2.

Table 2
Strength values of amygdala connectivity connected to associated networks

Network	Strength
Amygdala-Amygdala	0.00
Amygdala-DMN	0.00
Amygdala-Else	0.00

BDI-II Scores versus Network Weights
The relationship between BDI-II scores and network weights are shown in figures 3 and 4. The data indicates a non-linear relationship between the two variables amongst the total of the 13 patients. The correlation value (R) of BDI-II Scores vs. DMN-DMN was 0.320 while the R values of BDI-II Scores vs. DMN-Else was 0.280. Both values, considering p-value significance of less than 0.05, were not significant.

BDI-II Scores vs DMN-DMN Weights

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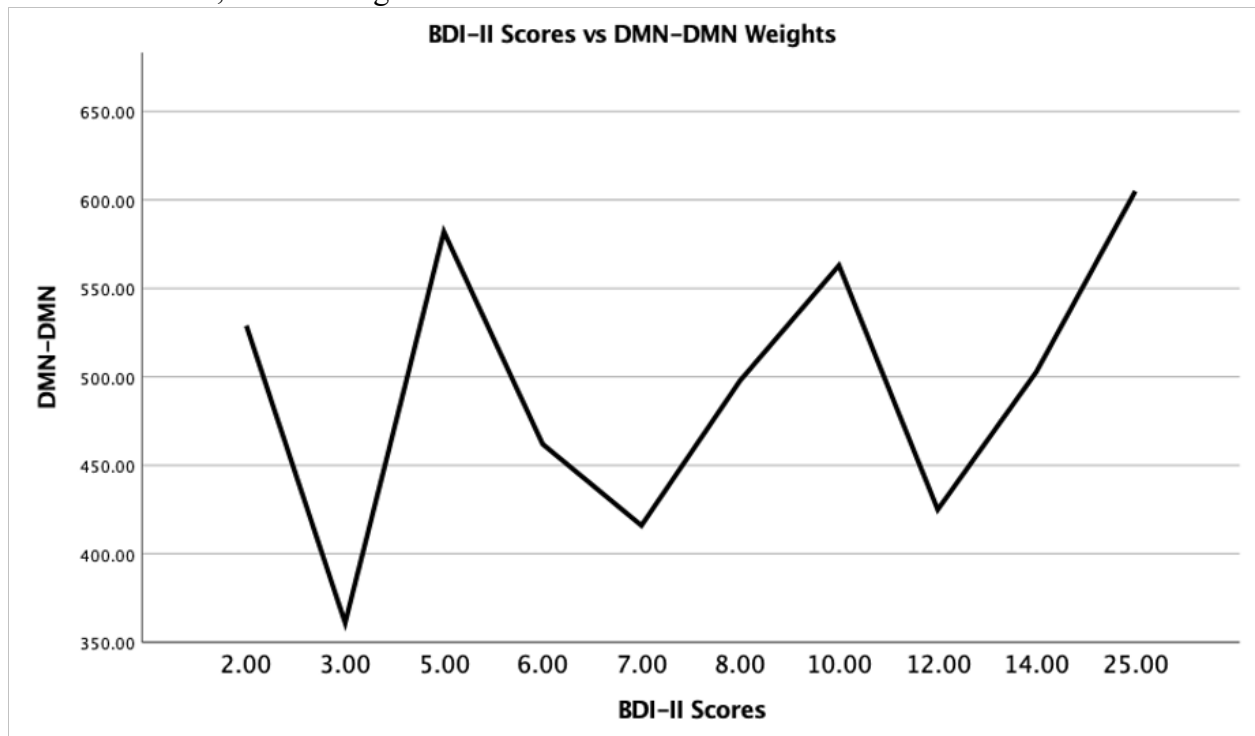
Figure 3: Linear model of relationship between BDI-II Scores, measurement of depression severity, and DMN-DMN weights (values).
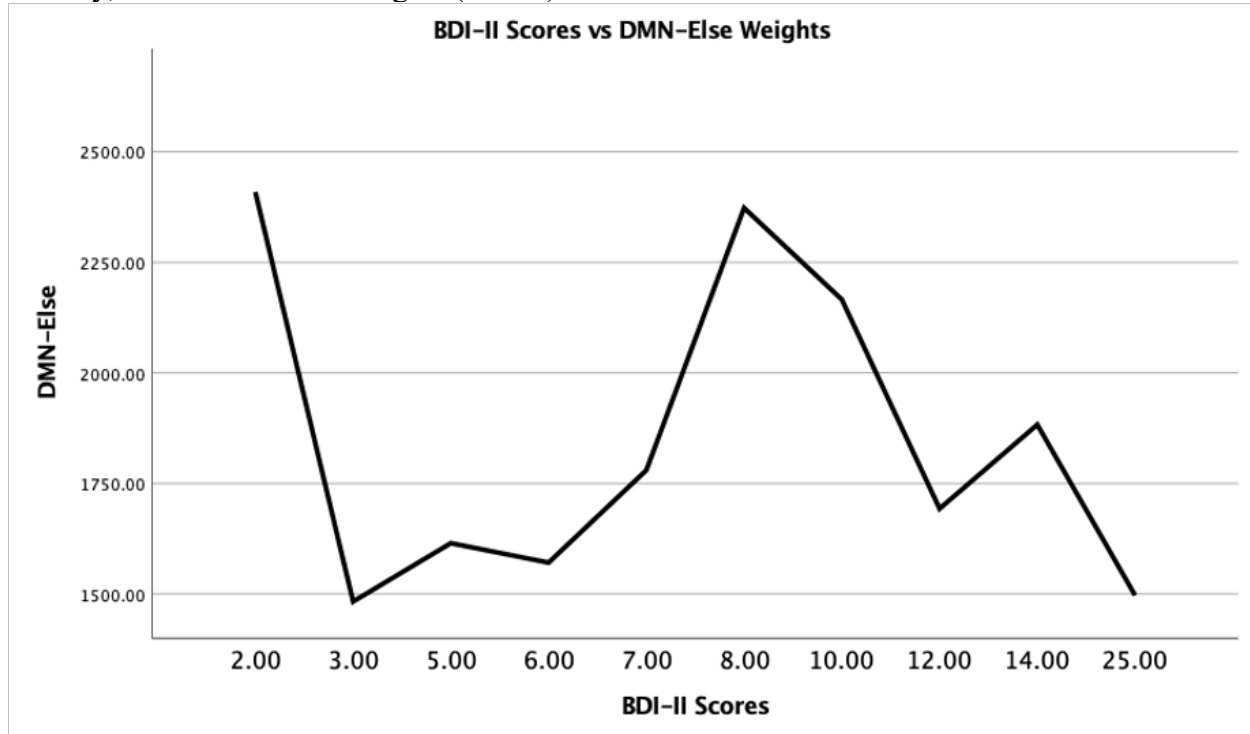
Figure 4: Linear model of relationship between BDI-II Scores, measurement of depression severity, and DMN-Else weights (values).

Strength Connectivity Between Networks
Within the DMN-DMN network, the p-value showed to be 0.286 while that value for the DMN-Else network was 0.355. Both values are not significant and therefore have no effect on what was observed.

Discussion
In this study, we found no evidence of depression after TBI associating with the individual networks that were examined, including the Left Amygdala-Right Amygdala, Amygdala-Else, Amygdala-DMN, DMN-DMN, and DMN-Else. No linear correlation was found between severity of depression and connectivity values within the networks where we were able to find data on (DMN-DMN, DMN-Else), indicating that there is no direct relationship between the severity of depression and amount of DMN connectivity within the amygdala region. Therefore, network connectivity, whether increased or decreased, in the amygdala and the DMN might not be altered by severity of depression.

The question stands on how no connections were found in the networks that included the Amygdala (Amygdala-Amygdala, Amygdala-DMN, Amygdala-Else). There is a sense that the amygdala must be connected to itself, so for the data to show no connection between the amygdala and itself must indicate an error in the methodologies. Further studies may involve the use of different methodologies to examine the pattern of connection with increasing severity in depression after TBI.

There are also clear inaccuracies regarding the strength of connectivity between networks. What can be found unusual is that the strength of the DMN-DMN is not significant. However, the network connected to itself is most likely to have a very strong connection, so the presented p-values are unlikely to be relied on.

Limitations of this study include sample size. We only had a sample size of 13, which is a significantly small population. Additionally, three of the 13 participants had mild-moderate depression while only one had moderate-severe depression. Given this, there is a lack of variability to determine the hypothesized causes and effects of depression on brain connectivity in TBI patients. Also, there is the limitation of the bias in BDI-II measures. Since the BDI-II test is self-administered, there is a great chance of bias in question-answering. Therefore, there is a lack of reliability on the scores for each participant.

In conclusion, there is a significant number of changes that can be made to this study regarding the inconsistencies and inaccuracies presented within the results. However, depression comorbid with TBI may not indicate any causation on how the amygdala connectivity is affected.

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Developing Analogs for Magnetic Synapses

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Introduction

Human brain could easily recognize different objects since it processes sensory and motor signals in parallel. The brain has many neural pathways that can replicate functions to correct small brain changes in development or temporary loss of function through damage [1]. The ability to overcome these changes in development is the result of the neuroplasticity. These changes range from individual neurons making new connections, to systematic adjustments like cortical remapping. The junction between the neuron's circuits, synapses, are the place to look for neuroplasticity. Synapses dominate the architecture of the brain and are responsible for the massive parallelism. Therefore, researchers are currently seeking engineered material analogs for the particular responses exhibited by biological neuromorphic materials. Neuromorphic systems, which mimic the nervous system in the brain, have recently become known as strong candidates to overcome the technical limitations owing to their proficiency in cognitive [2]. To successfully implement these neuromorphic systems, it is important to research and develop artificial synapses capable of synapse functions.

In the beginning neuromorphic computing was described as a concept involving large integrated electronics analogs systems that mimic biological neural networks. Therefore, a great importance for hardware implementation of the neuromorphic computation systems has been the realization of physical devices with synaptic functions. The first devices to emulate synaptic functions were complementary metal oxide semiconductor (CMOS) neuromorphic circuits [3]. However, the performance of these CMOS circuits is hard to scale up to a size comparable with the brain and is limited to access external memory. This has engendered motivation to explore bio-inspired neuromorphic systems focusing in resistive switching memory and memristors. Memristors have gained the spotlight because of their desirable characteristics as artificial synapses including device speed, small footprint, low energy consumption and analog switching [4]. Learning more about neuromorphic systems will allow us to create simulations that allow us to test brain injury treatments to help recover from trauma brain. Also, these simulations may help us develop sensors using electrical components such as memristors whose resistance relies on how much charge has passed through it in the past, mimics the way calcium ions behave at the junction between two neurons in the human brain where the junction is known as a synapse.

For example, environmental enrichment is the key to develop new connections that relies on sensory stimuli. However, in order to develop these new connections, it is important to understand electronic responses and brain functions that will help simulate the human brain in a technological way. One such response is the hysteresis in input versus output signals.

Hysteresis is a common phenomenon in physical systems and occurs when the system's output depends not only on its present inputs but also on past inputs, basically, when the system exhibits memory. Development of engineered neuromorphic materials focuses on creating materials that exhibit such memory. One possible model material involves arrays of rotating magnetic particles suspended in a medium. As the particle spin particles are placed in a rotating magnetic field. This generally assures the effective dipole moment, which permits the formulation of torque expressions for spherical shells. The work seeks to development simulations of spinning magnetic particles in a visco-elastic medium as a simulation framework for exploring hysteresis response in a similarly-structured engineered neuromorphic material.

1. Background/Literature Review

1.1 Brain plasticity

Researchers interested in understanding the factors that can change brain circuits investigate the behaviors of brain plasticity which is the change in neural circuitry. Brain plasticity or memory of response, is what the brain uses to store memories and process information. Without this ability, the brain would be unable to develop from infancy through to adulthood or recover from brain injury [1]. The Brain function relies on circuits of spiking neurons with synapses playing the key role of merging transmission with memory storage and processing.

Brain plasticity refers to the capacity of the nervous system to change its structure and its function over a lifetime, in reaction to environmental diversity. Neural plasticity, allows neurons to regenerate both anatomically as well as functionally, and to form new synaptic connections. Therefore, the best place to look for plasticity changes is at synapses which are the junction between the neurons. This is called Synaptic plasticity. Synaptic plasticity is the ability of synapses to reconfigure the strength with which they connect two neurons according to the past electrical activity of these neurons. It represents one of the most fundamental and important functions of the brain. In hardware, artificial synapses endowed with plasticity allow neural networks to learn and adapt to a changing environment. A very enduring form of synaptic plasticity is called long-term potentiation (LTP) a synaptic enhancement that follows brief, high-frequency electrical stimulation in the hippocampus and neocortex. Brain plasticity, or neuroplasticity, is the ability for the brain to recover and restructure itself. This adaptive potential of the nervous system allows the brain to recover after disorders or injuries.

The following image illustrates signs of synaptic plasticity emerging in a living brain.
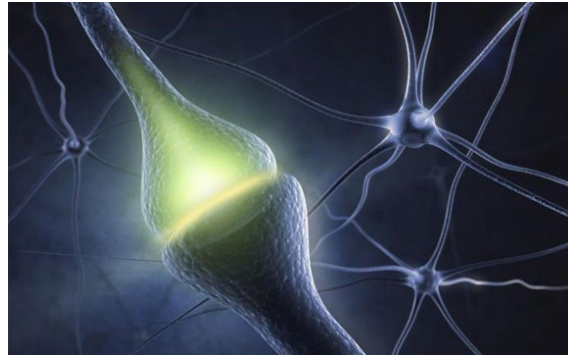
Figure 1: Signs of synaptic plasticity emerging in a living brain by Sukbin Lim (Neuroscience, 2015)

The lighting in the image shows how the living brain accomplishes the feat of beholding and recognizing stimuli. The lighting represents signs of synaptic plasticity emerging in a living brain while it accomplishes the feat of beholding and recognizing stimuli. These synapses are studied experimentally by stimulating the fiber tract. By studying the synaptic plasticity, we better understand the connections of the human brain and the way those functions can be simulated in artificial synapses. Developing simulations of those artificial synapses are the goals of this work.

1.2 Memristors responses in hysteresis
According to previous studies memristors are considered as the best solution to imitate the performance of synapses plasticity [8]. Since memristors cover a gap in the capabilities of basic electronic components by remembering the history of the applied electric potentials, and are considered to bring neuromorphic computers closer. A memristor is a passive two-terminal circuit element in which the resistance is a function of the history of the current through and voltage across the device. In other words, memristors are Nano scale devices with a variable resistance and the ability to remember their resistance when power is off. Memristors are based on the history of applied electrical stimuli. These capabilities lead to analog switching, which resembles biological synapses where the strength can increase or decrease depending on the applied action potential.

The nonlinear behavior of a memristor is shown in Figure 2, This shows evidences of the results of an intricate resistance versus the voltage of a memristor.
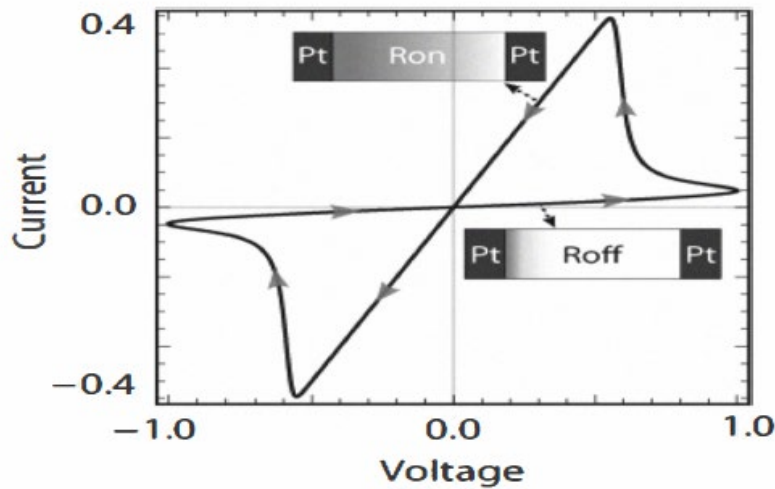
Figure 2: Nonlinear behavior of memristor (Chakraverty M. and Kittur M.H 2012)

The hysteresis loop pinched at the origin of the V – I characteristic is the well-known fingerprint of the memristor excited by sinusoidal signal. The pinching at the origin in Fig. 2 occurs because both current (I) and voltage (V) become zero at the same time. In order to show that hysteresis is at the origin (I, V) = (0, 0), calculations on the memristance must be determine. Different approaches have been done in previous studies; for example, in one of the studies the researchers treated the two-terminal circuit of the memristor as the time integral of the element's current I(t) and voltage V(t). However, in this research we will use the concept of the memristor to investigate if we can use rotating magnetic particles to produce a similar hysteresis response in the applied field versus magnetization.

1.3 Magnetic field and Magnetic particles

Previous research has focused on soft and hard magnetic particles such as Iron and Bromine, embedded in the elastomer matrix to produce magnetorheological elastomers (MREs). Soft magnetic particles have no preferred magnetic orientation, when exposed to a uniform magnetic field **H** will have magnetization, **M**, aligned with the external field. Hard-magnetic particles with remanent magnetization M_{rem} will ideally have **M** remain aligned with the axis of M_{rem} which is local to the particle and thus allows for the generation of magnetic torque **T**. Figures 3a and 3b shows a representation of soft and hard magnetic particles orientations.
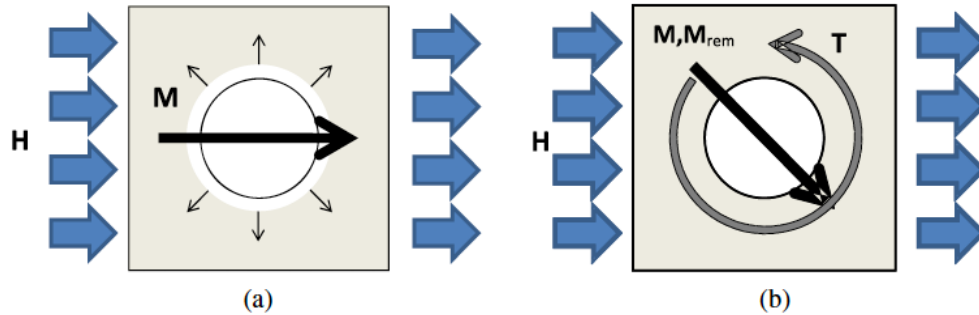
Figure 3 (a). Orientation of soft-magnetic particle and Figure 3(b). Orientation of hard-magnetic particle (P von Lockette et al 2011 Smart Mater. Struct. 20 105022)

According to classical electromechanics, for soft-magnetic particles magnetization **M** of a particle remains parallel to the external magnetic field **H**. Therefore, there is not net force or torque acting on spherical particle with respect to that field if it is uniform. In contrast to soft-magnetics particles, hard-magnetics particles generate substantial torques. Since, in this research we are developing system of equations for magnetic torques acting on anisotropic body to form neuromorphic systems, we focus on both hard-magnetic particles and soft-magnetic particles to produce hysteresis responses in the applied field versus magnetization. The magnetic torque **T**, within the particles themselves is determined by the cross product of the magnetization and the magnetic field **T** = **M** x **H**. However, since soft-magnetic particles are not driven by magnetic torques acting on individual particles this magnetic particle rely on demagnetizing effects to provide a restoring force, e.g. the particle themselves must be geometrically anisotropic.

Electric or magnetic fields are useful for manipulating dispersions containing polarizable dielectric and paramagnetic colloids and nanoparticles. Magnetic or electric fields can be used for rotation, however, magnetic fields are more common in experiments because their effects on the dispersion are easier to control, as electric fields can generate unwanted currents, electroosmotic flows, and electrochemical reactions [11]. Therefore, in this study we focused on magnetic fields to create our system of equations. Based on previous studies, to control how strong mutual polarization among particles is relative to the polarization due solely to the external field H_0, the magnetic of the susceptibility $|\chi|$ was used.

2. Methods

Consider a bar rotating in plane as shown in Figure 1. The bar can be magnetized by an external field, H. Once magnetized, the bar develops an internal magnetization M. It is important to realize that we can determine the amount of our external field, H, acting along $x - y$ axes *separately* from how we determine the amount of magnetization parallel and perpendicular to the bar itself. These are the next steps in our analysis:
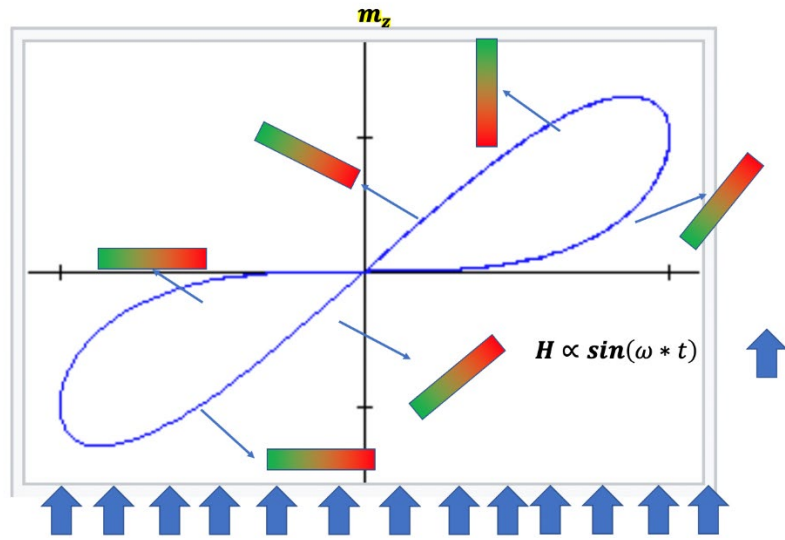
Figure 1. Bar rotating in a magnetic field showing the polarized body in the field

To begin we first define the rotation matrix, **A.** This matrix will be used to calculate the internal Magnetization, **M. A** is represented as

$$A = \begin{bmatrix} cos\theta & -sin\theta \\ sin\theta & cos\theta \end{bmatrix}$$

were θ is the deflection angle of the parallel and perpendicular component directions of the magnetic field **H** and magnetization **M** as shown in Figure 2.
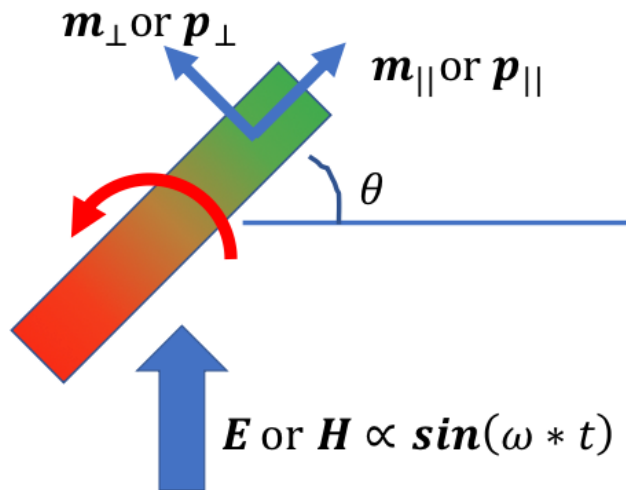
Figure 2. Schematic showing the angle deflection

Next, let m be represented as two vectors parallel and perpendicular to the bar

$$m = m_{||} + m_{\perp} \tag{1}$$

and subsequently

$$m = m_{||}\,\hat{m}_{||} + m_{\perp}\hat{m}_{\perp}$$
(2)

where $\|m_{||}\| = m_{||}$ and $\|m_{\perp}\| = m_{\perp}$. Next, we define the direction vectors perpendicular and parallel to the bars, $\hat{m}_{||}$ and $\hat{m}_{\perp}$, respectively, in the x – y coordinate system as

$$\hat{m}_{||} = \cos\theta\ \boldsymbol{i} + \sin\theta\ \boldsymbol{j} \tag{3}$$

and

$$\hat{m}_{\perp} = -\sin\theta\ \boldsymbol{i} + \cos\theta\ \boldsymbol{j} \tag{4}$$

with θ defined in Figure 1. This allows us by substitution to write

$$m = [m_{||}\cos\theta - m_{\perp}\sin\theta]\boldsymbol{i} + [m_{||}\sin\theta + m_{\perp}\cos\theta]\boldsymbol{j}$$

In eq. (5), $m_{||}$ and $m_{\perp}$ must be derived from demagnetization factors associated with the geometry of the bar. From reference [5] we find for an oscillating field of frequency ω and magnitude H_0 that

$$m_{||} = \chi * \sin(\theta) * H_0 sin(\omega t) \tag{5}$$

is the component of magnetization parallel to the bar and

$$m_{\perp} = \frac{\chi}{\chi+1} * \cos(\theta) * H_0\ sin(\omega t) \tag{6}$$

is the component perpendicular to the bar. Again, by substitution we can write

$$m = \left(\chi * \sin(\theta) * \hat{m}_{||} + \frac{\chi}{\chi+1} * \cos(\theta) * \hat{m}_{\perp}\right) H_0 sin(\omega t)$$

which gives the results in a coordinate system attached to the bar. This may be recast in the x – y coordinate system by substitution of eq. (3) and (4) to give our final result

$$m = \left(\chi * \sin(\theta) * [\cos\theta\ \boldsymbol{i} + \sin\theta\ \boldsymbol{j}] + \frac{\chi}{\chi+1} * \cos(\theta)\right.$$
$$\left. * [-\sin\theta\ \boldsymbol{i} + \cos\theta\ \boldsymbol{j}]\right) H_0 sin(\omega t)$$

In eq. (7) we have assumed

$$H = \begin{bmatrix} 0 \\ H_0 \end{bmatrix} sin(\omega t) \tag{7}$$

in the $x - y$ coordinate system. H_0 is the amplitude of the magnetic field.

After $\boldsymbol{m}$ is calculated we used its results to calculate the Torque, $\boldsymbol{T}$, where Torque is

$$\boldsymbol{T} = \boldsymbol{m} \times \boldsymbol{H} \tag{8}$$

and ϕ is the direction of the magnetic field.

Deriving torque from external field we obtain

$$\boldsymbol{T} = \boldsymbol{T_{EM}} + \boldsymbol{T_{viscous}} + \boldsymbol{T_{drag}} + \boldsymbol{T_{viscoelastic}}$$

where $\boldsymbol{T_{EM}}$ is the driving torque from external field, $\boldsymbol{T_{viscous}}$ is the retarding torque from viscous-elastic response.

where eq. (8) can be derived as

$$J\theta'' = \sum T \ (in \ plane) \tag{9}$$

and $\boldsymbol{J}$ is the polar moment of inertia. $\sum \boldsymbol{T} \ (in \ plane)$ is derived for rotational drag coefficient and its viscosity factors which give us the following form of a second order non-linear differential equation

$$J\theta'' = -D_\omega \theta' - D_\theta \theta + H_0 \cos \theta$$

D_ω is the rotational drag coefficient, which contains the viscosity, D_θ is the spring like a drag term in our equation, and in eq. (11)

We can recast variables as follows without loss of generality,

$$c_1 = \frac{D_\omega}{J} \tag{10}$$

$$c_2 = -\frac{D_\theta}{J} \tag{11}$$

$$c_3 = \frac{H_0}{J} \tag{12}$$

To obtain:

$$\theta'' = -C_1 \theta' - C_2 \theta + C_3 \cos \theta \tag{13}$$

where C_1 is the ratio of rotational drag coefficient over polar moment of inertia, C_2 is the spring-like drag term over polar moment of inertia and C_3 represents the strength of the magnetic field with respect to the polar moment of inertia.

We use the derived differential equation of eqs. (14-17) to measure the damping ratio and measure how oscillations in a system decay after a disturbance. We investigate if we can use an aggregate of rotating magnetic particles to produce a hysteresis response in the applied field versus magnetization.

The damping ratio is denoted by ζ and it is calculated as

$$\zeta = \frac{C_1}{2\sqrt{C_2}} \tag{14}$$

where

$$\zeta = \frac{Actual\ Damping}{Critical\ Damping} \tag{15}$$

and

$$Actual\ Damping = \frac{D_\omega}{J} \tag{16}$$

and

$$Critical\ Damping = 2\sqrt{\frac{D_\theta}{J}} \tag{17}$$

3. Results of Damping Ratio Visual Simulations

1. Constant Magnetic field with varying damping ratios (Zeta)

The results of the derived differential equation and damping ratio were used to create and examine visualized simulations in MATLAB. These simulations are similar spring-mass system with a difference of adding a steady stream of air pushing the mass, in other words we are adding torque to our system. As mentioned, the damping ratio measures how oscillations in a system decay after a disturbance and find the equilibrium position. The equilibrium position is the balance of the spring force and whatever torque has been applied.

Figure 1.3 shows the effect of varying damping ratios, ζ, of the derived second order differential equation with constant magnetic field of one. As the damping ratio varied, different oscillation cases were observed: undamped, underdamped, and overdamped. Undamped occurred when $\zeta = 0$, meaning there is not damping and we are getting perfect oscillation with a small rotation. Underdamped occurred when $\zeta < 1$. We can overshoot pass our equilibrium position, then oscillate back until the signal will settle down at its equilibrium position. Overdamped happens when $\zeta > 1$. This occurred due to the rotational drag coefficient term (D_ω) that acted on the velocity. If it D_ω is very high it takes longer to achieve equilibrium.
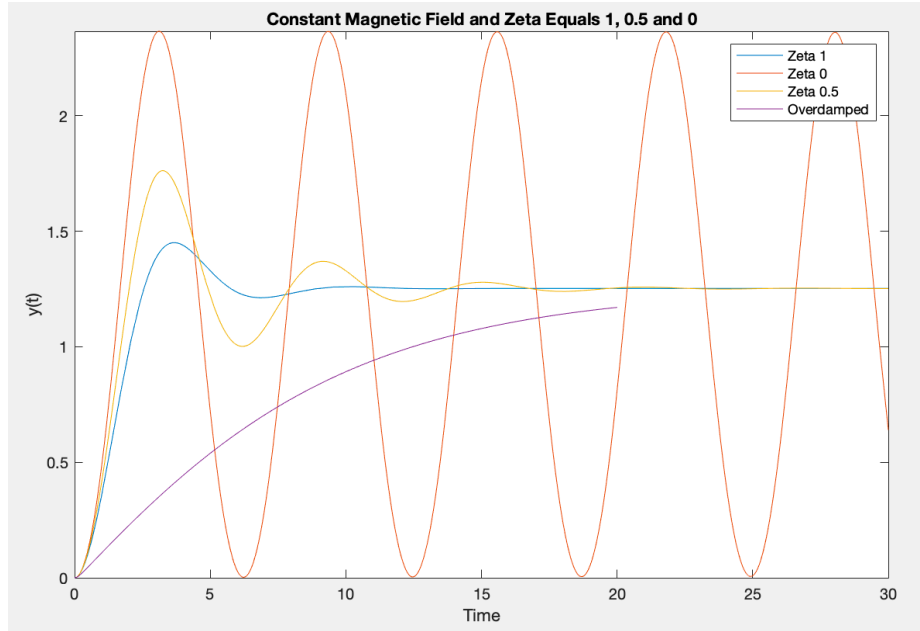
Figure 1.3 The effect of varying damping ratio of the second order system

2. *Change in Magnetic field with $\zeta = 1$) 1 and varying τ where τ is the constant time*

We used the same calculations as Figure 1.3, but for this case we only focused on $\zeta = 1$ with varying τ and H_0 . In Figures 1.4(a), (b) and (c), the magnetic field (Ho) sets the amplitude, the τ sets the period. We know that $period\ (T) = \frac{2\pi}{\omega}$ [6], therefore, in our calculations we let frequency ω be τ to set the period to be constant. We conclude that as Ho is larger, the rotation is larger, so as the torque rises and fall to higher and lower values the particle amplitude rotational amplitude increases.

In Figures 1.4a-c we have $\zeta = 1$and the Ho doubles and triples for each Figure, going from 2 to 4 and 2 to 6. The only thing that changes in each Figure is the τ. In Figure 1.4(a), 1.4(b) and 1.4(c) we have small, medium and large τ. As predicted the torque goes up as we increase Ho because the rotation is getting larger and the polar of inertia is getting smaller. Another observation from this Figures is that as τincreases the period is getting larger and the rotation is getting smaller meaning that the polar inertia is getting bigger and its harder to have the system spin.
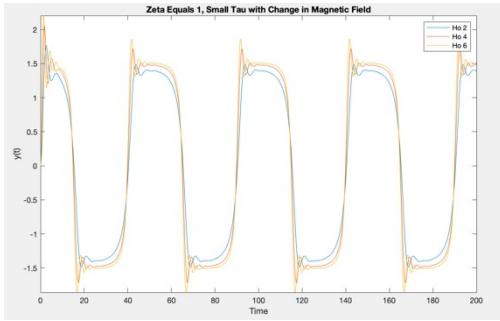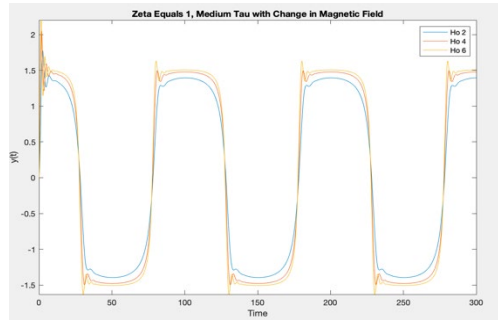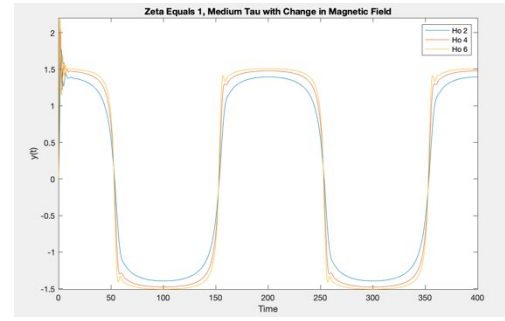
| Small τ (a) | Medium τ (b) | Large τ (c) |

Figure 1.4. The effect of varying magnetic field (Ho) on damping ratio equal 1 with (a) small τ, (b) medium τ, and large τ. As Ho increases, the rotation decreases and the period increases.

3. Change in Magnetic field with varying damping ratio $\zeta = 0.5$ and varying τ
The following Figures are similar to the Figures 1.4a-c, however, in these Figures we have Zeta equals to 0.5. In Figures 1.5a-c, as in In Figure 1.4a-c, we have 50, 100 and 200 τ. In contrast, the results in this figure shows that if we have a smaller damping ratio, we have more torque rising and falling to higher and lower values regardless the Ho. The rotation is the same as the simulation where the damping ratio is 1. Figures 1.5a, b and c have the same amplitudes in the first period. However, as τ increases the period increases and the rotation decreases, but there still a larger torque in the smaller damping ratio.
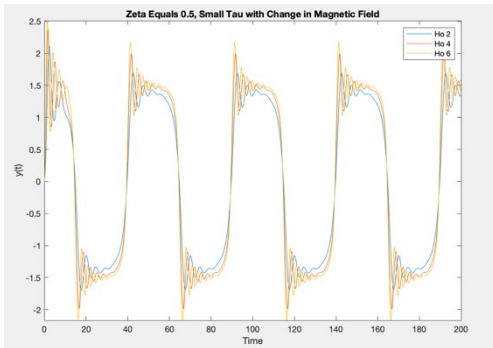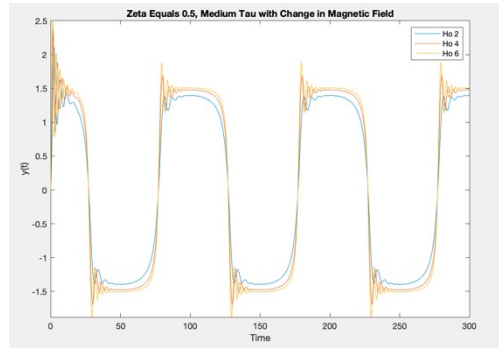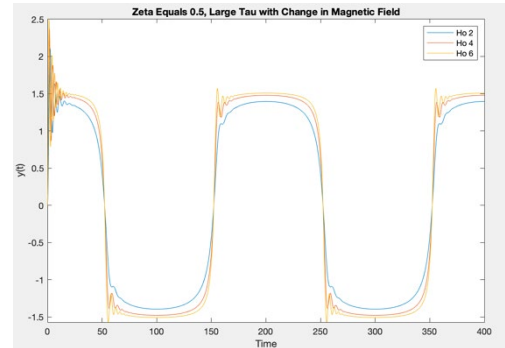
| Small τ (a) | Medium τ (b) | Large τ (c) |

Figure 1.5. The effect of varying magnetic field (Ho) on damping ratio $\zeta = 0.5$ with (a) small τ, (b) medium τ, and large τ. As Ho increases, the rotation still larger than zeta equals to 1 and the period still increases.

4. Change in Magnetic field with varying damping ratio ζ = 0 and varying τ

As in the previous Figure, the Figures 1.6a-c have the same change in magnetic field and small, medium and large τ. The only difference from previous cases, is the damping ratio is 0 which shows there is not damping. In this case the system tries to follow the external signal but instead it oscillates. With small τ we start off at zero, the field swings down and up, but is moving slowly enough without damping that as it is moving down the bar is oscillating around at whatever direction the field pointing. It is interesting to note that in the case of large τ, the oscilating system takes more than one cycle to reach its apex at $y(t) \cong 4.5$ before reversing immediately achieve oscillations about $y(t) \cong +4.5$.

Even when we had a large period the bar is actually moving slowly, and it is oscillating in the similar line.
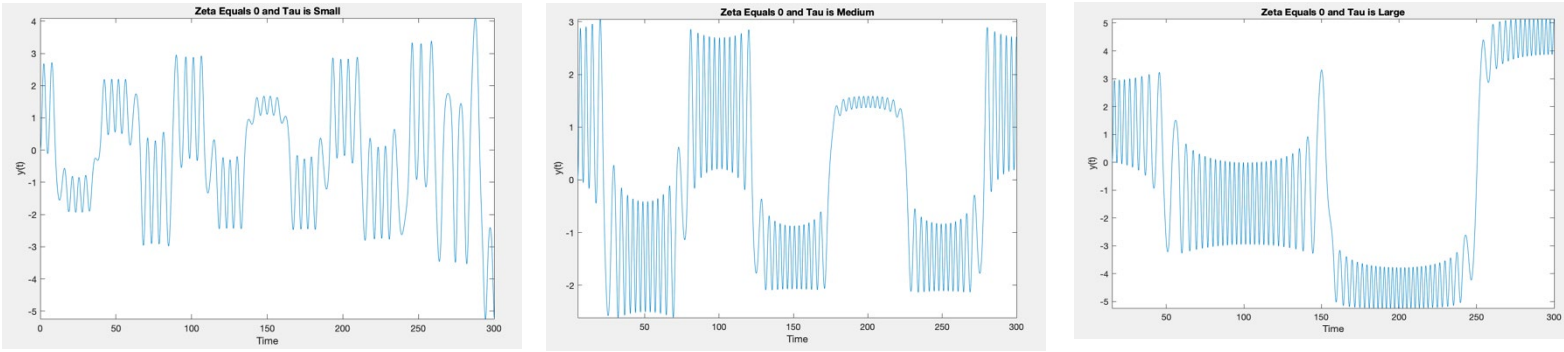
Small τ (a)   **Medium τ (b)**   **Large τ (c)**

Figures 1.6. The effect of varying magnetic field (Ho) on damping ratio (Zeta) equal 0 with (a) small τ, (b) medium τ, and large τ.

4. Conclusion

In this work, we study the material analogs for the particular responses exhibited by biological neuromorphic materials. We derived equations governing a rotating magnetic body that were similar to those governing a spring-mass system. A key difference was the inclusion of magnetic torque, which acted analogously to a stream of air pushing the mass. These simulations visualize the results from a unidirectional, sinusoidal magnetic field with proscribed amplitude and period; and with varying damping ratio of the system itself. After analyzing the simulations, we observed that for constant magnetic field, if the drag coefficient term D_ω is high it the system takes longer times to achieve its equilibrium position. For the change in magnetic field with varying damping ratio and varying period, we conclude that as the field amplitude is larger, the rotation amplitude is larger, so the torque rises and fall to higher and lower values. Finally, as the period increases the displacement amplitude decreases, showing that inertia is possibly a factor in the overshoot response.

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Determining malfunction in the neuron or muscle within neuromuscular dysfunction stemming from adenylosuccinate lyase deficiency

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Abstract

Adenylosuccinate lyase (ADSL) is a bi-functional biosynthesic enzyme for purine metabolism. The loss of the function in this enzyme causes a rare and often misdiagnosed disorder that ranges in severity. In humans, the severity ranges from fatal to phenotypes such as epilepsy, muscle dysfunction, and autistic like symptoms. *Caenorhabditis elegans* share the purine metabolic pathway with humans as well as showing a similar neuromuscular phenotype with a dysfunction in ADSL. To determine the question of whether the dysfunction is because of loss in the neuron or the muscle we used transgenic *C. elegans* with an extra chromosome that reestablishes the ADSL function in either the neuron or the muscle. Aldicarb was used to test the neuron and levamisole was used to test the muscle. The muscular transgenic C. elegans reacted like typical *adsl-1* in aldicarb, indicating an issue with the muscle since neural transgenic behaved more like normal. While the results with levamisole were inconclusive and will need to be adjusted in future experiments.

Introduction

Adenylosuccinate lyase (ADSL) deficiency is a recessive neurological disorder that causes a fault in the synthesis of purines through the de novo pathway which impinges on purine nucleotide recycling pathways. In humans, the primary function to be affected is neuromuscular with varying severity and onset stages. The most extreme cases are neonatal encephalopathy resulting in death just a few weeks after birth stemming from respiratory failure, seizures, and absences of spontaneous movement. Later onsets symptoms are seizures, ataxia, cognitive dysfunction, and autistic like behaviors. The only way to diagnose is through spinal fluid or urine by examining the accumulation levels of succinylaminoimidazole carboxamide riboside (SAICAr) and succinyladenosine (SAdo) (Macchiaiolo).

Adenylosuccinate lyase Deficiency

In order to learn if the dysfunction is in the neuron or the muscle, *Caenorhabditis elegans* are studied because purine metabolic pathways are conserved within all eukaryotes, and they have a well-characterized nervous system that is crucial for exploring the symptomatic traits of ADSL (Kappock; White). Neuromuscular deficiency will need to be explored to determine if the issue is within the neuron or the muscle.

Effects of Drugs on Neuromuscular Junction in *C. elegans*

The neuron releases the chemical acetylcholine (ACH) into the synapse where it is broken down through hydrolyzation into acetate and choline by the enzyme acetylcholinesterase (Mahoney). In the presence of an inhibitor like Aldicarb, ACH is no longer metabolized, causing a buildup in the synapses and in turn causing an over stimulus of choline receptors on the muscle leading to constant contraction. Thus, Aldicarb causes a paralysis in the wild type. It indicates an issue within the neuron if the *C. elegans* has delayed response (Mahoney). Whereas, in the presence of a cholinergic agonist like Levamisole, acetylcholinesterase is not hindered. Levamisole imitates ACH to appear as if there is an overproduction in the synapsis to overload the receptors on the muscle. If delayed response to levamisole occurs, then it shows a defect within the muscle, which is most likely to be caused by the receptor's inability to function (Lewis).

The Hanna-Rose lab at Pennsylvania State University uses both Aldicarb and Levamisole to study the effects they have on *C. elegans*. Using normal as the control (N2) and ADSL deficient (*adsl-1*) animals at the experimental strain it appeared that the muscle was malfunctioning because the *adsl-1* animal reacted with delayed paralysis for both chemicals aldicarb and levamisole. I will use transgenic animals to further investigate where the greater defect lies. There will be three different types of transgenic animals: 1) *adsl-1* with the ADSL function restored in the neuron 2) *adsl-1* with ADSL function restored in the muscle and 3) *adsl-1* with no function restored. These will be tested alongside N2 and *adsl-1* animals for added controls. My overall hypothesis is that ADSL function is important in the muscle. Thus, I have two sub-hypotheses, one for each type of transgenic *C. elegans* with both relating to the muscle function. First, if ADSL is only restored in the neuron, then the muscle will remain dysfunctional. Second, if ADSL is expressed only in the muscle, then the muscle function will be restored.
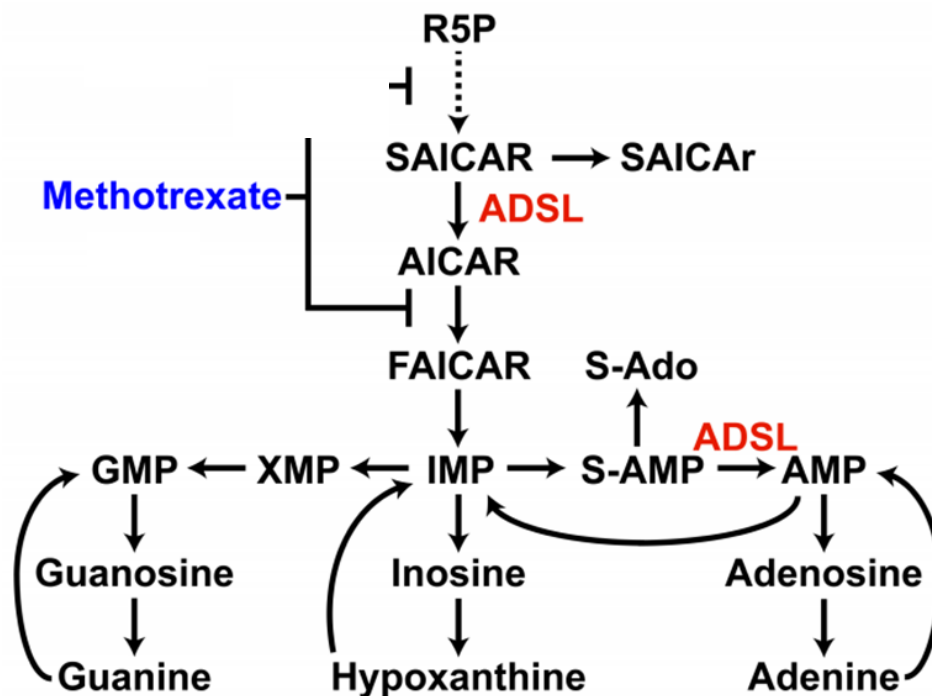
Figure 1: Purine Metabolic Pathway. ADSL (marked in red) functions twice in de novo purine biosynthesis. Abbreviations: SAICAR, succinylaminoimidazole carboxamide ribotide; SAICAr, succinylaminoimidazole carboxamide riboside; ADSL, adenylosuccinate lyase.

Methods
C. elegans strains and maintenance
The controls were N2, *adsl-1* (tm3328)/hT2, and HV856. The strain HV856 also doubled as the balancer for the transgenic animals. The balancer act as a visible marker though GFP in the pharynx, inhibits recombination, and is recessive homozygous lethal. (McKim). There are two different sets of transgenic *C. elegans* being studied: 1) *adsl-1* with ADSL function restored in the muscle strains: HV920, HV923, HV925 (Table 1); and 2) *adsl-1* with the ADSL function restored in the neuron strains: HV932, HV933, and HV934 (Table 1). All strains were grown on NGM agar plates with 50 µl of the food source OP50 *Escherichia coli* and stored at 20ºC (Brenner). To avoid the scarcity of *adsl-1* in one progeny due to *adsl-1* being autosomal recessive, *C. elegans* were maintained on 100 x 15 mm plates with three equal distance 50 µl of food spotted.

Table 1. C. elegans experimental strain descriptions

Strain	Genotype	Extrachromosomal Array
HV856	*adsl-1(tm3328)*/hT2 l; psEx306	[50 ng/µl pTG96 (sur-5p::GFP) + 50 ng/µl p Bluescript]
HV920	*adsl-1(tm3328)*/hT2 l; psEx372	[10 ng/µl pAA1 (myo-3p::*adsl-1*::GFP) + 50 ng/µl pTG96 (sur-5p::GFP) + 40 ng/µl pBluescript]
HV923	*adsl-1 (tm3328)*/hT2 l; psEx375	[10 ng/µl pAA1 (myo-3p::*adsl-1*::GFP) + 50 ng/µl pTG96 (sur-5p::GFP) + 40 ng/µl pBluescript]
HV925	*adsl-1 (tm3328)*/hT2 l; psEx377	[10 ng/µl pAA1 (myo-3p::*adsl-1*::GFP) + 50 ng/µl pTG96 (sur-5p::GFP) + 40 ng/µl pBluescript]
HV932	*adsl-1 (tm3328)*/hT2 l; psEx384	[10 ng/µl pAA2 (unc-14p::*adsl-1*::GFP) + 50 ng/µl pTG96 (sur-5p::GFP) + 40 ng/µl pBluescript]
HV933	*adsl-1(tm3328*/hT2 l; psEx385	[10 ng/µl pAA2 (unc-14p::*adsl-1*::GFP) + 50 ng/µl pTG96 (sur-5p::GFP) + 40 ng/µl pBluescript]
HV934	*adsl-1 (tm3328)*/hT2 l; psEx386	[10 ng/µl pAA2 (unc-14p::*adsl-1*::GFP) + 50 ng/µl pTG96 (sur-5p::GFP) + 40 ng/µl pBluescript]

Paralysis Assays
Unspotted NGM plates were treated with either aldicarb or levamisole to have a final concentration of 0.5mM or 1mM respectively at the beginning of the week. This was done by placing 8mL of NGM on the plate with a stock concentration of 10mL of either chemical, aldicarb or levamisole where both were diluted in 70% ethanol. After a day of being set out at room temperature to dry, the treated plates were spotted with 10 µl of OP50 *E. coli* to help localize the *C. elegans* to the center of the plate for easier monitoring. Once the food has dried, the plates were stored in 4ºC until needed. Roughly 10 hermaphrodites of each strain were cultured for a day in 20ºC. Then each genotype was placed on a separate treated plates and observed every 30 minutes for 5 hours or until all stains were fully paralyzed (Mahoney).

Results and Discussion
Aldicarb
NGM plates were treated with aldicarb then 10µl OP50 *E. coli* was spotted at the center. The first sub hypothesis stated if ADSL is only restored in the neuron, then the muscle will remain dysfunctional. *adsl-1* and HV856, a transgenic stain with no restored ADSL function to set a more established control than plain *adsl-1* both fully paralyzed at 60 minutes standing as a marker for typical ADSL dysfunction. In contrast, N2 fully paralyzed at 240 minutes to indicate normal behavior (figure 2). *adsl-1* mutants are more sensitive to aldicarb and paralyze faster. We expect muscular transgenic *C. elegans* to behave like *adsl-1* if function is restored to a normal state in the neural transgenic.

Neural Transgenic
For the neural transgenics, HV932 behaved as *adsl-1*, HV933 behaved closer to *adsl-1* but fully paralyzed 30 minutes after, HV934 fully paralyzed halfway between *adsl-1* and N2 (Figure 2). Because neural transgenes restored some function to *adsl-1* making them more like N2, it appears that function in neuron is important for the role that ADSL plays in aldicarb response.

Muscular Transgenic
For the muscular transgenics, HV920 behaved as *adsl-1* while both HV923 and HV925 behaved like *adsl-1* by paralyzing 30 minutes after (Figure 2). Since nearly all the strains behaved the same or close to the ADSL deficient strains, there is no evidence that response to aldicarb is affected by expression of ADSL in muscle.

A   B
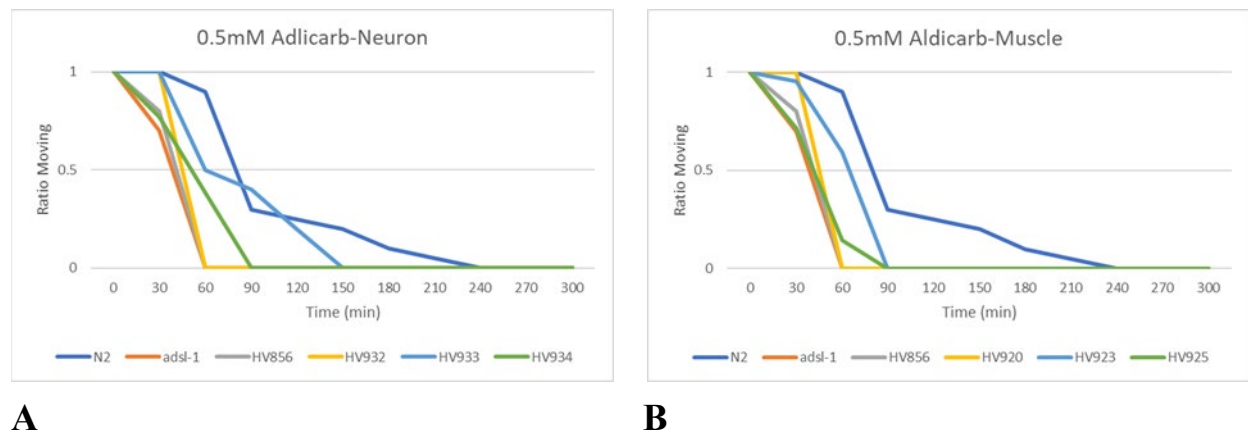
Figure 2: Ratio moving in 0.5mM Aldicarb for Transgenic *C. elegans.* All strains are exposed to aldicarb at the beginning of the fourth larval stage. (**A**) Transgenic strains with the ADSL function reinserted into the neuron compared to the control strains. (**B**) Transgenic stains with the ADSL function reinserted into the muscle compared to the control strains

Levamisole
NGM plates already spotted with OP50 E. coli were treated with levamisole diluted in 70% ethanol. The second sub hypothesis stated if ADSL is expressed only in the muscle, then the muscle function will be restored.

Then *C. elegans* were placed on the levamisole treated plates and monitored every 30 minutes. HV920 strain was the only strain to fully paralyze past the initial check (Figure 3). When levamisole was diluted the in 70% ethanol the chemical became more potent and in turn caused all the C. elegans to paralyze too quickly.

A

B
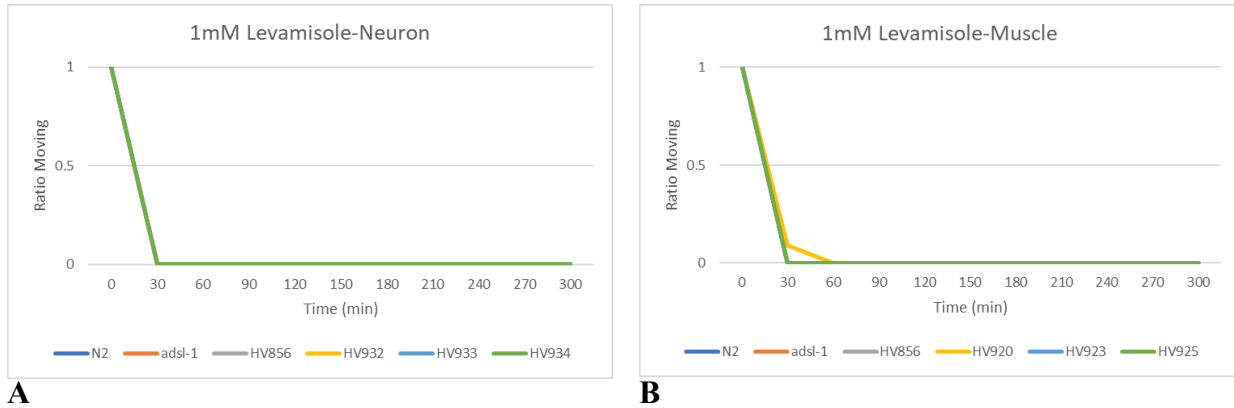
Figure 3: Ratio moving in 1mM Levamisole for Neural and Muscular Transgenic *C. elegans.* All strains are exposed to aldicarb at the beginning of the fourth larval stage. (**A**) Transgenic strains with the ADSL function reinserted into the neuron compared to the control strains. (**B**) Transgenic stains with the ADSL function reinserted into the muscle compared to the control strains

Summary
The overall hypothesis is that ADSL function is important in the muscle. The first sub-hypothesis, if ADSL is only restored in the neuron, then the muscle will remain dysfunctional is supported in Figure 2. ADSL function in the neuron reverts to normal function in Figure 2 (A) but muscle function remains dysfunctional in in Figure 2 (B). To further support the general hypothesis the second hypothesis, if ADSL is expressed only in the muscle, then the muscle function will be restored will need to reconducted. Levamisole was excessively potent so to rectify this the chemical will be diluted in water and the concentration on the plate will be reduced to 0.5mM. in doing this, I hope that there will be more of a separation between the strains so that a conclusion can be determined.

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Acknowledgements

Ocular Influence on Upper Limb Voluntary Movement

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Abstract

Most people in the world experience the world through their eyes and hands. As a species, we perform many tasks with our upper limbs while maintaining posture. However, very little is known about the visual system's role during upper limb voluntary movement after perturbations that require upper limb motor corrections and whole-body postural adjustments. Our study was designed to find the relationship between eye movements, center of pressure (COP), and muscle activation of the lower and upper limbs when a mechanical disturbance deviates a goal-directed reaching task. We hypothesized that neural copies of oculomotor signals, which track object-motion and are mediated by frontoparietal networks, serve as input to gate feedforward and feedback motor responses. With more testing we hope to better understand the relationship between hand and eye movements during upright stance. Our study could have implications for motor development and clinical rehabilitation in Parkinson's disease patients.

Introduction

Many of the actions that we perform during the day throughout our lives involve standing and using our hands. For example, when we are playing catch with friends. As objects are in mid-flight, our motor and visual centers must work together to predict the correct trajectory for interception. However, sometimes we experience disturbances, such as a friend hitting our arm or, if we're playing in a ballpark, the wall brushing against us. This led us to wonder what's the relationship between eye movements, center of pressure (COP), and muscle activation during goal-directed reaching tasks while standing?

When we use our upper limbs voluntarily, our body activate mechanisms to stabilize our posture. One of the mechanisms that activate prior to voluntary movement to stabilize our posture is anticipatory postural adjustment (APA) (Cordo & Nashner, 1982). APA is a feedforward mechanism that occurs before the voluntary movement could potentially destabilize the body. It's designed to help keep our COP within a range to stop us from falling over from sudden postural changes. One of the ways it can be characterized is by the activation of the gastrocnemius about 100-150 ms before the biceps during a pulling or pushing task (Purves et al. 2018). A recent study found that when mechanical perturbations are applied to the upper limb, rapid activation of the lower limb muscles also occurs (Catherine et al. 2017).

One of the main findings was that lower limb responds either at the same time or after upper limb corrections during goal directed reaches. They also found significant changes in COP when performing the task in relation to the constant postural sway contributed by the soleus and gastrocnemius (Loram et al., 2005).

Our visual system plays a role in our movement planning and initiation. Eye movements are characterized into four forms: saccades, slow pursuit, and vergence (Purves et al., 2001). Our experiment is focusing primarily on smooth pursuit slow eye movements, to get a better understanding of the how the nervous system processes visual sensory information to stabilize the body when intercepting a moving target. An early study found that although not instructed to do so, subjects will use smooth-pursuit eye movements to track a target up to the time of interception for targets moving in quasi-unpredictable trajectories (Mrotek & Soechting, 2007).

Our study is designed to analyze the relationship eye movements have on center of pressure and muscle activation of the upper and lower limbs. To date, we do not completely understand the neural functions associated with catching moving objects and the role of the visual system in stabilizing posture. We hypothesized that neural copies of oculomotor signals, which track object-motion and are mediated by frontoparietal networks, serve as input to gate feedforward and feedback motor responses. Our hypothesis is based on the findings of a relationship between the adjustment of muscle activation and feedback gain to the relative speed of the body and a moving object (Gómez-Granados et al., 2021). Defining these functions would give us a better understanding of the complex integration of the sensory and motor systems within our brains. Examples in which a disconnect between these two systems include people that suffer from ataxia and some stroke patients. A symptom of ataxia is poor hand-eye coordination. By completing this experiment, scientific approaches to the neural aspect of movement will improve and there could also be clinical implications related to motor rehabilitation.

Methods

Participants

We will recruit ~10 subjects. We will collect written consent before they're allowed to participate in the experiment. They will also be screened for right-handedness, free of neurological disorders, muscular disorders, and ocular diseases. The protocol was approved by the Institutional Review Boards at The Pennsylvania State University. The duration of the experiment will be 1 day: 120 minutes. Participants will be compensated for their time.

Experimental Apparatus and Setup

All tasks are performed on the KINARM end-point robotic device integrated with gaze-tracking and a single force plate sensor (BKIN Technologies, Kingston, ON, Canada). The KINARM robot will be adjusted vertically to allow each participant to stand comfortably and view the visual display that projected spatial targets and hand position (white circle, 0.5-cm diameter) onto the workspace. Participants will stand (only socks) on the single force plate sensor that measures ground reaction forces (GRFs) and moments in the medial/lateral (x), anterior/posterior (y), and vertical (z) axes. Subjects will be instructed to grasp onto the robotic handle comfortably

while maintaining an upright posture and keep their weight equally distributed between their feet. During the entirety of the experiment the subject will observed to maintain their posture. Also, they will be harnessed to prevent falling in the instance loss of balance occurs.

The Task

In the first condition, each trial starts with a yellow circular target appearing 20 cm from the midline. Participants are instructed to place the white dot representing their hand in the start target (target turns green). A fixation cross appears on the screen 10 cm from the start target. Participants are to look at the fixation cross. After a random delay, another target begins to move from the fixation cross at 30 cm/s towards the end target that appears 20 cm to the right of the fixation cross. Participants are instructed to intercept the moving target at the position of the end target. If the participants reach the end target within 150 ms before or after the moving target reaches the end target, it is considered a successful trail and the end target will turn green. However, if the participant reaches the end target before the 150 ms window, the end target becomes blue, and it is considered a failed trial. If the moving target makes it to the end target before the hand it is a failed trial. In ~20% of trials perturbations rapid perturbations (8 N) are applied when the hand had moved 3 cm and 9 cm (in the x-direction) from the start target. Perturbations will be applied orthogonal to the direction of the participant's hand movement.

In the second condition participants are instructed to intercept the moving target before it reaches the end target. If participants intercept the moving target before it reaches the end target it is considered a successful trial (end target turns red). If participants do not touch the target with their hand before it reaches the end target, the end target turns red, and the trial is unsuccessful.

Each condition will have 12 blocks consisting of 20 trials. Within each block there will be 4 perturbed (at 3 cm or 9 cm: towards or away). Trials will be presented in a random order for each block. To avoid fatigue participants will sit after every 4 blocks and rest for approximately 3 minutes.

Muscle Recording

Our electromyographic (EMG) recordings will be taken from 12 muscles with surface electrodes. There will be 8 electrodes on the lower extremity and 4 on the upper extremity. The skin overlying the muscle will be cleaned with alcohol wipes, and electrodes will be placed on the muscle belly parallel to muscle fibers. Muscle activity will be collected from: anterior deltoid (flexion/medial rotation of shoulder), posterior deltoid (extension/lateral rotation of shoulder), triceps lateralis (elbow extensor), brachioradialis (elbow flexor). Muscle activity will be collected bilaterally from the lower limbs: tibialis anterior (ankle dorsiflexor), gastrocnemius medialis (ankle plantar flexor), rectus femoris (knee extensor), and long head biceps femoris (knee flexor). Muscle activity will be amplified, band-passed filtered (20-450 Hz), and digitally sampled at 1000 Hz.

Discussion

Due to the time constraints of eight weeks, we were not able to collect data on participants. Therefore, we cannot make any conclusions based on the design of the experiment. However, the study is still ongoing and so far, we've completed one pilot where we collected EMG and COP data. We can speculate that participants would likely look at their hand after the perturbations to make the corrections. They may also focus on the target and try to use their peripheral vision and proprioception to make corrective movements. We hope to complete our research within the upcoming year.

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Pettit's Dilemma: Legitimacy and the Problem of Contestation in Rousseau's "The Social Contract"

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Abstract. This is a critical analysis of Philip Pettit's interpretation and reception of Jean Jacques Rousseau's "The Social Contract" for Pettit's neorepublican project. The author addresses the essay "Rousseau's Dilemma" in which, Pettit argues that the principles of Rousseau's theories of sovereignty and legitimacy would not allow for contestation to occur in Rousseau's republic. While Pettit believes that Rousseau's theory of legitimacy upholds the republican conception of freedom as nondomination, by preventing private domination in individuals' relations with each other, he stipulates that Rousseau's theory of absolute sovereignty does not protect against public domination. Specifically, it prevents citizens from stepping outside of their roles in the legislative assembly and contesting those laws that they have enacted in a majoritarian voting process. He determines that because the sovereign is absolute, contestation is impermissible. The author argues that Pettit conflates the logic of absolutist government with the directives of the general will. She finds that by conceiving of the general will as an active principle and as the sole source of reason for the conduct of the body politic that it grounds both political obligation and the ability for citizens to contest sovereign law in the event of a contradiction of sovereignty.

Introduction

Born in Geneva in 1712, Jean-Jacques Rousseau led a life of passionate intellectual inquiry. By conversing with himself about the problems that grieved him most regarding civil society he became a key figure in the history of cultural critique. The late Judith N. Shklar speaks for most who have taken an interest in this thinker when, in her delivery of the 1989 Charles Homer Haskins Lecture, she describes her affinity for Rousseau: "since my undergraduate days I had been absolutely mesmerized by Rousseau…when I read him, I knew I was in the presence of an unequaled intelligence, so penetrating…to read Rousseau is to acquire a political imagination and a second education…his writings are so perfect and lucid, and yet so totally alien to a liberal mentality."[1]

The work that is the subject of this paper, *The Social Contract*, is far from perfect, on the contrary John B. Noone characterizes it as one of the most 'unsystematic, disarranged, confusing classics of political philosophy.' Noone elucidates the hidden complexities of Rousseau's argument for sovereignty by reconstructing it and presenting eighteen unique elements that make the social contract legitimate. Many scholars like Noone approach exposition of this text with

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[1] Judith N. Shklar, A Life of Learning: Charles Homer Haskins Lecture
Issue 9 of ACLS occasional paper, (American Council of Learned Societies, 1989), 17.

sensitivity and attention to its organic nature.[2] In recent years no one has done this better than Joshua Cohen. His account of the general will, especially the way he explains how implications for interests of individual independence relate to the common good condition, gives rise to a unique and comprehensive reading that elaborates more fully on the theoretical and practical consequences of Rousseau's complex yet compressed contract.[3]

One might suggest that it is difficult to get Rousseau right, and that it can be especially difficult to get him right while thinking about his ideas within a specific theoretical tradition. Obvious misinterpretations surface when the unorganized manner that Rousseau wrote is taken as 'evidence of a simple lack of system'.[4] Interpreters treat concepts atomistically and in isolation from a more comprehensive system that other scholars have worked to provide significant analyses for. An example of this treatment can be found in the way that Rousseau's work is understood in Neorepublicanism. Philip Pettit, one notable scholar, draws distinctions between the Italian-Atlantic tradition that neorepublican ideas are primarily derived from and the 'stylized' Franco-German tradition.[5] He rightfully or wrongfully places Rousseau in this latter tradition. This distinction primarily has to do with meeting the requirements of those 'institutional ideals' of republicanism, i.e., the mixed constitution and contestatory citizenry. Pettit argues that while Rousseau meets the 'ideological ideal' of promoting freedom as nondomination, his promotion of an absolute, inalienable, and indivisible sovereign prevents citizens from taking on a contestatory role in their government.[6]

Pettit does not understand what is unique and 'alien' about Rousseau's theory of sovereignty – he is unaware of certain aspects that might allow for a different conclusion to be drawn about the role of a contestatory citizenry. Section I. of this paper summarizes Pettit's theory of legitimacy that is based on his central neorepublican ideal of freedom as nondomination and the institutional ideals of a mixed constitution, esp. contestation. Section II. gives the broad contours of Rousseau's theory of legitimacy and how it aligns with the ideal of freedom as nondomination. Here, I elaborate more on Pettit's critique of Rousseau's *The Social Contract* in his essay "Rousseau's Dilemma." Section III. addresses two points of departure of Pettit's critique: unanimous consent and absolute popular sovereignty. In addition, I consider a few points that reveal some logical insights regarding Pettit's interpretation, specifically, the purpose and extent of the alienation of natural freedom that is required for the original contract and the possibility of an express right to contestation. Section IV. I argue that Pettit confuses the logical implications of absolutist government and the directives of the general will. Then, I speculate about the function of the general will in the event of a contradiction of sovereignty and that the general will as the grounds for political obligation in a legitimate state also permits contestation by members of the legislative assembly in their dual roles as subjects and citizens.

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[2] John B. Noone Jr., *Rousseau's Social Contract: A Conceptual Analysis*, (Athens: University of Georgia Press, 1980), 1-8.

[3] Joshua Cohen, *Rousseau: A Free Community of Equals,* (Oxford, Oxford University Press, 2010), 44.

[4] Noone, *Rousseau's Social Contract: A Conceptual Analysis,* 3.

[5] Philip Pettit, "Two Republican Traditions" in *Republican Democracy: Liberty, Law and Politics;* ed. Andreas Niederbeger and Philip Schink, (Edinburgh: Edinburgh University Press, 2013), 169.

[6] Pettit, "Two Republican Traditions," 197; Pettit, and "Rousseau's Dilemma" in *Engaging with Rousseau: Reception and Interpretation from the Eighteenth Century to the Present*; ed. Avi Lifschitz, (Cambridge University Press, 2016), 184-88.

I

The central ideal of neorepublicanism is the concept of freedom as nondomination.[7] Philip Pettit says that the primary concern of the state should be to protect individuals from being subject to the arbitrary will of another. Domination, or the power to interfere arbitrarily in another's choices, is checked by the constitutional constraints associated with the mixed constitution – these include the elements of equality under the rule of law, representation, and separation of powers.[8] Another measure to prevent the state from itself becoming a dominating force is an active citizenry that must contest those laws that they do not see as tracking the relevant interests of individuals and the community; relevant interests meaning those interests that align with the ultimate aim of securing and maintaining republican freedom.[9]

The ideal of freedom as nondomination has specific implications for conceptions of justice and political legitimacy. The theory distinguishes between interference and domination. This permits that nondominating interference of authority or law that is created through a fair process and that applies equally to all is not abrogative of freedom – that it actually enhances our free experience within the civil state.[10] The effects of this law become the content factor that Pettit uses to determine the justice of a political order. In plain terms, the justice of an order is understood by considering the acceptability of the order itself and how it regulates citizen's horizontal relations with one another, or in other words, how well the order protects individuals from private domination. However, Pettit says that the legitimacy of an order is determined by considering the acceptability of the coercive imposition of that order and how it regulates the vertical relations between citizens and the state – to what degree the order protects against public domination.[11]

Pettit makes clear that these ideals are distinct – "it is at least logically possible for a just social order to be imposed in an illegitimate manner and for an unjust order to be imposed in a legitimate manner."[12] This distinction also provides that there are separate implications for political obligation involved in these two situations. If an order is imposed legitimately but there is a law that is unjust on subjective grounds, there is still a content-independent justification for accepting the regime.[13] To render the imposition of said law politically illegitimate would necessitate that individuals do not have access to the necessary channels to contest laws within the standard norms of that order. He notes that at the bare minimum citizens can engage in civil disobedience to draw attention to the law in question.[14] This point about contestation is essential for Pettit's account of political legitimacy because theoretically if the standards for legitimacy have been met than the implication for obligation must be attuned to this fact or else citizens who are moved to act, risk creating political turmoil and violence that is not considerate and proportionate to the general acceptability of the regime that is imposing said unjust law.[15]

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[7] Pettit, *Republicanism: a theory of freedom and government,* (Oxford: Clarendon Press, 2002), 31-35.
[8] Ibid, 20.
[9] Ibid, 63.
[10] Ibid, Rep.
[11] Pettit. "Legitimacy and Justice in Republican Perspective." *Current Legal Problems* 65 (2012), 60.
[12] Ibid.
[13] Ibid, 63.
[14] Ibid, 80, 63.
[15] Ibid, 64-5.

II

Jean Jacques Rousseau was also concerned with the problem of legitimacy. In on the *Social Contract,* he provides a solution by substituting legitimate interference for domination by presenting a form of association where no individual is personally dependent and subject to the arbitrary will of another. In other words, Rousseau adopts the classical republican ideal of freedom as nondomination. This is clear from SC I.4 in which freedom is contrasted with servitude. Returning to the basis of natural liberty Rousseau says that "since no man has a natural authority over his fellow man, and since force does not give rise to any right, conventions therefore remain the basis of all legitimate authority among men."[16] Preserving individual freedom is a priority for legitimate authority. As he says, "To renounce one's freedom is to renounce one's quality as man, the rights of humanity, and even its duties. There can be no possible compensation for someone who renounces everything. Such a renunciation is incompatible with the nature of man."[17] So, the question becomes what kind of association can achieve the goal of establishing a common authority yet at the same time allows each individual to follow their own will?[18]

Neorepublicans and Rousseau agree in principle that the solution requires an understanding of law as nonarbitrary interference. Public authority exercises coercive interference, but it is not arbitrary as the law is required to track the interests and ideas of the people.[19] This relationship between liberty and law is grounded on an understanding of how equality is fundamental for political legitimacy. In Joshua Cohen's view, final authority in Rousseau's contract relies on a shared understanding of what the common good requires.[20] And the common idea about this authority between the republican traditions is 'that the state should be founded in concern for the equal liberty of its citizens.'[21] Only when natural freedom is replaced by a 'civil freedom', and a new condition is established in which by being subjected to laws that have their 'essence' and 'object' as the equal liberty of citizens, can the state provide a society in which individuals are protected from domination.[22]

In his essay on republicanism and legitimacy, Pettit summarizes how Rousseau's grounds for legitimacy and political obligation are of a traditional contractarian nature. He says that Rousseau's argument 'was that state coercion is capable of being legitimate if and only if the citizens unanimously vote to submit themselves to the rule of the majority that focuses only on general laws, not particular issues; and with the common good in mind…then the will supported by the unanimously endorsed assembly must count as a general will in which all have an equal share…even if an individual voted no on a law that passed by majority vote, the law is still a part of themselves that is attuned to the general will – so that government cannot be said to deprive them of their freedom'.[23] Pettit argues that this argument is 'over-demanding and infeasible' that 'no states are unanimously endorsed, rule on the basis of a committee of the whole or satisfy the conditions that transform the majority will into a general will.'

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[16] Jean-Jacques Rousseau, Donald A. Cress, and Peter Gay, The Basic Political Writings, on the Social Contract, (Indianapolis, Hackett Publishing Company, Inc., 1987), 144.
[17] Ibid.
[18] Ibid, 148.
[19] Pettit, *Republicanism*, 65.
[20] Cohen, *Rousseau: A Free Community of Equals*, 33.
[21] Pettit, "Two Republican Traditions," 3.
[22] Rousseau, 173.
[23] Pettit, "Legitimacy and Justice in Republican Perspective," 67.

Furthermore, Pettit acknowledges that Rousseau is concerned with legitimizing the exercise of coercive power by a popular sovereign.[24] However, in "Rousseau's Dilemma," he concludes that Rousseau's solution does not call for a contestatory citizenry and neither do his adopted principles of absolute sovereignty allow for one in theory. Pettit argues that Rousseau's theory of sovereignty includes a citizenry that is composed of individuals that can only act in their roles as lawmakers in the legislative assembly.[25] In other words, there is no citizenry that exists as a check on the absolute power of the sovereign. This amounts to a skeptical view of the conception of legitimacy that Rousseau is working with. While freedom as nondomination is the common goal, and the social contract might provide a general framework for creating law that is equal in its essence and object, it does not account for possibly the greatest threat to freedom – public domination.

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III

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Pettit finds Rousseau's answer to the question of political legitimacy problematic precisely because of Rousseau's theory of sovereignty. As an association that arises from a unanimous and consensual agreement, a principle of majority rule is established and on the grounds that the sovereign is absolute this majority rule is incontestable.[26] It is important to note early on that Rousseau's *Social Contract* does not address how citizens ought to behave in the event that they feel as though the sovereign no longer legislates according to the general will, or in other words, when a regime becomes oppressive. So, where might Pettit be getting Rousseau wrong? It is important to begin by considering how we ought to interpret this omission in light of Rousseau's attempt to ground legitimate authority. Pettit thinks Rousseau 'prudently ignored the issue."[27] It could be true that he ignored the contestation problem for the sake of establishing a cohesive and ideal theory for political community. As a matter of practicality this might be a shortcoming of the text in general. Another relevant point is Rousseau's concern for social stability. Generally, he viewed factionalism and contestation as signs of the deterioration of an upright sovereign guided by the general will. This highlights the kind of conception of legitimacy that Rousseau is attempting to articulate as this conception is highly relevant for making determinations about the political obligation that the sovereign requires from citizens. A normative conception of legitimacy attempts to justify the state's exercise of coercive power and to create an obligation to obey. Under a normative concept of legitimacy, certain criteria or a benchmark of acceptability must be met. For Rousseau, this criterion amounts to the conditions of the social contract. The conditions of the social contract are a difficult and ambiguous set of principles and claims to understand clearly, without always arriving at some kind of contradiction. But to begin, it is intelligent to consider the basic contractarian elements that Pettit criticizes, unanimous consent and majority rule, before, in section four, I examine Rousseau's special brand of absolutism and its logical conclusions that Pettit is most concerned with.

Liam Farrell points out how explicitly Pettit "emphasizes in a Lockean fashion the importance of 'contestation' over that of 'consent' as the basis for political legitimacy and, further, its significance in order to secure the ideal of liberty as non-domination.[28] This is most evident in Pettit's critique of Rousseau. The feasibility of actual unanimous consent at the origins

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[24] Ibid, 60.
[25] Pettit, "Rousseau's Dilemma," 32.
[26] Ibid.
[27] Pettit, "Two Republican Traditions," 197.
[28] Liam Farrell. "The Politics of Non-Domination: Populism, Contestation and Neo-Republican Democracy." Philosophy and Political Criticism 46, no. 7 (2020), 859.

of political society is clearly suspect.[29] However, Pettit takes the social contract at face value and puts aside questions of feasibility in order to get a clear sense of Rousseau's ideas. We might understand obligation within society arising from placing one's person under the supreme direction of the general will. This requires a unanimous voluntary agreement to surrender natural right in order to establish the public person, a sovereign that makes creates civil liberty and law on the basis of majority rule.

Pettit allows that Rousseau's main point about the social contract – that it is an 'act by which a people is a people' where 'each, by giving himself to all, gives himself to no one' – somewhat aligns with the republican goal of preserving freedom as nondomination, yet he is skeptical about the social contract's ability to protect against public domination.[30] He is wary of this idea of submitting to the general will of the public person.[31] This understanding confuses Rousseau's grounds for political legitimacy and his grounds for political obligation. Pettit's basic criticism here is about the ability of consent to justify legitimacy. I do not disagree that this is the idea of the contract; however, I am skeptical that the content and activity of this original agreement seamlessly carry over to political community in the way Pettit thinks so.

In her lectures *On Political Obligation*, Judith Shklar elucidates the meaning of consent for obligation in Rousseau's contract. She understands that the citizens are obliged to the general will by which they have been 'transformed and reeducated to feel and know that their condition as free and equal citizens depends on it. Their obligation is [to] the general will within and to repress the particular will…real obligation [is] possible only as part of a transformative contract, sustained by constant civic education."[32] In a similar vein, she says that Rousseau was moved by David Hume's own criticism: that any account of obedience or disobedience based on 'promising' is incorrect and that real obligation arises from the internalization of custom.[33] This custom for Rousseau is sovereignty, the exercise of the general will. This understanding supports the line of thought that in the social contract the voluntary act of consent is prior to moral community, political obligation, and duty, therefore this act is not binding on the community. The contract itself is merely a definition for political obligation.[34] The sovereign can be dissolved at any time. Consent might only be the grounds for the initial association and basis for majority rule in order to justify an overarching concept of legitimacy – however, Pettit still argues Rousseau's idea of political obligation is still greatly tied to this latter point.[35]

The simple of act of express consent itself might not warrant political obligation, but what about the form of association that individuals are consenting to? Does majority rule, the principle that makes this association worthwhile for the goal of creating nondominating authority establish absolute obligation to the sovereign? In other words, what should an individual's relationship be with this democratic ideal? Similar to how a virtually empty act of consent does not justify total obligation, the required alienation of freedom by each individual for the creation of a popular sovereign is not total impersonal alienation that would give the sovereign absolute

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[29] Tacit consent is most often associated with Rousseau's theory; however, here I am most concerned with the moment of unanimous consensual agreement of the social contract.

[30] Pettit, "Rousseau's Dilemma," 181.

[31] Pettit, "Two Republican Traditions," 187.

[32] Judith N. Schklar, Samantha Ashenden, and Andreas Hess. *On Political Obligation*. (New Haven: Yale University Press, 2019), 118-9.

[33] Ibid 113-116. See David Hume. "10. Of the Original Contract" In *David Hume on Morals, Politics, and Society* edited by Angela Coventry and Andrew Valls. (New Haven: Yale University Press, 2018). 208-223.

[34] Noone, "The Social Contract: A Conceptual Analysis," 8-13, 26.

[35] SC I.7.2; I.5.3.

power in its majoritarian decision making. The alienation required for the contract is not total alienation of the will, but a total individual alienation on behalf of the group as whole. From this we understand individuals as still possessing a moral quality to their action, this is necessary for obligation and the legitimacy of the contract.[36] Pettit points out this 'central anti-Hobbesian conclusion,' that a people cannot simply promise to obey or else it is no longer a people.[37] Rousseau recognizes this requirement, or necessary caveat, for political obligation that Hobbes did not; however, Pettit correctly emphasizes the idea that the people as a whole have this privilege as a contracting party, not individual citizens.

For the character of unanimous consent to carry over from the original contract to the nature of sovereign law, individuals are 'forced to be free.'[38] And this point might appear contradictory in light of the goal to preserve freedom as nondomination. But as John B. Noone points out, the equal coercive imposition of authority preserves freedom.[39] Notably, in his hypothetical Pettit says let fallibility of the general will not be an issue in determining if contestation would be permissible.[40] For the sake of this experiment let us pretend that the general will is in the majority decision in regard to any type of law. Now, what does this mean for obligation? Yes, it is true that the majority rightly binds the minority in this case, as described above. But is this not just another way that the state exercises its coercive power in the way that most states do?

However, this is not precisely the problem. This is not the relevant point of concern and Pettit acknowledges this.[41] His hypothetical embedded in the *Social Contract* is approximately a situation in which a legitimate order imposes a law that is unjust in the eyes of some individual, and under these conditions there might still be a 'content-independent justification' for political obligation.[42] On the other hand, it appears that the legitimacy of the imposition of the order is still under scrutiny in regard to this concept of the general will. Pettit sees majority tyranny arising from the popular sovereign that Rousseau establishes. The problem of majority rule is not just a problem in Rousseau, but for most theories of government – as democratic government can become arbitrary by losing sight of its primary goal of preserving equality and liberty through the fair and equal participation and distribution of law by instead substituting a populist approach to governing. But where neorepublicans have adopted methods of mixed government to curb tyranny, Rousseau found an answer in the general will originating in the finer points of the social compact.[43] But as far as Pettit is concerned Rousseau barely provides an answer.

Noone quotes Rousseau, "anyone who refuses to obey the general will shall be forced to do so by the whole body," and Noone himself says that "commentators see something sinister in this conjunction of force and freedom" but it is right to say that "political freedom is maintained by de facto obedience to law" to disobey a law would be an "individual seeking to establish an unequal relationship" between himself and the body. By shirking sovereign authority, this

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[36] Noone, 14, 33-4 & SC I.8.1.

[37] Pettit, "Two Republican Traditions," 186. See SC II.1.3; I.7.3.

[38] SC I. 7.7.

[39] Noone, "The Social Contract: A Conceptual Analysis," 34-6.

[40] Pettit, "Rousseau's Dilemma," 28.

[41] Ibid, 24. Pettit accepts that Rousseau's theory of legitimacy as it requires coercion to establish civil liberty is legitimate as long as the assembly is established by common consent and turns out to operate in a "distinctively benign manner."

[42] Pettit, "Legitimacy and Justice in Republican Perspective," 63.

[43] For a discussion of the problem of majority tyranny see Annelien de Dijn, "Rousseau and Republicanism," *Political Theory* 46, no. 1 (2018).

individual steps outside of the realm of morality and political obligation and therefore does not have any freedom or rights because of this choice.[44] This is unacceptable for Pettit as his conception of legitimacy requires not only a justification for what we might call positive political obligation or obedience, but also a vertical relationship with mechanisms, such as contestation, to protect against public domination.

It seems that Rousseau's definition of sovereignty, as the exercise of the general will, is understood by Pettit as grounds for political obligation that only justifies obedience in cases where the general will is upheld in the decisions of the legislative assembly. "Insofar as a society is set up by a social contract, it counts for Rousseau as legitimate; and insofar as it operates on the basis of the general will it counts, we might say, as just."[45] But this presents a common dilemma in interpretation. Many critics of Rousseau deny that a true differentiation can be made – that there is no general will beyond the will of the majority. In reflection on Rousseau's answer to the question of if citizens are still free even if they are required to submit to laws that they did not consent to, Pettit accepts the traditional positive answer that if the assembly is not factionalized and still acts for the general will then the civil freedom that was established by the original consensual and voluntary contract still stands; therefore, citizens are still required to submit, they are "forced to be free".[46] However, in his question about contestation, he detracts from this position and rather than considering if the sovereign is legitimate under Rousseau's definition, he places more weight on the subjective position of an individual in relation to their government. "If individuals *judge* that it is factionalized and *believe* that its decisions no longer follow the general will would the sovereign allow contestation by these citizens?"[47] Pettit's interpretation, and I think Annelien de Dijn shares my sentiment, is very neglectful of any innovative conception of the general will. While individuals might "legitimately feel that they are ruled according to the will of another and hence unfree" – this subjective side of freedom that Pettit appeals to might not be adequate to declare that the sovereign is illegitimate and no longer tracks the general will.[48] It is possibly not adequate because as Rousseau says there is much difficulty in distinguishing the general will from a particular will, but it must be done. When a person disagrees with the sovereign's decision their feeling must not be based in how the law might interfere with their particular interests in a benign manner, but their reasoning must be directed toward the common good.

But this still does not quite get to the heart of the matter concerning contestation. I emphasize that this problem of the general will is much more than a matter of differentiation in the way described above. I have described Rousseau's theory of 'positive' political obligation and its characteristics in regard to the general will; however, Pettit's problem concerning contestation still stands and I believe this is due to his decision to 'not let fallibility of the general will be an issue' and his framing of the question in the language of a 'right' to contest. I see that he does this to avoid ambiguity, but to consider the fallibility of the general will is indispensable for understanding obligation in *The Social Contract*. The idea that the general will cannot *err* is not the same as to say that the law that sovereign enacts cannot err. Rousseau was aware of this problem.[49] I might propose that the general will in itself, as something that cannot be wrong, this

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[44] Noone, "The Social Contract: A Conceptual Analysis," 34-35.
[45] Pettit, "Rousseau's Dilemma," 31.
[46] Ibid, 24.
[47] Ibid, 30-1.
[48] Dijn, "Rousseau and Republicanism," 64-5.
[49] SC II. 3.1.

idea grounds the legitimacy of the state, but in order to understand obligation we must consider this other point about the fallibility of the people as sovereign. I am not proposing what had already been mentioned that obligation is only demanded when the general will is embodied in sovereign law. Possibly, the very fact that we cannot always determine this, I think, makes the general will a much more pliable concept than Pettit imagines it to be for a theory of obligation. I will elaborate on this point of interpretation in section IV. But first, I will address some specifics of Pettit's argument concerning absolute popular sovereignty.

In light of this confusion over the general will, Pettit's interpretation of Rousseau's theory of sovereignty is a little too purist and bent on the idea of a tyrannical majority. He cites the SC II.4 "On the Limits of the Sovereign Power" to support his insistence that individuals really have no rights beyond those established by sovereign. He refers to the social contract, 'if individuals were left some rights,' he interjects with 'presumably, rights of contestation' and then back to Rousseau's words, 'there would be no common superior to adjudicate between them and the public'… 'each would be judge in his own case'… 'the state of nature would obtain.'[50] This is why the sovereign's decisions must be absolute. It is clear that Pettit's added idea in this context would amount to a seemingly clear textual defense for why citizens could not assume a contestatory role. However, it is important to point out that in this context the issue of contestation appears as a question of individual rights, which in Rousseau is already quite ambiguous.

Joshua Cohen provides one way of reconciling rights and a sovereign directed by the general will. Cohen makes a very compelling argument that considerations for individual independence can be implied if we adopt an understanding that the general will is upheld through a method of collective decision making in which citizens of the assembly enact common good legislation that benefits all individuals due to the standard commitment of treating 'associates as equals.' He makes a point that Rousseau never discusses a need to 'weigh consideration of the common good against the value of individual independence in deciding whether a regulation ought to be imposed.'[51] This is showing that individual independence is not necessarily a sufficient condition for the common good, which might appear unacceptable to some. However, Cohen points out that enacting the common good, creating sovereign law, is also not simply a matter of a majority rendering a decision on a regulation of individual freedom that meets the singular criteria of being somewhat beneficial to the community – on the contrary, "the regulation cannot be a burden that is useless to the community," and also, each person 'alienates by the social pact only that portion of his freedom which is important for the community."[52]

The force of this section for Pettit is that the sovereign at the end of the day is 'judge of the importance' of what individuals must alienate for the good of all. In "The Limits of the Sovereign Power" it seems that the sovereign's determination in individual isolated cases of legislation is absolute and at the end of the day the provision of 'individuals alienating only what is necessary' comes off as unenforceable in the looming shadow of this latter qualification, due to a basic lack of political right to contest sovereign decision about what is to be alienated. It is important to remember that the sovereign is the people and individual citizens make up this sovereign who are legislators in one regard and subjects in another, it seems only logical that considerations about the level of individual coercion that is involved with a regulation would be considered for the purpose of determining if the legislation aspires to the common good. As

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[50] Pettit, "Rousseau's Dilemma," 18. See SC I.6.7 & II.4.6.
[51] Cohen, *Rousseau: A Free Community of Equals*, 45.
[52] SC II.4.3.

Rousseau says it is not necessary for the sovereign to offer a guarantee to its subjects that it will uphold this reciprocal relationship that ensures the equality of rights because it is already inherent in the activity of the people as self-legislators.[53] Here, we adopt an understanding of the common good not as mere public utility in aggregate form but one that requires consideration of each member as an equal part of the whole.

But what does any of this say about the hypothetical permissibility of a certain right like that of contestation? Directly to the question the previous discussion does not provide a satisfactory answer. Pettit's reference to the reciprocal relationship between subject and sovereign, but in which the sovereign is the de facto final judge in deciding what individuals must alienate, bolster's his claim that only the people as a whole have the right to oppose the sovereign and that individuals are only meant to comply. To put it plainly I do not think that an individual right of contestation could theoretically exist under this sovereign. Pettit is correct in assuming that contradiction of sovereignty does arise when 'individuals are left some rights,' this is akin to partial personal alienation required of individuals, these 'natural rights' are not tied to political obligation that legitimacy requires.[54] In Rousseau's vision contestation is not a simple right that individuals can possess at the leisure of a decent state, it is a radical idea that opposes the unity of the people and is a rejection of a common good approach to politics. With the positive title as citizens, individuals have rights under the sovereign, not rights that are contrary to the moral community's very existence.

However, just because contestation is denied in the form of a right it does not follow that contestation itself can be a liberty alienated at the bequest of the sovereign that would in effect deny any contestatory activity. Cohen's account introduces us to the general will in a way that allows for individual rights to be considered possible and reveals how a populist reading of Rousseau's sovereignty is disingenuous to the foundation of the social contract. We might understand obligation within society as placing one's person under the supreme direction of the general will, not necessarily under the law that is created by the sovereign. Rousseau himself repeatedly expressed that while the general will is not wrong, the people in their legislative capacity can make law that is wrong. Cohen makes this clear in stating that while the 'general will is sovereign or supreme, it is not exhaustive or complete.'[55] The obligation that is required for the social contract and sovereignty to be legitimate might not consist in submitting to the general will as embodied in sovereign law as it is 'not the sole source of reason for conduct.'[56] And even more crucially, this latter quotation from Cohen along with his idea that individuals must be considered as indivisible parts of the whole brings to light that individuals possess a moral quality to their actions that is independent from majority enacted decisions and determinations for political obligation.[57] Now, we may understand that majority rule as a facet of the general will grounds political obligation, but not in all circumstances of individual conscience. Political obligation is the ideal that those positive elements that Pettit highlights give rise to, but the general will as it acts to direct the legitimate imposition of coercive power by the sovereign also acts as a device for regulating a vertical and reciprocal relationship that Pettit himself demands for a theory of legitimacy. I am imagining a relatively straightforward situation in which citizens are most definitely obliged, but can simultaneously possess other convictions

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[53] SC I.7.5.
[54] Noone, "The Social Contract: A Conceptual Analysis," 14.
[55] Cohen, *Rousseau: A Free Community of Equals*, 37.
[56] Ibid, 38.
[57] Noone, 34.

and act differently, such as contest laws that they find to be unjust, even if this might seem contradictory to sovereignty.

IV

The general will provides direction for the sovereign in creation of law and imposition of authority. The sovereign can only consider and decide on issues that are general and in the abstract. And the general will also acts as a self-mediating guide for individuals in their considerations for the common good. It was important for Rousseau to separate the particular from the general in the making of law because of his concern for creating nondominating law that promotes equality and liberty. But this method brings to light questions about contestation and the vertical relationship individuals may have with the sovereign. How can the sovereign have such a relationship if it cannot consider particular matters? In order to answer this question, we should first examine how Pettit understands an absolute sovereign directed by the general will.

As previously noted, Pettit does not see much potential in the concept of the general will – nor does he understand its role in the exercise of sovereignty, he more so picks it up and puts it in down in the manner that I have described. And then he moves on to thinking about contestation according to an orthodox interpretation of Rousseau's theory of absolute sovereignty. In "Rousseau's Dilemma," he understands Rousseau's theory of popular sovereignty in such a way that he *should* reach his conclusion in the manner in which he proceeds. Rather than looking at the structure of Rousseau's social compact to make better sense of sovereignty, Pettit forfeits this undertaking and adopts a rather anemic and predictable Hobbesian understanding of absolutism. In Rousseau's case it might be too easy to say that because the sovereign enjoys absolute power contestation is in effect ruled out. But this is more or less how Pettit goes about interpreting Rousseau.

It appears that Pettit interprets absolutism as the grounds for obligation. This reflects a similar problem - that Hobbes himself fails to distinguish between legitimate authority and the mere exercise of power.[58] Noone points out that a very important difference between Hobbes's and Rousseau's respective theories is that while Hobbes thinks legitimacy is itself conventional, that authority must simply be justified in order to count as legitimate; Rousseau understands that legitimacy is itself not conventional, but that legitimate authority must rest on some kind of convention.[59] This convention is not the absolute status of the sovereign, but the convention is a general will that arises from the social contract. In other words, political obligation does not rely on the absolute status of the sovereign, the absolute status is just the form that meets the demands of legitimacy that the contract sets forth.

Legitimate law in Hobbes' view consists in little more than consent and renunciation on behalf of people to a determinate judge that makes law on behalf of all. All law is sovereign and therefore legitimate. Under this regime the possibility of a contestatory citizenry is nil. One reason for this is that consent is not ongoing, there is no basis for understanding sovereignty as a reciprocal relationship. A citizen might offer a word of advice to the Sovereign, but there is no obligation on behalf of the Sovereign to listen or act on citizen voices as if they are of a distinctively political will that speaks authoritatively.[60]

To support his understanding, Pettit cites parts of the chapters "On the Sovereign" and "On the Limits of the Sovereign Power." This interpretation of Rousseau's sovereignty that I

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[58] Christine Korsgaard, The Sources of Normativity, (Cambridge, Cambridge University Press, 1997), 29.
[59] Noone, *Rousseau's Social Contract: A Conceptual Analysis*, 11.
[60] See Chapter 30 of *Leviathan*.

attribute to Pettit colors his reading of these chapters as we shall see in this section. Pettit places much weight on signs of the incontestability principle of absolute sovereignty. He thinks that in the case of a conflict between an individual and the sovereign – the sovereign is the 'judge of what is of consequence' for the general will.[61] It is true that the sovereign is the final judge, but in light of the directives of general will this absolute power becomes ambiguous for the question of contestation.

I propose that he conflates the logic of absolutism and that of the general will. An idea of absolutism is that the sovereign must be 'above the law' and this leads to a standard consideration that the sovereign should not, but more so *cannot*, be in contradiction with itself, and therefore, it cannot 'give a command to itself.'[62] In discussing the inalienability of sovereignty Rousseau says, "it is absurd for the will to tie its hands for the future and since it does not depend upon any will's consenting to anything contrary to the good of the being that wills."[63] Pettit correctly identifies that this notion of an absolute sovereign unconstrained by other bodies or wills is not unlike the idea that a sovereign ought to not be in contradiction with itself. However, the nature by which contradiction arises is quite different from a situation in which the sovereign ends up being subjected to law rather than being in its rightful place which is above the law. The nature by which contradiction arises in Rousseau's account depends on the law or limits already set forth by the general will. It is absurd for the will to consent to anything contrary to the good of the being that wills. One might suggest that this is the same as to say that the sovereign is absolute in and for itself. But clearly 'the good of the being that wills' is a qualification, that the sovereign is bound to something other than its pure existence. What is contrary to this 'good' is in one respect any matter that is outside the 'competence' of the sovereign.[64] This is any matter that is not general and not deemed essential for the common good. Therefore, when a particular matter is brought before the sovereign this is when a contradiction occurs. It is worth quoting this section from "On the Limits of the Sovereign Power" at length:

> In effect, once it is a question of a state of affairs or a particular right concerning a point that has not been regulated by a prior, general convention, the issue becomes contentious. It is a suit in which the private individuals are one of the parties and the public the other, but in which I fail to see either what law should be followed or what judge should render the decision. In these circumstances it would be ridiculous to want to defer to an express decision of the general will, which can only be the conclusion reached by one of its parts, and which, for the other party, therefore, is merely an alien, particular will, incline on this occasion to injustice and subject to error. Thus, just as a private will cannot represent the general will, the general will, for its parts, alters its nature when it has a particular object; and as general, it is unable to render a decision on either a man or a state of affairs.[65]

Pettit sees in this quotation that in an incident where the general will comes into conflict with a particular will there is no 'super-sovereign' to decide on the issue.[66] This demonstrates the

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[61] SC II.4.3.
[62] Hobbes, *Leviathan*, 26.6. Also see SC I.7.
[63] SC II.1.3. And Pettit, "Rousseau's Dilemma," 22.
[64] SC II.4.9.
[65] Ibid II.4.6.
[66] Pettit, "Rousseau's Dilemma," 18.

contradiction that I have described above. This moment of conflict could be thought of as an incident where an individual or group brings a point of contestation regarding the sovereign law to the attention of the sovereign. In conjunction with this textual evidence, Pettit emphasizes that the sovereign decides the importance of what is to be alienated for the general will. However, it is far from clear that in the event of the contradiction of wills that the sovereign does decide, and even less clear that the sovereign would decide on the matter arbitrarily.

There are two conceptual possibilities that I would like to explore. As stated previously contestation could be an example of a particular matter that cannot possibly be considered by the sovereign. This particularity hinges on the idea that contestation itself is a contradiction of sovereignty in the way Pettit describes. The content of the point of contestation is not of concern, but the very fact that the act of contestation is a questioning of sovereign authority makes it an alien object, something that is outside the scope of the sovereign's legislative competence. If we interpret this situation as Pettit does, we are only left to accept his conclusion that the majority tyrannically binds the minority to the law in question. Here we clearly see the relevance of his reference to Hobbes in saying that the 'sovereign cannot give a command to itself' or we might say the sovereign cannot rule against itself.

By placing greater importance on the 'competence' of the sovereign, we might imagine that the contradiction is resolved due to individuals' roles in the sovereign assembly and their relationship with the absolute nature of law that upholds the general will. Rather than thinking along the lines of absolutism plus contestation equals a contradiction of sovereignty, it is necessary to consider that the general will as the grounds for political obligation does *not* expressly deny contestation. We can move on to considering if the content is general and relevant for the common good. If the point of contestation has been regulated by a general convention, that it is a matter of the sovereign law itself then it is within the sovereign's domain to decide on the issue. If the point of contestation is particular as described in the quotation above this contradiction disturbs the relationships between citizen and sovereign and an express decision of the general will is not possible, but what does this mean? In this case how will the sovereign respond?

To speculate, the legislative assembly must not always 'force' those who engage in contestation to be free. If we remember that the general will is always upright but that the legislative assembly can be incorrect in its decisions, this insight gives a reason for why the sovereign can and ought to sometimes rule against itself, because it is not capable of providing an express decision of the general will. At the beginning of the First Discourse Rousseau says something relevant for this interpretation. In speaking of the expected reception of his essay by an 'enlightened' assembly he says, "Fair minded sovereigns have never hesitated to pass judgments against themselves in disputes whose outcomes are uncertain; and the position most advantageous for a just cause is to have to defend oneself against an upright and enlightened opponent who is judge in his own case."[67]

Yet, sovereignty is not whole, "The general will is no longer general, sovereignty becomes magistracy, when it is faced with an individual will's particular question that is not answered by a prior convention."[68] But this fact is a safeguard against despotism. On a point as important as contestation the absolute word of the sovereign could render any future attempts at contestation unlawful. But if the legislative assembly is sensitive to this fact that Rousseau puts

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[67] Jean-Jacques Rousseau, Donald A. Cress, and Peter Gay, The Basic Political Writings, Discourse on the Sciences and the Arts, (Indianapolis, Hackett Publishing Company, Inc., 2.
[68] SC II. 4.6.

forth, and aware that a contradiction has arisen but that a decision must be rendered, it must look to something beyond the express directives of the general will. By becoming a matter of magistracy, the sovereign can go back and review how the generalities of the sovereign law ought to be corrected to prevent future injustice if this is what the people in their magisterial capacity have ruled on the issue at hand. The sovereign can rule on what has already been decided.[69] For the sovereign must realize that it is impractical to decide on the matter arbitrarily or without considering the particularities of the point of contestation. Or, in Pettit's words, without 'looking at the context of subjugation,' – the political realities of domination to see if particular forms of government interference are nonarbitrary and legitimate – that they continue to track the 'certain relevant interests and ideas' of those who are affected.[70]

How can the people realize this special circumstance? Book 2 Chapter 7 "On the Sovereign" states that the "Sovereign has no interest contrary to that of individuals, therefore the sovereign power has no need to offer a guarantee to its subjects, since it is impossible for a body to want to harm all of its members, and, as we will see later, it cannot harm any one of them in particular."[71] The relationship between citizen and sovereign might appear dubious. Rousseau thinks that the sovereign only requires a relationship with itself, this is true; however, in stating that a determination must be made between the respective rights and duties of citizens highlights how the sanctity of the contract that is found in the whole body depends on if individuals in their dual roles as citizens and subjects "seek to combine their two-fold relationship and all the advantages that result from it."[72] While Pettit views the sovereign as isolated in its relationship with itself, he forget that individuals in an association do in fact establish a reciprocal or vertical relationship that is informed by their dual-roles as citizens and subjects. Rousseau says, "there is a considerable difference between being obligated to oneself, and to a whole of which one is a part."[73] This interpretation of the reciprocal relationship that Rousseau alludes to is essential for creating sovereign law that is nondominating.

In the case of contestation, the general will, as the source of legislative authority and political obligation, is unclear in its direction. Rousseau says that, "By itself the populace always wants the good, but the judgment that guides it is not always enlightened. It must be made to see the objects *as they are*, and sometimes as they *ought* to appear to it. It must be given a sense of *time* and *place*. It must weigh present, tangible advantages against the danger or distance, hidden evil."[74] The sovereign in special circumstances *must* consider what is particular in order to uphold the general will. Rousseau himself makes clear that this itself is a necessary contradiction.[75] The Prince is thought to be the one who gives the people direction and enlightens their judgment. However, what distinguishes this prince from a 'usurper' bent on injustice who could really just be an ordinary and virtuous citizen bringing forward a point of contestation relevant for the general will?

And in light of this twofold commitment that individuals have, I speculate that when a contradiction occurs and the sovereign must consider what is particular, for example, when there is a point of contestation brought before the sovereign that concerns a great injustice that has permeated the heart of the body politic, there is no greater law to give the sovereign a sense of

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[69] SC III.17.
[70] Pettit, "Republicanism: a theory of freedom and government, (Oxford: Clarendon Press, 2002), 61-63.
[71] SC I.7.5.
[72] SC I.7.4.
[73] SC I.7.1.
[74] SC II.6.9. My emphasis.
[75] SC III.17.3.

direction on the matter than the law that emanates from within.[76] Rousseau says that the most important law is in the hearts of citizens. This law "preserves a people in the spirit of its institution and imperceptibly substitutes the force of habit for that of authority. I am speaking of mores, customs, and especially of opinion, a part of the law unknown to our political theorists but one on which depends the success of all the others."

Conclusion

This paper has shown that there is great potential evidence for reconciling Rousseau's theories of legitimacy and absolute sovereignty with contestation. I have sought to present an interpretation of *The Social Contract* that depicts Rousseau's republic as one where individuals do have rights and liberties that they can enjoy in the absence of a dominating state. I continue to believe that contestation as a method for curbing the abuse of power by an absolute sovereign is a necessary consequence of this theory of government. There is always more work to be done when inquiring into the thought of a thinker as great as Rousseau. I just hope I have done his work justice in this attempt.

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[76] SC II. 12. 5.

The effect of adultification on empathy for Black individuals

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Abstract

Empathy is fundamental in our interpersonal and prosocial interactions, as it allows us to share and understand others' experiences vicariously. Cameron et al. (2019) assessed the cognitive perspective-taking facets of empathy and found that when attempting to empathize with someone, it can be seen as effortful or difficult and this can lead to greater empathy avoidance. The present study examined whether the motivation for empathy with Black girls would be lower than for Black boys, men, and women because adultification of Black girls. Adultification refers to the stereotype of how adults perceive children as less innocent and more adult-like (Epstein, Blake, & González, 2017), which might lead society to see these young women as needing less help or support. We tested this by asking 147 White Penn State students to complete the *Empathy Selection Task* (Cameron et al. 2019), which asks participants to select between *empathizing* with or *describing* Black target individuals varying in age and gender (boys, men, girls, and women). The findings showed that Black girl and boy targets engendered more empathy approach in comparison to Black men and women. However, it was Black women that engendered the least empathy across the four targets, contrary to our hypothesis. We discuss the possibility of the strong Black woman stereotype as a potential driver of this phenomenon.

Introduction

Empathy plays a critical role in our behavioral, moral, and cognitive interactions as it heightens one's engagement with others by allowing them to build an emotional bridge. (Zaki, 2014; Batson, Darley & Coke, 1978). Empathy allows a person to emotionally and cognitively perceive another person's emotion, situation, and perspective as their own (Miller & Eisenberg, 1988; Eisenberg & Fabes, 1998). But in today's society, there's a broken bridge of empathy between Black individuals and their counterparts. We are continually bombarded with news headlines of Black individuals who are not afforded the benefit of empathy; these images show Black people constantly being dehumanized and treated in an animalistic manner. Slavery, which is perhaps the most apparent illustration of the dehumanization of Black people, left a legacy of unequal treatment which until this day can be seen in the injustice and inequity manifest toward African Americans and Blacks in almost every social institution (e.g., legal, health, and educational systems).

In recent news, we have seen how Black individuals such as George Floyd, Breonna Taylor, and Elijah McClain have been murdered with little to no justice for their killers and with what appeared to be little sense of empathy extended toward these individuals by their attackers (i.e., the police).

The media has categorized the inequality of Black People as Black person issue, when in reality it is a White problem, that affects Black lives. However, this impact may not be felt equally among members of the Black community. Inequality has a different impact on Black men and women. When dealing with racial issues, these differences are important to understand because Black women do not experience racism the same way as Black men (Crenshaw, 1991; Davis 1983). Black women have two salient identities, being a woman and being Black, both of which are seen or categorized as inferior (Crenshaw, 1991). This intersectionality leaves Black women uniquely struggling with racism and sexism and having to adapt to the perspective that society constantly throws at them. "The image of the Black woman is the opposite of the colonizer. She is not male, she is not White, and she is generally not affluent" (Hairston, 2008). Davis (1983) explains that both men and women slaves endured abuses, however, "women suffered in different ways as well, for they were victims of sexual abuse and other barbarous mistreatment that could only be inflicted on women." Today, Black men uphold a dominant role relative to Black women within society (Brah & Phoenix, 2004). In this paper we examine how the relative expectations and stereotypes of Black men and women, across development (adults vs. children), impact willingness to engage in empathy with Black individuals.

Adultification of Black girls

Black women continue to find their emotional, social, and educational intelligences challenged, while also having to constantly maneuver and overcome identities of race and gender in America (Carter, 1994). This issue starts at a very young age as Black girls are viewed by adults to be less innocent and more adult-like than their White counterparts, which is known as adultification. Adultification refers to "children functioning at a more mature developmental stage because of situational context and necessity, especially in low-resource community environments" and represents a stereotype of how adults perceive children (Epstein, Blake, & González, 2017). Black girls are not given the same opportunity to have a childhood as their non-Black peers. As a result of their battling with racial inequality and bias, Black girls are deprived from the innocence to make mistakes and to learn, grow, and benefit from correction (Epstein, Blake, & González, 2017). Recently, we have seen the popularized images of seven-year-old Wynta-Amor Rogers all over social media, as she was marching at a Black Lives Matter protest in New York chanting, "no justice, no peace" with her fists up and pointed to the camera, and individuals all over social media are commending her and other younger black girls for their strength and passion (Harris, 2020). However, this is stripping Black girls of the transition into womanhood and the "traditional" femininity that comes with it, while emphasizing the narrative society enforces on them as strong. In regard to Wynta-Amor Rogers' image, Rogers' mother and different journalists stated that young black girls need to be heard, seen, and need to learn about the world. However, they don't need to learn about the world this way, as this symbolizes a loss of innocence and pushes the narrative of strong Black women on them at a young age. Girls like Wynta-Amor Rogers are still children that need to be at home being nurtured and protected, not on the front line fighting for racial inequality.

In order to effectively combat inequality, we may need to address the different needs of those who are victims of inequality. The root of the problem may be due to the fact kids are normally seen as vulnerable and vulnerability leads to empathy. However black girls may not be given the same treatment as they are seen as less weak and vulnerable and more adult-like than they actually are (Bagattini, 2019). The current paper examines whether adultification of Black girls might lead to lower empathy towards Black girls.

Adultification and the Strong Black Woman Stereotype

In order to understand how it is that people perceive young Black girls, we have to understand how society perceive Black women. The perception of Black girls is linked with society's perception of Black women and stereotypes around Black women. Stereotype of Black or African American women intersect with their race and gender roles and most often are characterized as hypersexualized (jezebel), angry (sapphire), sassy, and strong (Collins, 2000; West 1995). Black women have been sexualized since the beginning of slavery, which has resulted in fetishizing and dehumanization of Black Women bodies (Jones, 1982). Black women are often painted as angry, hysterical, or aggressive when they show the slightest emotion, offense, or discomfort. Black women in the media are portrayed as individuals who are loud, always finger clicking and rolling their necks (Herro 2015).

Black women are also portrayed to be strong at all times despite any obstacle they face (Beauboeuf-Lafontant, 2007). These stereotypes manifest itself in many ways such as racial bias, adultification of Black girls, and so on. However, for the purpose of this paper, our main focus is on how the stereotype of Strong Black women and the adultification of Black girls can be harmful. The Strong Black Woman (SBW) stereotype is the expectation for Black Women to remain in the constant state of strength and self-sacrificing, while assuming multiple roles- such as caretaker and provider. In a recent study, Woods-Giscombé (2010) described SBW as an obligation to manifest strength, an obligation to suppress emotions, resistance to being vulnerable or dependent, determination to succeed (despite limited resources) and an obligation to help others, while neglecting themselves. This idealization leads to African American Women viewing themselves as individuals who are required to always remain independent and resilient, even at times when their White counterpart women are encouraged to seek support and help (Beauboeuf-Lafontant, 2009). The idea of Strong Black Women has been dated back to the years of slavery, as we see Black Women such as Harriet Tubman and Mary Prince celebrated for preserving through adversity and having strength. Black women were seen to embrace strength as a way to mask their emotion and insulate themselves from further abuse (Thompson, 2000; Romero, 2000).

These expectations of strength, while seemingly positive, can also be highly destructive and passed down to Black girls, especially those from low-income families. Black girls at an early age assume the role of possessing strength by taking on adult-like roles of responsibility to meet family needs, such as caregiver to their younger siblings and cousins. These may lead to children gaining adult knowledge, behaving more maturely, and displaying greater resilience than their peers (Blake & Epstein, 2019). From age one and onward, Black parents practice racial socialization which they believe will help young Black girls to buffer against the negative/harsh messages and experiences they may encounter; however, this may have an adverse outcome as it

forces Black girls to mature, possess "strength" and act independently at a younger age (Adams, 2010; Blake & Epstein, 2019). The idea of strength and resilience may have a positive effect on children, more generally, but when applied to Black girls it has led to harsher treatment, judgement and burden (Blake & Epstein, 2019). The possession of maturity, strength and independence has also led to Black girls being perceived by society to be less innocent, less in need of protection and nurturing, to be more aware of adult topics and sex than their white counterparts (Blake, Epstein & González, 2017). All of these may result in less empathy shown toward Black girls.

This paper focuses on the racial aspect of adultification. Dr. Monique W. Morris observed that "the assignment of more adult-like characteristics to the expressions of young Black girls is a form of age compression. Black girls are likened more to adults than to children and are treated as if they are willfully engaging in behaviors typically expected of Black women. This compression [has] stripped Black girls of their childhood freedoms [and] renders Black girlhood interchangeable with Black womanhood…" (Epstein, Blake, & González, 2017). The issue of adultification can be extremely problematic as it may lead others to empathize or sympathize less with Black girls. Epstein et al (2017) both demonstrated how adultification can be a contributing cause to harsher treatment of Black girls and lead to them being perceived as more problematic by authority figures when compared to their white counterparts of the same age. The treatment Black girls receive may be subconsciously influenced by the femininity stereotypes of older Black women, which mean that adult would more likely view black girls as more culpable for their actions and punish them more harshly despite their status as children (e.g., the Sapphire and Jezebel). The typical traditional role of femininity is to encourage girls to mask their emotions, be reserved and not voice their opinion, while Black girls at a young age are taught to be assertive, independent, and emotionally intelligent (Morris 2007; West 1995). Blake & González (2019) showed that black girls are two times more likely to be disciplined for minor infractions like dress-code violations or loitering, two-and-a-half times more likely to be punished for disobedience, and three times more likely to be cited for being disruptive due to the presumed bias of individuals. So, when engaging in empathy with young Black girls, it may seem to be difficult because individuals would have to work harder to counteract the subconscious stereotypes.

Present work

To date, no study has examined how adultification may engender lower empathy engagement with Black girls. Cameron et al. (2019) assessed the cognitive perspective-taking facets of empathy and found that when attempting to empathize with someone it can be seen as effortful or difficult and this can lead to greater empathy avoidance. This was noted when participants completed the Empathy Selection Task (EST), a free-choice response procedure that assess one's motivation to engage in empathy. Participants are shown images of different people and the participants are given the choice to empathize (feel) with the target and attempt to feel the target's emotions or objectively describe (describe) the target focusing on external features such as age and gender. We utilize a modified version of the EST, asking participants to empathize with or describe pictures of Black individuals varying in age and gender (boys, men, girls, and women).

Our main hypothesis is that motivation for empathy with Black girls will be lower than for the other conditions because adultification of Black girls might lead society to see these young women as needing less help or support.

Methods

Participants. Participants for the study were 147 White Penn State students, ages 18-25, who completed the study for course credit. Participants had to be US citizens and over the age of 18. The final sample had an average age of 19.1 ($sd = 2.34$). The percentage of participants who reported that they had completed the EST task as part of a previous study was approximately 20%. Result of our analyses were the same whether these individuals were included or not, so all participants were included in the final analyses for greater power.

Modified Empathy Selection Task (EST). Our study was modeled after Cameron at el. (2019), making use of the empathy selection task (EST). For the purpose of this study, we used a modified version of the EST in which participants are specifically presented with 20 pictures each of a distressed Black girl or boy or a Black woman or man (4 conditions for a total of 80 trials) with brief vignettes stating that the person in photograph has been struggling. Next, participants were asked to choose between engaging in empathy (FEEL option) or remaining objectively detached (DESCRIBE option). We then calculated the percentage of trials that the participant selected empathy (over describe) as the primary dependent variable.

NASA Task load index. After completing the EST, Participants completed the NASA task load index which measures the participants perceived cognitive cost associated with each choice. The NASA task load index included questions regarding the degree of mental demand ("How mentally demanding was this option?"), effort ("How hard did you have to work to accomplish your level of performance with this deck?"), efficacy ("How successful were you in accomplishing what you were asked to do in this deck?"), and stress ("How irritated, stressed or annoyed were you by this option?). These different questions allowed us to examine how distinct facets of cognitive work might relate to empathy avoidance (Cameron et al, 2019).

Demographics. After participants completed all 80 trials, they proceed to answer questions about their demographics, such as gender, country of birth, political leaning, and age.

Additional Measures. Our survey incorporated additional measures that were not used in the current study. Participants completed the Interpersonal Reactivity Index (IRI) which comprised of personal distress (PD) and Empathic Concern Scale (subscale of the interpersonal Reactivity Index) which measures participants' feelings of warmth, compassion, concern for others (Davis, 1980) and the Identification with All Humanity Scale (IWAH).

Procedures
Participants was recruited from the psychology department subject pool to complete an online survey via Qualtrics. The first screen presented to the participant was the informed consent form and participants indicated their consent by continuing with the study. Once consent was obtained, the participants were given task instructions informing them that they would

complete a series of trials in which they would be asked to make decisions. Participants then completed the modified Empathy Selection Task. Next, they completed the demographics questions along with additional measures. After the survey, a debriefing was provided to explain the purpose of the study to the participants.

Results

Data Analytic Approach

The main dependent variable for the study was *empathy choice*, calculated as the percentage of total trials where participants chose to feel empathy over describe, calculated separately for each of the four stimulus conditions (Black Boys, Black Men, Black Girls and Black Women). The mean empathy choice across these four conditions was subjected to a one-way ANOVA to determine whether the means differed. We also tested whether the mean empathy choice score for each condition was significantly different from .50 using a one-sample t-test to indicate if there was evidence of empathy avoidance (or approach) for each stimulus condition.

Preliminary Results

Table 1 presents the mean level of empathy choice across the four stimulus conditions. Overall, we found a significant effect of empathy choice in the Black women condition, $F(3, 438) = 4.65$, $p < .03$), with the results denoting that individuals were more likely to choose to empathize with Black boys, Black men and Black girls than they were chose to empathize with Black Women. Contrary to our hypothesis, empathy choice was highest for Black girls relative to the other three stimuli conditions, though this difference was only significant when compared to Black Women.

Table 1

Mean (standard deviation) empathy choice scores across four stimulus conditions

Black Boys	.55 (.29) [a]
Black Men	.54 (.30) [a]
Black Girls	.56 (.29) [a]
Black Women	.51 (.30) [b]

Note. Means that do not share the same footnote differ significantly from each other.

Using a one-sample *t*-test, we also tested the differences from .50 (probability of choosing either empathy or describe if choosing at random) for each condition. The findings showed that Black girls and boys engendered empathy approach (significantly higher empathy choice than .50), while Black men and women did not.

However, Black men still engendered more empathy approach than Black women. This difference in empathy choice across conditions might be associated with how effortful or difficult they found the task or how efficacious participants felt in empathizing with the various targets. Table 2 presents how overall effort was related to empathy for each stimulus category. The level of effort was significantly associated with empathy choice for each empathy choice variable; however, it was less strongly correlated with Black women choice. Interestingly, efficacy was unrelated to empathy choice across all four stimulus conditions meaning that their selection of empathy or describe was unrelated to how good participants felt they were at empathizing.

Table 2

Correlations between effort, efficacy and empathy choice across the four conditions.

	Effort	Efficacy
Black Boys Choice	-.269	.130
Black Men Choice	-.264	.029
Black Girls Choice	-.275	0.74
Black Women Choice	-.211	-.011

Discussion

The purpose of the current study was to evaluate whether empathy approach would be significantly lower for Black girls in comparison to other groups due to adultification. Black girls are stripped of their childhood and are often treated and viewed like they are older than they are. Somewhat unexpectedly, our results show that empathy motivation across the four conditions varied significantly, with Black girls engendering *more* empathy approach than any other group (counter to our prediction) and Black women engendering greater empathy avoidance than any other group.

In Blake & Epstein's focus group study, they asked Black girls and women ages 12-60 about their real-world observations and found that adults had less empathy for Black girls than their White counterparts, due to them being viewed as less innocent and needing less protection and comfort (2019). However, in our study Black girls engendered more empathy approach than any other targets. One key difference in our study relative to Blake and Epstein was the utilization of the EST task, which is a more quantitative assessment of motivation to empathize from the perspective of the perceiver. In Blake and Epstein, the perspective was from that of the target (i.e., Black girls felt they received less empathy than did their White peers) and these two perspectives may not match up, given that motivation to empathize may not translate to actual empathizing.

Furthermore, our study examined motivation to empathize (or remain objective) with Black Girls *relative* to Black Boys, Black Men, and Black Women, not in contrast to White individuals. In this context, the drive to empathize might be more driven by youthfulness and vulnerability, given that young girls are often viewed as more vulnerable and in need of protection and support than those who are older. Thus, the adultification bias seen with Black girls may be most pronounced when in comparison to young girls who are White or from other ethnic/racial groups.

Although none of the targets in our sample were associated with empathy avoidance—our participants' empathy choice scores were more indicative of empathy approach with scores above the .50 chance level—Black women targets evinced the least amount of empathy approach relative to the other targets. In fact, participants chose to empathize with Black women and Black men at levels that did not differ significantly from chance, though Black women were the closest to chance levels. Individuals might have been relatively less willing to empathize with Black women due the perceived cognitive effort involved in empathizing with the stereotyped image of the Black woman. Malcom X stated that "The most disrespected person in America is the black woman. The most unprotected person in America is the black woman. The most neglected person in America is the black woman." Stereotypes of Black women include them being hypersexual (jezebel), angry (sapphire), and sassy. Participants may feel too different or removed from these stereotyped personas to connect with their lived experience (necessary for empathy) and the effort needed to counteract these stereotypes may be too great. Indeed, we saw a significant correlation between perceived cognitive effort and empathy choice. In comparison to their counterparts, the societal image of Black women also emphasizes their strength and less need for support and protection (Beauboeuf-Lafontant, 2009; Woods-Giscombé, 2010). These views of Black women might have affected the motivation to empathize with them as participants may have seen them as resilient and able to endure painful experiences.

Limitations and Future Directions

Our study had several limitations that are important to acknowledge. Due to the survey being a within-subjects design, fatigue might have been a factor in participants response over time as they may have become exhausted and uninterested toward the end of the 80 trials. If the study had utilized a between-subjects design, that might have minimized the learning and transfer across conditions and participants would have experienced less burnout since the session would have been shorter (only 20 trails), but we would have lost out on the increased power gained from this approach.

In the future, we aim to study individual tendencies in being empathic (using the empathic concern subscale of the interpersonal Reactivity Index) and how that might affect empathic choice. We also aim to include a more diverse participant pool and include a Black only participant pool. Future studies should also examine how the intersectionality among participants relates to the level of empathy avoidance/approach that's given to Black girls and women. We need to examine how situational vulnerabilities affects adultification for Black girls and ways that this influences the perception that others hold towards them.

Conclusion

Ultimately, our study highlights the complex situational vulnerability towards Black girls and women, when it comes to empathy. The empathy that Black girls are given might be associated with different contexts such as how empathy is measured (perspective of the targets vs. motivation of the perceiver to empathize) and who Black girls are being compared to (e.g., their White peers vs. Black boys or Black Adults). Our study also highlights the continued relevance that in comparison to their counterparts, Black women are often not given the same kindness and treatment. This study finding adds to previous research that pertain to the adultification of Black girls and perception of Black women. By investigating these through the lens of empathy, the present study fills a gap in the literature that has not examined how empathy motivation may differ between different segments of the Black population. Additionally, the current study better contextualizes the complexity of factors (e.g., race, age, gender) that might contribute to understanding vulnerability and the motivation to empathize with diverse others.

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Perceived Discrimination and African American Mental Health Service Utilization

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Abstract

Introduction: Large disparities in black-white mental health service utilization remain despite access to utilization increasing. Due to the distress caused by discrimination we hypothesized that, experiencing events of perceived discrimination will lead to an increase in utilization. Rates of utilization may be skewed because many studies do not include informal supports such as religious care. **Methods:** We conducted a secondary analysis of the data collected in the Midlife in the United States (MIDUS) series, the Milwaukee samples. Total mental health service utilization was measured by formal utilization (e.g., visiting a psychiatrist, a general practitioner, or a counselor) as well as informal supports which was only measured in terms of religious care. Discrimination was measured by daily, lifetime, and job discrimination. **Results:** Almost 30% of participants reported utilizing some form of service. Discrimination also leads to an increase in likelihood of utilization across all mental health services. **Discussion:** Discrimination is a strong predictor of utilization. Discrimination causes distress that leads individuals to want to receive treatment beyond factors associated with pathology.

Introduction

Mental health is a public health concern with 20% of U.S. adults living with a mental illness (NIH, 2019: Goodwin University, 2021). Mental disorders (25.5%), excluding intellectual disabilities is the second leading reason disabled workers enroll in the U.S. Social Security Disability Insurance Program (Social Security Administration, 2019). Access to mental healthcare services is essential to alleviate mental disorders in the population. Rates of access among African Americans has remained significantly lower than that of Caucasians. As recently as 2019, 23% of white American adults received some form of mental health treatment out of that, 19.1% had taken prescription medication and 10.9% received counseling/therapy in the past 12 months. Compared to 13.6% of black adults that received any treatment, of that 11.1% relied on medication exclusively and 8.1% relied on therapy only (Terlizzi & Zablotsky, 2019). Furthermore, though population-wide access in mental health has increased over time, the gap in access to mental healthcare has grown – rates of access to mental healthcare increased from 16% to 20 % for Caucasians and from 7% to 10% for African Americans from 2004 to 2012 (Cook et al, 2016). It is crucial to better understand rates of mental health service utilization among black Americans and to identify factors among black Americans that are contributing or detracting from the utilization of mental health services.

Formal mental health care services are often underutilized and viewed as ineffective by African Americans whereas, family, friends, churches, and other forms of informal services are sought after (Dana, 2002; Hays & Lincoln, 2017; NAMI, 2009). Formal services are performed by a mental health professional such as a psychiatrist or counselor, whereas informal services are performed by community members like clergy (Hays & Lincoln, 2017). Informal services are often seen as more accessible due not only to geographical location but also due to the relationships built in these settings and their cultural significance. In a 2017 study, 95% of black American respondents were grouped into a class defined by their moderate use of informal service and medical providers and low reliance on mental health professionals (Hays & Lincoln, 2017). There is a close tie to religion in many African American communities. African Americans often turn to religious figures rather than trained professionals when seeking mental health assistance (NAMI, 2009). African Americans in Northern Pennsylvania and central New Jersey that were highly religious tended to have fewer positive attitudes towards professional mental health treatment (Davenport & McClintock, 2020). The higher reliance on informal resources such as church members and medical providers is often due to relationship that has already been built between the individual and the person providing the service. While selecting a clinician or looking for care, African Americans often seek providers that do not present prejudice and show that they understand the effects of racism and discrimination in their daily lives (Dana, 2002). Due to the often-established connection to community resources, there may be a better understanding of the effects of discrimination.

Discrimination could affect rates of mental healthcare utilization among African Americans. According to the American Psychology Association (APA), experiences of discrimination lead to more stress and poorer health outcomes (2016). Because discrimination leads to more stress and poorer health outcomes, it is possible that experiences of discrimination could lead to a greater demand for mental health services. Some studies that have explored the role of discrimination found minimal correlation to mental health (Kessler et al., 1999), this study only utilized data from the original Midlife in the United States (MIDUS) studies which underrepresented African Americans in the original series.

More recent studies have not only recognized the negative relationship between discrimination and mental health but have also found discrimination to be a significant predictor of utilization (Evans & Sheu, 2018; -Ault-Brutus, 2012). Lifetime discrimination is often depicted as discouragement from further development, unjust denial of a job, bank loan denial, etc. (Williams, 1997). The APA has found that black Americans report experiences of lifetime discrimination at a higher frequency than white Americans (2016). Although black Americans are likely to feel stressed due to experiences of discrimination, they utilize mental healthcare services at a lower rate than white Americans. Previous studies have examined mental health service utilization among African Americans and black Americans but gaps in the literature remain. Regarding utilization, correlates such as socioeconomic status and education level rather than discrimination (Cook et at., 2016). There are conflicting findings concerning discrimination's role in mediating utilization among African Americans (Kessler et al., 1999; Choi et al., 2019). African Americans are often underrepresented in the literature; therefore, the results of these studies are not generalizable, and their results may not be as accurate (DeCoux et al., 2010; Evans & Sheu, 2018).

Present Study

The present study examined rates of mental healthcare utilization among African Americans in the Milwaukee area and correlates of mental health service utilization in this population. Mental health service utilization variables included visiting a Fromal mental healthcare provider and visiting religious leaders for mental health concerns. A potential correlate of mental health service utilization is perceived discrimination. We conducted descriptive analyses of mental health service utilization to add to the literature on rates of mental health service utilization among African American. We also examined the association between lifetime discrimination and several important demographic variables (age, sex, marital status, income, level of education, insurance status, and living with a chronic condition) and utilization of mental healthcare utilization services to provide a greater understanding of possible determinants of mental healthcare utilization among African Americans.

Methods

Data

We conducted a secondary analysis of the data collected by the Midlife in the United States (MIDUS) Milwaukee African American Studies. Two Milwaukee African American samples were conducted in conjunction with the MIDUS 2, Refresher, and MIDUS 3. Each sample is considered a "wave." In this study we analyzed data from MIDUS 2 Milwaukee African American Sample and the MIDUS Refresher Milwaukee African American Samples which comprised two independent samples that completed identical self-report measures.

Participants

Wave 2 consisted of 592 participants and the refresher collected data from 508 individuals a allowing the current study to examine the responses of 1,100 participants. Table 1 shows that 59.9% of participants were female, 25.7% were married, 80.9% had medical insurance, and 82.1% were living with a chronic condition. The average age of participants was 47 years old. Only 25.7% of participants were married. The median household income was $28,000. The mean Kessler score for negative affect was 11.14. The Kessler Psychological

Distress Scale (K6) was developed to evaluate distress to determine cases of serious mental illness from non-cases (Kessler et al., 2003). The K6 scale asks participants 6 questions which are answered on a Likert scale. The range of scores goes from 6 to 30 and scores below 13 often indicate that an individual is psychologically well (Harvard Medical School, 2005). On average, participants experienced 2 events of lifetime discrimination. The demographic variables included, age, sex, marital status, income, level of education, insurance status, and living with a chronic condition and were measured using a questionnaire.

Measures

Mental health service utilization was measured in terms of formal and informal services. In this study, formal services were services provided by a mental health professional such as a therapist, psychiatrist, or general practitioner. The other form of service measured was religious care. Attending one or more sessions with any service provider in the past 12 months was marked by a 1, no attendance was marked by a 0. Discrimination was calculated based on lifetime events of perceived experience of discrimination based on race.

Results

Table 2 displays the rates of utilization for all service types. 27.86% of participants reported the utilization of any service. Rates of utilization are relatively equal across care types. General Practitioners are the most frequently utilized with 16.04% of participants reporting the use of this form of care. GPs were followed by psychiatrists and counselors for formal care, with 11.36% and 11.04% of participants reporting utilization, respectively. Formal care accounted for 21.26% of utilization whereas religious care accounted for only 12.18% of all utilization.

There was a positive association between lifetime discrimination and the utilization of any form of cares, $\chi^2(1) = 13.42$, $p < .001$, OR = 1.09, 95% CI = [1.007-1.172] (see Table 3). These results are similar across formal service types. **(Table 6)**.

Overall, formal care had a positive relation with experiences of lifetime discrimination, $\chi^2(1) = 11.32$, $p < .001$, OR = 1.12, 95% CI = [1.049-1.202] (Table 4). Religious care also had a positive relationship with lifetime discrimination, $\chi^2(1) = 4.53$, $p = .010$, OR = 1.09, 95% CI = [1.007-1.172] (Table 5).

Additionally, negative affect was a correlate had a very significant relationship with the utilization of mental health services. The utilization of formal care had a significant positive relationship with negative affect, $\chi^2(1) = 56.83$, $p < .001$, OR = 1.14, 95% CI [1.099-1.179] (Table 4). There was a similar positive relationship between negative affect and religious care, $\chi^2(1) = 20.96$, $p = .001$, OR = 1.09, 95% CI = [1.05-1.139] (Table 5). This overall positive relationship is seen between negative affect and the utilization of any form of service, $\chi^2(1) = 67.61$, $p = < .001$, OR = 1.14, 95% CI = [1.106-1.183] (Table 3).

Discussion

In the current study, we investigated rates and correlates of mental health service utilization among African Americans located in Milwaukee, Wisconsin. Black Americans are utilizing a variety of mental health care resources, including formal and religious care. Religious care accounted for a low portion of care utilization compared to all forms of formal care. As we expected, experiences of discrimination had a significant positive relationship with service utilization across all service types, including religious care, when adjusted for other relevant correlates. A 2008 study found a higher reliance on informal supports alone than formal supports alone (Woodward et all., 2008). The results of the present study contradict those that found no correlation or a negative correlation between discrimination and utilization. A study found gender and evaluated need to be significant predictors of utilization whereas discrimination was not (Williams, 2014). Burgess et al. made the distinction between U.S.-born and African-born black Americans and found that U.S.-born black Americans had a more significant negative correlation between discrimination and utilization (2008). The results of this study show that experiences of lifetime discrimination still have a significant relationship with utilization when adjusting for negative affect.

The results of our study indicate that the relationship between discrimination and utilization is more complex. Other studies have suggested that racial identity moderates the impact of discrimination on utilization (Richman, 2007). Depending on an individual's nationality and/or ethnicity, there would not be the same historical relationship to acts of racial discrimination. Without the historical connection, racism may affect an individual less.

There are several important limitations to this study. First, the data used to conduct the present study was sourced from a cross sectional study with data being collected over a variety of years from different participants each time. Due to the nature of the original study, a causal relationship could not be determined. Data on stigmas surrounding the discussion of mental health and receiving mental healthcare was not collected. Also, participants were not asked about feeling discouraged from receiving care. Both factors could also be influenced by discrimination and reveal a more complex patter.

Based on the results of the present study, it is evident that African Americans do use a variety of mental health resources at a relatively equal rate with GP being most frequently utilized. In order to get more individuals to see a psychiatrist or counselor, practitioners will have to be more conscious of the experiences of racial minorities, particularly black Americans. If a practitioner is prepared to discuss issues surrounding race, black clients maybe more comfortable meeting with mental health professionals.

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<table>
<tr><td colspan="6" align="center">**Table 1:** Participant Demographic Characteristics</td></tr>
</table>

Correlate	n	Mean	sd	Median
Age	1100	47.6	12.3	47
Sex	1100			
Female	659 (59.9%)			
Male	441 (40.1%)			
Income	1093	40,023.13	42,693.27	28,000
Marital Status	1100			
Married	283 (25.7%)			
Unmarried	817 (74.3%)			
Insurance	1099			
Insured	889 (80.9%)			
Uninsured	210 (19.1%)			
Chronic Conditions	1100			
No Chronic Condition	197 (17.9%)			
Has Chronic Condition	903 (82.1 %)			
Negative Affect	1095	11.14	5.1	10
Daily Discrimination	1004	2.23	2.57	1
Lifetime Discrimination	926	2.38	2.55	`2

Table 2: Rates of All Service Utilization	
Correlate	**Utilization in Percent**
Psychiatrist	11.36
GP	16.04
Counselor	11.04
Formal Care	21.26
Religious Care	12.18
Any	27.86

<table>
<thead>
<tr><th colspan="5" align="center">Table 3: Anova Test for Any Care with OR and 95% CI</th></tr>
</thead>
<tbody>
<tr><td>Correlate</td><td>ChiQ</td><td>df</td><td>OR</td><td>95% CI</td></tr>
<tr><td>Intercept</td><td></td><td></td><td>0.13</td><td>[0.059-0.282]</td></tr>
<tr><td>Negative Affect</td><td>67.61***</td><td>1</td><td>1.14</td><td>[1.106-1.183]</td></tr>
<tr><td>Lifetime Discrimination</td><td>13.42***</td><td>1</td><td>1.12</td><td>[1.056-1.196]</td></tr>
<tr><td>Age</td><td>5.12*</td><td>1</td><td>0.98</td><td>[0.969-0.998]</td></tr>
<tr><td>Sex</td><td>0.31</td><td>1</td><td>0.91</td><td>[0.640-1.279]</td></tr>
<tr><td>Married</td><td>0.68</td><td>1</td><td>0.84</td><td>[0.55-1.268]</td></tr>
<tr><td>Income</td><td>0.02</td><td>1</td><td>1</td><td>[0.999-1]</td></tr>
<tr><td>Education</td><td></td><td></td><td></td><td></td></tr>
<tr><td>High School Diploma</td><td rowspan="3">3.63</td><td rowspan="3">3</td><td>0.91</td><td>[0.606-1.371]</td></tr>
<tr><td>Bachelor's Degree</td><td>1</td><td>[0.787-2.999]</td></tr>
<tr><td>Professional Degree</td><td>0.77</td><td>[0.311-1.791]</td></tr>
<tr><td>Insurance</td><td>7.87</td><td>1</td><td>1.89</td><td>[1.208-3.039]</td></tr>
<tr><td>Chronic</td><td>8.45</td><td>1</td><td>2.11</td><td>[1.267-3.682]</td></tr>
<tr><td>Sample</td><td>1.83</td><td>1</td><td>0.79</td><td>[0.557-1.112]</td></tr>
</tbody>
</table>

n = 1100; Chi-square statistics reflects likelihood ratio chi-square values for the association between correlates and the utilization of any service; *** p = 0, ** p = 0.001, * p = 0.01, . p = 0.05, ' ' p = 0.1,   p = 1

<table>
<thead>
<tr><th colspan="5" align="center">Table 4: Anova Test for Formal Care with OR and 95% CI</th></tr>
</thead>
<tbody>
<tr><td>Correlate</td><td>ChiQ</td><td>df</td><td>OR</td><td>95% CI</td></tr>
<tr><td>Intercept</td><td></td><td></td><td>0.046</td><td>[0.017-0.117]</td></tr>
<tr><td>Negative Affect</td><td>56.83***</td><td>1</td><td>1.14</td><td>[1.099-1.179]</td></tr>
<tr><td>Lifetime Discrimination</td><td>11.32***</td><td>1</td><td>1.12</td><td>[1.049-1.202]</td></tr>
<tr><td>Age</td><td>0.03</td><td>1</td><td>0.99</td><td>[0.983-1.014]</td></tr>
<tr><td>Sex</td><td>0.44</td><td>1</td><td>0.878</td><td>[0.595-1.288]</td></tr>
<tr><td>Married</td><td>2.03</td><td>1</td><td>0.713</td><td>[0.442-1.134]</td></tr>
<tr><td>Income</td><td>2.64</td><td>1</td><td>0.99</td><td>[0.999-1]</td></tr>
<tr><td>Education</td><td></td><td></td><td></td><td></td></tr>
<tr><td>High School Diploma</td><td rowspan="3">2.96</td><td rowspan="3">3</td><td>0.83</td><td>[0.543-1.294]</td></tr>
<tr><td>Bachelor's Degree</td><td>1.43</td><td>[0.679-2.926]</td></tr>
<tr><td>Professional Degree</td><td>1.03</td><td>[0.397-2.503]</td></tr>
<tr><td>Insurance</td><td>20.64***</td><td>1</td><td>3.46</td><td>[1.97-6.425]</td></tr>
<tr><td>Chronic</td><td>8.69**</td><td>1</td><td>2.53</td><td>[1.344-5.219]</td></tr>
<tr><td>Sample</td><td>0.82</td><td>1</td><td>0.84</td><td>[0.572-1.227]</td></tr>
</tbody>
</table>

n = 1100; Chi-square statistics reflects likelihood ratio chi-square values for the association between correlates and the utilization of formal care; *** p = 0, ** p = 0.001, * p = 0.01, . p = 0.05, ' ' p = 0.1,   p = 1

Table 5: Anova Test for Religious Care with OR and 95% CI				
Correlate	**ChiQ**	**df**	**OR**	**95% CI**
Intercept			0.06	[0.028-0.192]
Negative Affect	20.96***	1	1.09	[1.05-1.139]
Lifetime Discrimination	4.53*	1	1.09	[1.007-1.172]
Age	8.72**	1	0.98	[0.951-0.99]
Sex	0.02	1	0.97	[0.622-1.499]
Married	2.43	1	1.51	[0.897-2.497]
Income	1.39	1	1	[0.999-1]
Education				
High School Diploma	1.35	3	1.25	[0.731-2.232]
Bachelor's Degree			1.28	[0.492-3.148]
Professional Degree			1.82	[0.612-4.94]
Insurance	1.5	1	0.72	[0.431-1.226]
Chronic	2.38	1	1.67	[0.877-3.397]
Sample	0.26	1	0.97	[0.623-1.491]

n = 1100; Chi-square statistics reflects likelihood ratio chi-square values for the association between correlates and the utilization of religious care; *** p = 0, ** p = 0.001, * p = 0.01, . p = 0.05, ' ' p = 0.1,   p = 1

On the Evolution of Shallow-Water Waves

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Abstract

This project studies the evolution of shallow-water waves for an initial-value problem using experiments, modeling, and analysis. To model the behavior of a wavetrain at a water surface, we compute solutions to the linearized boundary value problem for water waves. We solve for the dispersion relation between frequency and wavenumber and consider various limits of the solution. For shallow-water waves, we determine a soliton solution of the full KdV equation and solve the linearized equation with given initial conditions, relevant to the experiments. In the WGP Fluid Mechanics Lab, a system fabricated with a submerged plate abruptly moves horizontally to generate a soliton or vertically to generate an evolving wavetrain. We obtain measurements of the surface displacement as a function of distance from the plate using two capacitance-type wave gages. We compare the experimental results to predictions from our mathematical models. Analytic solutions of the KdV equation agree reasonably well with the measurements of the surface displacement obtained from the experiments on solitons. Analytic solutions of the linearized KdV equation provide qualitative insight into the observed evolution of the evolving wavetrains.

§I. Introduction

In this paper, we investigate analytically and numerically the evolution of waves at a water surface. The study focuses primarily on shallow-water waves, which describe waves for which the wavelength is long compared to the water depth. However, we first consider, in general, the dispersive effects and wave speed for waves in all depths of water. We conduct experiments, in which we generated waves by the pushing, dropping, and lifting of a plastic box, and obtained measurements of surface displacement. We compare these measurements with graphical representations of our solutions to the full and linearized KdV equation.

Stokes (1847) first postulated the boundary value problem (BVP) for water waves. Dean & Dalrymple (1991) provide the background in fluid mechanics required to derive these equations. Stewart (2007) imparts the mathematical tools required to derive the kinematic boundary conditions at the free surface. To make the BVP tractable, we follow Dean & Dalrymple (1991) who show how to linearize the BVP subject to weak nonlinearity. Consequently, their procedure corresponds to small-amplitude waves. We solve the governing equation with linearized boundary conditions using the method of separation of variables learned from Strauss (2008).

Additionally, Dean & Dalrymple (1991) discuss various limits of the resulting dispersion relation, including the deep-water limit, in which the waves are short compared to the depth, and the shallow-water limit. They show that using asymptotic analysis, one can approximate the BVP for waves in shallow water with an evolution equation for the free surface, called the Korteweg de Vries (KdV) equation. Using initial conditions relevant to the experiments analyzed herein, we solve the linearized version of the KdV equation, following Walsh (2011) and Hammack & Segur (1978), who previously conducted similar experiments in shallow water. We compare initial value solutions to the KdV equation with the wave experiments.

This paper is organized as follows. In §II, we describe the methods that we use throughout our research project. We present the boundary value problem for water waves in §III. First, we introduce the fully nonlinear problem and discuss its difficulties. Then, we show how to linearize the problem and find the linear solution, including the dispersion relation. In §IV, we focus on shallow-water waves. We find the soliton solution of the KdV equation and solve the linearized KdV equation with given initial conditions. We compare the experimental results to the corresponding solutions of the full KdV and linearized KdV equation.

§II. Methodology

For this project, we rely primarily on calculation, modeling, and analysis to develop insight into the evolution of surface water waves. We compute and interpret solutions to the linearized BVP for water waves and the KdV equation with given initial conditions. We determine the solutions by following known techniques from Strauss (2008) and recently acquired procedures from Walsh (2011). We utilize methods presented by Dean & Dalrymple (1991) to analyze our results. Furthermore, we learn and use the computational software system Mathematica to graphically represent the solutions to the mathematical models. Using mathematical programs (Henderson, private communication), we compare our graphical representations to the laboratory measurements.

In the William G. Pritchard Fluid Mechanics Lab in the Mathematics Department, we conduct physical experiments using the 50ftx10in wave channel. The water depth is 5.5 cm. To initiate the propagation of a wavetrain in the wave channel, a system fabricated with a submerged plate of known thickness abruptly lowers or raises a given distance. We obtain measurements of the evolution of the surface displacement as a function of distance from the plate using capacitance-type wave gages. We qualitatively compare the measurements from the experiments to the graphical representations of solutions of the KdV equation using Mathematica.

§III. The Fully- Nonlinear Water Wave Boundary Value Problem

We consider the fully nonlinear BVP for water waves, first posited by Stokes (1847), and solve its linearization to determine the dispersion relation between frequency and wavelength as well as a description of the surface displacement. In this model, we ignore the motions of the air. Further, we assume that the water is an incompressible and inviscid fluid, with irrotational motions. Mathematically, an incompressible velocity field has zero divergence, and irrotational flow signifies zero curl. Since the velocity field of the water particles is incompressible and irrotational, we can introduce the velocity potential $\phi(x, z, t)$ and reduce the number of unknowns by one. Thus, the statement of conservation of mass reduces to Laplace's equation

$$\Delta\phi = \phi_{xx} + \phi_{zz} = 0 \text{ on } -\infty < x < \infty, -h < z < \eta(x,t). \tag{1.1}$$

For this two-dimensional model, the wavetrain propagates infinitely along one horizontal direction, x, with a velocity field that varies in the horizontal and vertical, z, directions. The uniform water depth, h, defines the bottom boundary. The vertical velocity, therefore, must vanish at the bottom boundary, $z = -h$. The equation describing no flow through the bottom boundary is given by:

$$\phi_z = 0 \text{ on } z = -h. \tag{1.2}$$

Our model for a monochromatic wave requires periodic boundary conditions in the horizontal dimension and with respect to time. At the free surface, the boundary conditions dictate that particles on the surface stay on the surface and the pressure jump across the interface is balanced by curvature due to surface tension. Using calculus methods from Stewart (2007), we derive the kinematic free surface boundary condition,

$$\eta_t - \phi_z + \eta_x\phi_x = 0 \text{ on } z = \eta(x,t). \tag{1.3}$$

The second boundary condition at the free surface, called the dynamic boundary condition, dictates a balance of pressure across the surface, which varies due to the restoring forces of gravity and capillarity. This condition is given by:

$$\phi_t + g\eta + \frac{1}{2}[(\phi_x)^2 + (\phi_z)^2] = T\frac{\eta_{xx}}{[1 + (\eta_x)^2]^{3/2}} \text{ on } z = \eta(x,t), \tag{1.4}$$

where g is the acceleration of gravity and T is the coefficient of the kinematic surface tension. The two free surface boundary conditions describing our system are nonlinear. Not only do these two equations contain nonlinear terms, but they are also evaluated at an unknown boundary, $z = \eta(x,t)$. To model the main physics, we linearize the problem in §III.1.

§III.1. The Linearized Problem

The linearized problem is given by (1.1), (1.2), and the following two linearized versions of the boundary conditions evaluated on the quiescent surface:

$$\eta_t - \phi_z = 0 \text{ on } z = 0 \tag{1.5}$$

and

$$\phi_t + g_\eta = T\eta_{xx} \text{ on } z = 0. \tag{1.6}$$

We use separation of variables to solve Laplace's equation (1.1) subject to the bottom boundary condition (1.2) and periodic boundary conditions in x. First, we assume a product of solutions of the form:

$$\phi(x,z,t) = X(x)Z(z)Y(t). \tag{1.7}$$

Then, Laplace's equation (1.1) becomes

$$X''(x)Z(z)Y(t) + X(x)Z''(z)Y(t) = 0. \tag{1.8}$$

Requiring $Y(t) \neq 0$ and using algebraic simplification, we obtain

$$\frac{X''(x)}{X(x)} = \frac{-Z''(z)}{Z(z)} = \lambda, \tag{1.9}$$

where λ is an arbitrary constant. Since we have a function dependent only on x equal to a function dependent only on z, these functions must both be equal to the same constant. By the method of separation of variables, we have reduced the original PDE to equations involving ordinary derivatives. Since λ is a constant, we find the solutions to each corresponding ordinary differential equation (ODE) subject to the boundary conditions for different sign restrictions. To avoid the trivial solution and to find solutions periodic in x, we select the case where λ is nonzero and negative. Thus, we consider each side of the equation separately and obtain the following two ODEs for $\lambda = -k^2 < 0$:

$$X''(x) + k^2 X(x) = 0 \tag{1.10}$$

and

$$Z''(z) - k^2 Z(z) = 0. \tag{1.11}$$

The corresponding solutions are

$$X(x) = A\cos(kx) + B\sin(kx) \tag{1.12}$$

and

$$Z(z) = C\cosh(kz) + D\sinh(kz), \tag{1.13}$$

where $A, B, C,$ and D are constants. To determine more information about the solution, we apply the boundary conditions. By periodicity, we define $k = \frac{2\pi}{L_x}$, where k represents wavenumber and L_x is the wavelength. We evaluate $\phi_z = 0$ at $z = -h$ and use our results to obtain

$$\phi(x, z, t) = [\hat{A}\cos(kx) + \hat{B}\sin(kx)]\cosh(kh + kz)Y(t). \tag{1.14}$$

We use a combination of the linearized free surface boundary conditions (1.5-1.6) to determine $Y(t)$. After algebraic manipulation of the linear free-surface boundary conditions, we obtain an equation in terms of the velocity potential, given by:

$$g\phi_z = T\phi_{xxz} - \phi_{tt} \text{ on } z = 0. \tag{1.15}$$

We determine respective derivatives of (1.14) evaluated at $z = 0$ and substitute them into (1.15) to obtain

$$Y''(t) + [gk\tanh(kh) + Tk^3\tanh(kh)]Y(t) = 0. \tag{1.16}$$

The solution to (1.16) is

$$Y(t) = E\cos(\omega t) + F\sin(\omega t), \tag{1.17}$$

where E and F are constants,

$$\omega^2 = gk\tanh(kh) + Tk^3\tanh(kh) \tag{1.18}$$

is the radian frequency, and (1.18) is called the dispersion relation. It is the relationship between wave frequency and wavelength, $L_x = \frac{2\pi}{k}$.

Hence, we can write our solution as

$$\phi = \left[\hat{A}\cos(kx) + \hat{B}\sin(kx)\right]\cosh(kh + kz)[E\cos(\omega t) + F\sin(\omega t)]. \tag{1.19}$$

To solve for the free surface displacement, $\eta(x, t)$, we use (1.5) and (1.19). Taking the partial derivative with respect to z of the velocity potential (1.19) and integrating the differentiated function with respect to t gives

$$\eta(x, t) = \left[\hat{A}\cos(kx) + \hat{B}\sin(kx)\right]k\sinh(kh)\left[\frac{E}{\omega}\sin(\omega t) - \frac{F}{\omega}\cos(\omega t)\right]. \tag{1.20}$$

We can combine some constants, use trigonometric identities, and ignore the waves moving in the left horizontal direction. In our model, we only consider waves that propagate from left to right, which corresponds to the positive x-direction. Thus, we can rewrite our solution as

$$\eta(x, t) = a_0 \cos(kx - \omega t + \theta_0), \tag{1.21}$$

where a_0 is the amplitude of the linearized wave and θ_0 is the wave's phase shift. Following similar procedures and applying the kinematic boundary condition, we can rewrite the velocity potential as

$$\phi(x, z, t) = a_0 \frac{\omega}{k} \sin(kx - \omega t + \theta_0) \frac{\cosh[k(h + z)]}{\sinh(kh)}. \tag{1.22}$$

§III.2. Limits of the Solution

Here, we consider various limits of the dispersion relation (1.18) to gain insight on the behavior of waves for their respective water depth. We determine the corresponding dispersion relation by computing the deep-water and shallow-water limit for waves.

For deep-water waves, the wavelength is short compared to the depth. Thus, $kh \gg 1$, where $k = \frac{2\pi}{L_x}$ represents the wavenumber and L_x is the wavelength. In this limit, $\lim_{kh \to \infty} \tanh(kh) = 1$, which implies that $\omega^2 = gk + Tk^3$. The phase speed, $c_p = \frac{\omega}{k}$, becomes $c_p = \frac{\sqrt{gk + Tk^3}}{k}$ for deep-water waves. Since the speed of the waves depends on the wavelength, deep-water waves are dispersive.

Shallow-water waves correspond to waves with long wavelengths in comparison to the depth, such that $kh \ll 1$. We use Taylor Series expansion to obtain $\lim_{kh \to 0} \tanh(kh) = kh$.

In the case of shallow water, the dispersion relation is $\omega^2 = gk^2h + Tk^4h$ and the wave speed is $c_p = \sqrt{gh + Tk^2h}$.

If surface tension dominates gravity, then phase speed depends on the wavelength, so the waves are dispersive. However, shallow-water gravity waves, which have gravitation as the dominating restoring force, are non-dispersive. Their speeds for all wavelengths is $c_p = \sqrt{gh}$.

An initial surface deformation initiates a response from the restoring forces, gravitation and surface tension, and causes waves to form on the surface. Ripples refer to waves for which the two restoring forces are near being balanced. The wavelength corresponding to the balance of gravitation and capillary forces can be calculated from the dispersion relation. For ripples in deep water, we rewrite (1.18) as

$$\omega^2 = gk(1 + \frac{Tk^2}{g}) \tag{1.23}$$

We set $\frac{Tk^2}{g} = 1$ and obtain the wavenumber, $k = 3.634$ cm, and wavelength, $L_x = 1.728$ cm.

§III.3. Graphs of Solutions

Consider the dispersion relation for deep-water waves. We previously defined the phase speed for deep-water waves to be $c_p = \frac{\sqrt{gk+Tk^3}}{k}$. Figure 1 shows a graph of the dispersion relation in the form of phase speed as a function of k.
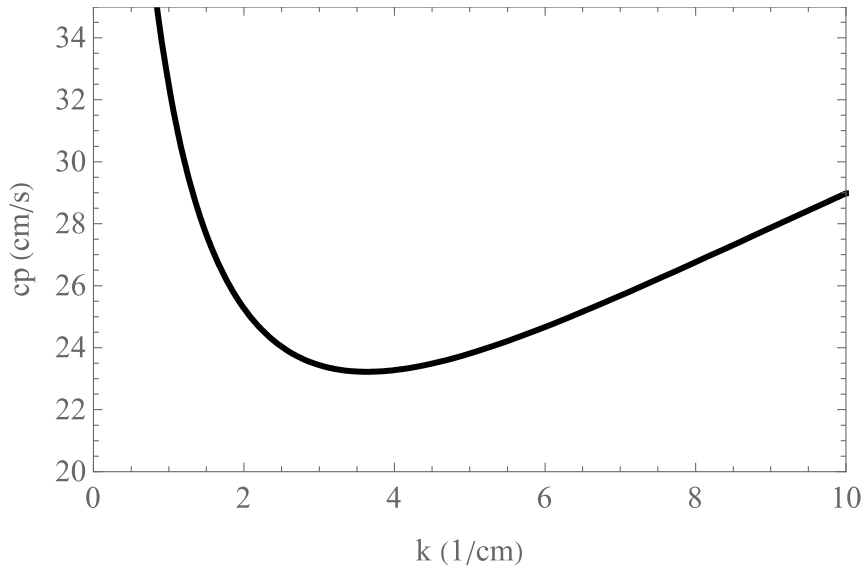
Figure 1—Phase Speed Graph

Using the equation for the dispersion relation of deep-water waves (1.23), we can compute the values of the wavenumber, k, and wavelength, L_x, for various frequencies,

$f = 0.1, 1, 3, 5, 10\ Hz$, where $f = \frac{\omega}{2\pi}$ is the cyclic frequency. We use values for the acceleration of gravity as $g = 980\ \frac{cm}{s^2}$ and for the coefficient of the kinematic surface tension as $T = 74.2\ \frac{cm^3}{s^2}$. Using Newton's Method learned from Stewart (2007), we solve for the wavenumber. Results are listed in Table 1.

f (cycle/s)	$\omega(1/s)$	$k(1/cm)$	$L_x(cm)$
0.1	0.2π	0.004	15597.18
1	2π	0.04	155.99
3	6π	0.359	17.49
5	10π	0.943	6.65
10	20π	2.638	2.38

Table 1— Wavenumber and Wavelength for Varying Frequencies

Consider a monochromatic wavetrain with a frequency of 3 Hz. Figure 2 shows a graph of the free surface, η (1.20), as a function of x at a fixed time $t = 0$, and for $\phi_0 = 0$.
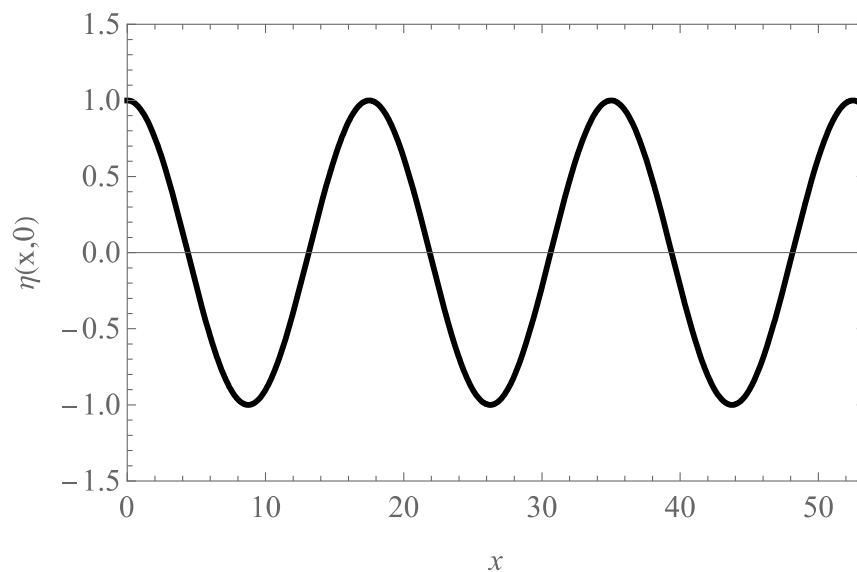
Figure 2—A Monochromatic Wavetrain with Frequency 3 Hz

§IV. The KdV Equation for Shallow-water Waves

In the case of shallow-water waves, one allows for weak dispersion and weak nonlinearity to derive the KdV equation. In §III.2, the shallow-water limit provided an approximation for the dispersion relation that neglects dispersion. To allow for weak dispersion, we evaluate the limit including the first two terms of the Taylor series expansion for $\tanh(kh)$. Thus, $\lim\limits_{kh\to0} \tanh(kh) = kh + \frac{1}{3!}(kh)^3$. Additionally, we allow for weak nonlinearity by using an asymptotic expansion in a small parameter, ε. Following Walsh (2011), we define the slow

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variables, $\psi = \varepsilon \frac{1}{h}(x - c_0 t)$ and $\tau = \varepsilon \frac{c_0}{6h} t$, which correspond to slow changes in space and time, in terms of $\varepsilon \ll 1$. Models of the slow evolution of wave amplitudes is given by the KdV equation:

$$u_\tau + 6 u u_\psi + u_{\psi\psi\psi} = 0, \tag{2.1}$$

where $u(\psi, \tau) = \frac{3}{2h} \eta$ corresponds to the wave amplitude.

§IV.1. The Soliton Solution

Following Strauss (2008), we determine a soliton solution of the KdV equation. We anticipate a traveling wave solution $u(\psi, \tau) = f(\zeta)$, where $\zeta = \psi - c\tau$ and c refers to a constant speed. Rewriting (2.1), we obtain an ODE,

$$-cf' + 6ff' + f''' = 0. \tag{2.2}$$

After integrating, (2.2) becomes

$$-cf + 3f^2 + f'' = a, \tag{2.3}$$

where a is a constant of integration. Next, we multiply both sides of (2.3) by $2f'$ and integrate the resulting product to obtain

$$-cf^2 + (f')^2 + 2f^3 = 2af + b, \tag{2.4}$$

where b is a constant.

We look for a solitary wave solution. Because this solution is localized such that the surrounding water has no elevation, the function f and its derivatives tend to 0 as $\psi \to \pm\infty$. Therefore, we must set, $a = b = 0$, which gives

$$-cf^2 + (f')^2 + 2f^3 = 0. \tag{2.5}$$

From (2.5), we can derive the solution

$$u(\psi, \tau) = \frac{c}{2} \operatorname{sech}^2[\frac{1}{2}\sqrt{c}(\psi - c\tau - \psi_0)]. \tag{2.6}$$

In laboratory coordinates, this becomes

$$\eta(x, t) = a_0 \operatorname{sech}^2[\sqrt{\frac{3a_0}{4h^3}}\left(x - c_0 t \left(1 + \frac{a_0}{2h}\right) - x_0\right)], \tag{2.7}$$

where $c_0 = \sqrt{gh}$ and x_0 is an arbitrary constant. From this solution, we observe, as a result of nonlinearity, that solitons with increasing amplitude travel with increasing speed.

§IV.2. The General Solution

We now linearize the KdV equation (2.1) so that we can analyze the behavior of additional, approximate solutions. We obtain

$$u_\tau + u_{\psi\psi\psi} = 0. \tag{2.8}$$

To assess the dispersion relation for the linearized KdV equation, we consider oscillatory waves given by

$$u \sim e^{i(\omega\tau - k\psi)}. \tag{2.9}$$

Substituting (2.9) into (2.8) results in the following equations for the dispersion relation

$$\omega = -k^3, \tag{2.10}$$

and for the phase speed

$$c(k) = -k^2. \tag{2.11}$$

Here, allowing for weak dispersion decreases the speed of the waves. Waves influenced by dispersive effects tend to break up into a train of waves. Weak nonlinearity competes with weak dispersion by causing the waves to steepen and increases the speed of the waves. When both effects are acting on a wave, the wave remains in a stable form. When nonlinearity and dispersion are in perfect balance, one obtains the KdV equation.

Since (2.8) is linear with constant coefficients, we can use Fourier transforms to find solutions. Applying the forward Fourier Transform, we obtain

$$u(\psi, \tau) = \int_{-\infty}^{\infty} A(k, \tau) e^{-ik\psi} dk. \tag{2.12}$$

After substituting (2.12) into (2.8) and simplifying, we find the solution for $A(k, \tau)$, given by

$$A(k, \tau) = A_0 e^{ik^3\tau}, \tag{2.13}$$

where A_0 is a constant, determined by the initial data. If we apply the Fourier transform to the initial conditions, we obtain

$$A_0(k) \equiv A(k, 0) = \int_{-\infty}^{\infty} f_0(\psi) e^{-ik\psi} d\psi. \tag{2.14}$$

and by inverse Fourier transforms,

$$u_0(\psi) \equiv u(\psi, 0) = \frac{1}{2\pi} \int_{-\infty}^{\infty} A(k) e^{ik\psi} dk. \tag{2.15}$$

Thus, the general solution for an initial condition given by u_0 is

$$u(\psi, \tau) = \frac{1}{2\pi} \int_{-\infty}^{\infty} A_0(k) e^{(ik\psi + ik^3\tau)} dk. \tag{2.16}$$

§IV. 3. Solutions for Given Initial Data

In this section, we look for solutions of the linearized KdV equation for two initial conditions. The first condition is an initial upward elevation, and the second condition is an initial downward movement. To find solutions, we substitute these initial conditions into the general equations obtained using Fourier transforms.

First, we look at an initial positive-displacement rectangular wave of the form

$$u_0(\psi) = \alpha[H(\psi + 2\lambda) - H(\psi)], \tag{2.17}$$

where H is the Heaviside step function given by

$$H(\psi - \psi_0) = \begin{cases} 1, & \psi > \psi_0 \\ 0, & \psi < \psi_0. \end{cases} \tag{2.18}$$

To find a solution to the linear KdV equation, we substitute this initial condition into (2.14) to obtain

$$A_0(k) = \int_{-2\lambda}^{0} \alpha\, e^{-ik\psi}\, d\psi. \tag{2.19}$$

After evaluating the integral, we find

$$A_0(k) = \frac{\alpha i}{k} e^{ik\lambda}[e^{-ik\lambda} - e^{ik\lambda}]. \tag{2.20}$$

Rewriting the complex exponential function as a trigonometric function, we obtain

$$A_0(k) = \frac{2\alpha}{k} e^{ik\lambda} \sin(k\lambda), \tag{2.21}$$

which implies that the solution corresponding to (2.17) is

$$u(\psi, \tau) = \frac{\alpha}{\pi} \int_{-\infty}^{\infty} \frac{\sin(k\lambda)}{k} e^{ik\lambda + ik\psi + ik^3\tau}\, dk. \tag{2.22}$$

Second, we consider a negative-displacement rectangular wave of the form

$$u_0(k) = \alpha[H(\psi) - H(\psi + 2\lambda)], \tag{2.23}$$

Which is (2.17) multiplied by -1. Therefore, the solution for this initial condition is the negative solution of the first initial condition, which is given by

$$u(\psi, \tau) = -\frac{\alpha}{\pi} \int_{-\infty}^{\infty} \frac{\sin(k\lambda)}{k} e^{ik\lambda + ik\psi + ik^3\tau}\, dk. \tag{2.24}$$

To understand the nature of the water surface displacement, we examine the behavior of the solution near the wave front for long-time solutions, such that $\tau \to \infty$.

The waves we observe near the wave front, for which $\psi \to 0$, include the waves with the fastest speeds. Recall that the wave speed results from a ratio of frequency to wavenumber. Hence, the fastest waves correspond to small values of k. Correspondingly, we seek waves such that $k \approx 0$. We rewrite our general solution (2.16) by introducing the following similarity variables:

$$\xi = \frac{\psi}{(3\tau)^{1/3}}, \tag{2.25}$$

$$\kappa = k(3\tau)^{1/3}, \tag{2.26}$$

and $g(\xi, \tau) = u(\psi, \tau)$ to obtain

$$g(\xi, \tau) = \frac{(3\tau)^{-1/3}}{2\pi} \int_{-\infty}^{\infty} A_0\left[\frac{\kappa}{(3\tau)^{1/3}}\right] e^{ik\xi + \frac{ik^3}{3}} \, dk. \tag{2.27}$$

With further computation, we determine the value of τ that provides information on the asymptotic behavior of the waves. For an approximation about $k \approx 0$, we use Taylor series to obtain

$$A_0(k) \sim A_0(0) + kA'_0(0) + \frac{k^2}{2} A''_0(0) + \cdots \tag{2.28}$$

We can rewrite the general solution in terms of the similarity variables using this approximation for $A_0(k)$. Considering (2.28), we rewrite (2.27) as

$$\begin{aligned} g(\xi, \tau) = \frac{1}{(3\tau)^{1/3}} \Bigg\{ & A_0(0) \frac{1}{2\pi} \int_{-\infty}^{\infty} e^{i\left(\kappa\xi + \frac{1}{3}\kappa^3\right)} \, d\kappa \\ & + \frac{A'_0(0)}{(3\tau)^{1/3}} \frac{1}{2\pi} \int_{-\infty}^{\infty} \kappa e^{i\left(\kappa\xi + \frac{1}{3}\kappa^3\right)} \, d\kappa \\ & + \frac{A''_0(0)}{2(3\tau)^{2/3}} \frac{1}{2\pi} \int_{-\infty}^{\infty} \kappa^2 e^{i\left(\kappa\xi + \frac{1}{3}\kappa^3\right)} \, d\kappa + \cdots \Bigg\}, \end{aligned} \tag{2.29}$$

which we can further rewrite in terms of the Airy function:

$$Ai(\xi) := \frac{1}{2\pi} \int_{-\infty}^{\infty} e^{i(\kappa\xi + \frac{1}{3}\kappa^3)} \, d\kappa, \tag{2.30}$$

such that (2.29) becomes

$$g(\xi, \tau) = \frac{A_0(0)}{(3\tau)^{1/3}} Ai(\xi) + \frac{A'_0(0)}{i(3\tau)^{2/3}} Ai'(\xi) - \frac{A''_0(0)}{2(3\tau)} Ai''(\xi) + O\left(\frac{1}{(3\tau)^{4/3}}\right). \tag{2.31}$$

We can simplify (2.31) for the respective initial data. The solution for the positive initial condition, graphed in Figure 3, is

$$g(\xi, \tau) = \frac{2\alpha\lambda}{(3\tau)^{1/3}} \left[Ai(\xi) + \frac{\lambda}{(3\tau)^{1/3}} Ai'(\xi) - \frac{\frac{2}{3}\lambda^2}{(3\tau)^{2/3}} Ai''(\xi) + \cdots \right].$$
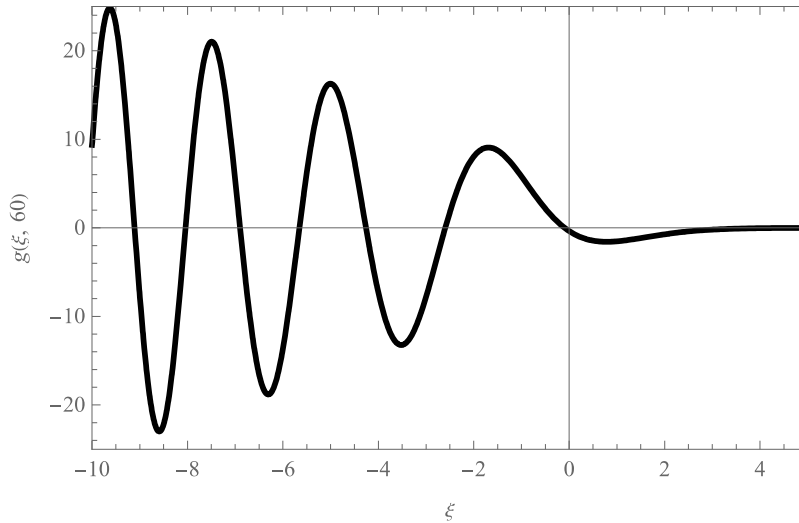
Figure 3—Solution for Initial Positive Displacement

The solution for the negative initial condition, graphed in Figure 4, is

$$g(\xi, \tau) = \frac{-2\alpha\lambda}{(3\tau)^{1/3}} \left[Ai(\xi) + \frac{\lambda}{(3\tau)^{1/3}} Ai'(\xi) - \frac{\frac{2}{3}\lambda^2}{(3\tau)^{2/3}} Ai''(\xi) + \cdots \right].$$
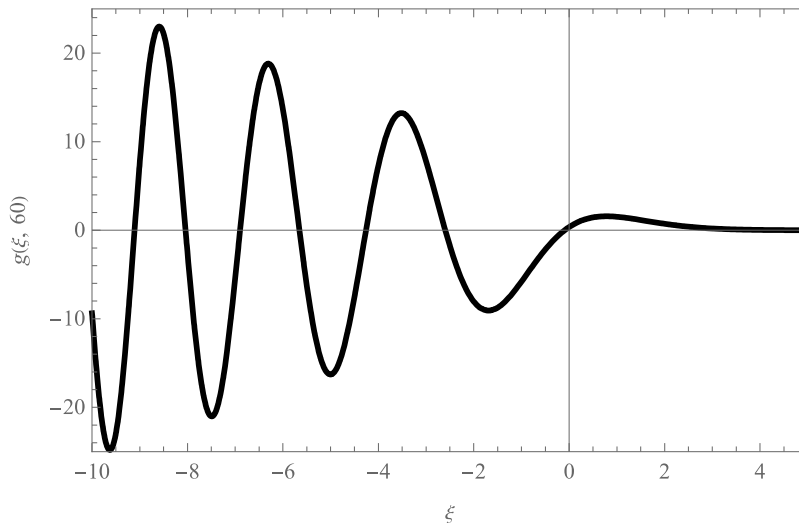
Figure 4—Solution for Initial Negative Displacement

§IV. 4. Experiments

We conducted nine experiments for which the water in the channel was $h = 5.5$ cm. We used a plastic hand-held box to generate solitons and waves corresponding to the initial data. Table 2 shows the amplitudes of the first three peaks observed in the experiments.

Experiment	Information	Amp 1 (cm)	Amp 2 (cm)	Amp 3 (cm)
E1	2.45 cm	0.397	0.183	0.151
E2	8.45 cm	2.296	1.070	0.940
E3	6.50 cm	1.472	0.776	0.631
E4	4.00 cm	0.837	0.480	0.416
E5	Lowered	0.609	0.310	0.317
E6	Lowered	0.739	0.569	0.429
E7	Lowered	0.683	0.342	0.283
E8	Raised	-0.191	-0.150	-0.092
E9	Raised	-0.733	-0.392	-0.275

Table 2— Experimental Data. For E1-E4, the second column lists the horizontal distance traveled by the box. For E5-E9, the second column indicates whether the box was raised or lowered.

To generate a soliton, we pushed the submerged box, which was placed at one end of the tank, forward. In E1, the box was moved 2.45 cm in the direction of the gages. We compare the experimental data, denoted by the black line, to the anticipated solution, identified by the colored line. Figure 5 shows this comparison for the first soliton peak in the second gage data.
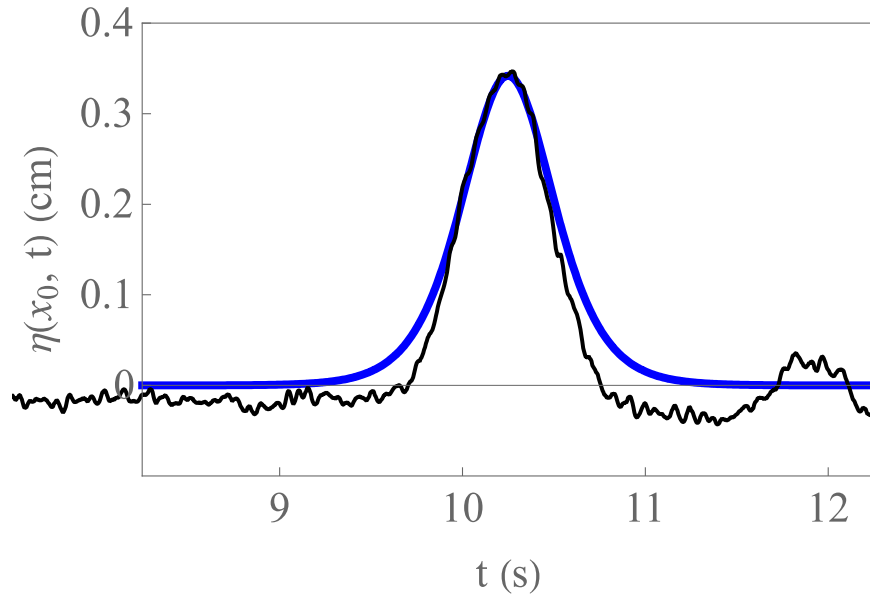
Figure 5—Comparison of E1 and the Soliton Solution (2.7)

E2 follows the same procedure as E1, but the distance of the box changes. The displacement of the box was 8.45 cm for the second experiment. Figure 6 compares the data collected on the second soliton wave and the corresponding solution.
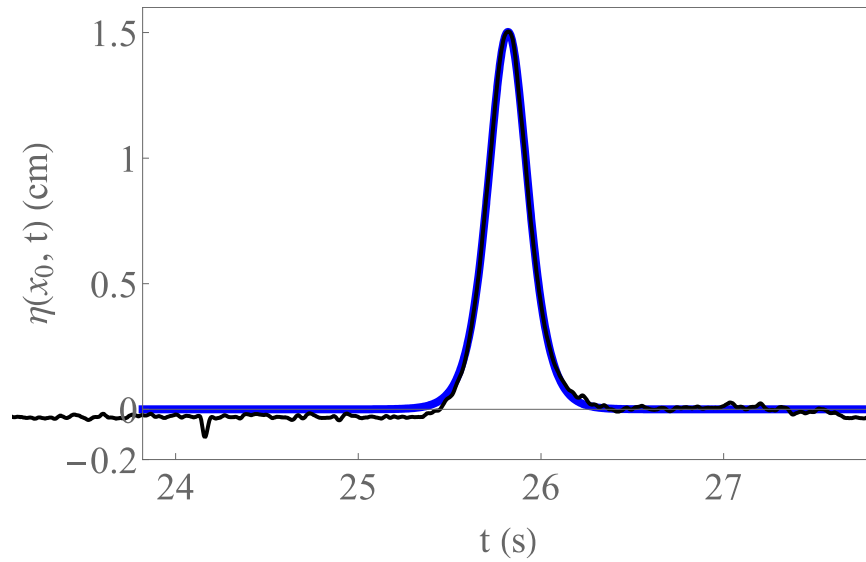
Figure 6—Comparison of E2 and the Soliton Solution (2.7)

For E3, we repeated the same steps, but we pushed the box 6.5 cm. Figure 7 shows a comparison of the data and soliton solution.
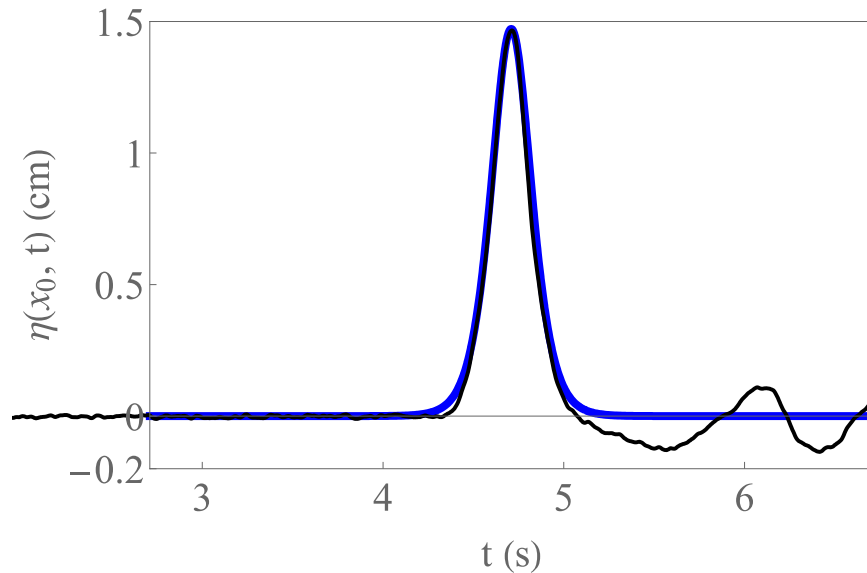
Figure 7—Comparison of E3 and the Soliton Solution (2.7)

In E4 we pushed the box 4.0 cm forward to generate a soliton wave. We compare the collected measurements again with our solution, shown in Figure 8.
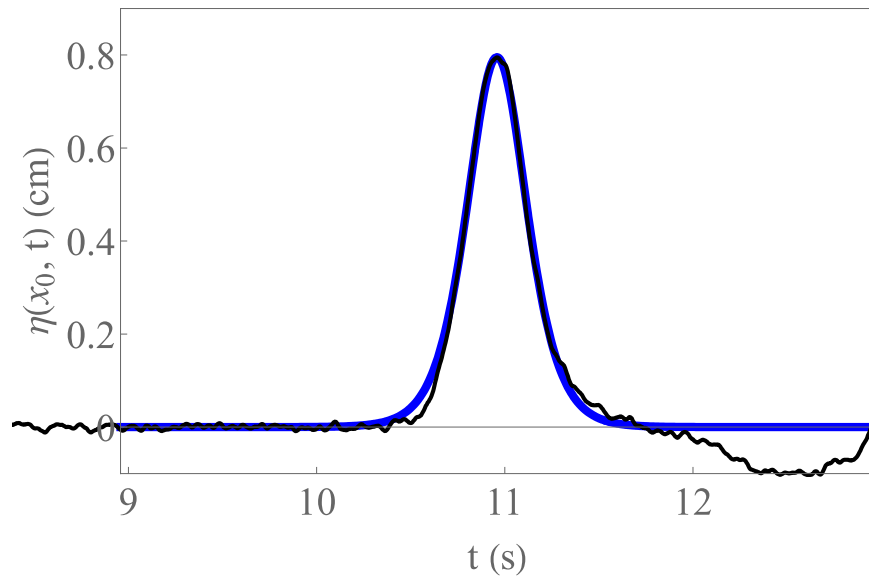
Figure 8—Comparison of E4 and the Soliton Solution (2.7)

For the soliton experiments, we notice agreement between the experimental measurements and the analytic solutions of the full KdV equation. Agreement is qualitatively better for the larger amplitude solitons. A next step would be to do an error analysis to make a quantitative comparison. Further horizontal distances traveled by the box increase the quality of the comparison. The graphed soliton in Figure 6 shows the most agreement, and it corresponds to the E2 data. As shown in Table 2, the soliton with the largest amplitude was generated in E2, which is the experiment where the box traveled the furthest horizontal distance. Figure 9 shows a zoomed in view of the comparison originally shown in Figure 6.
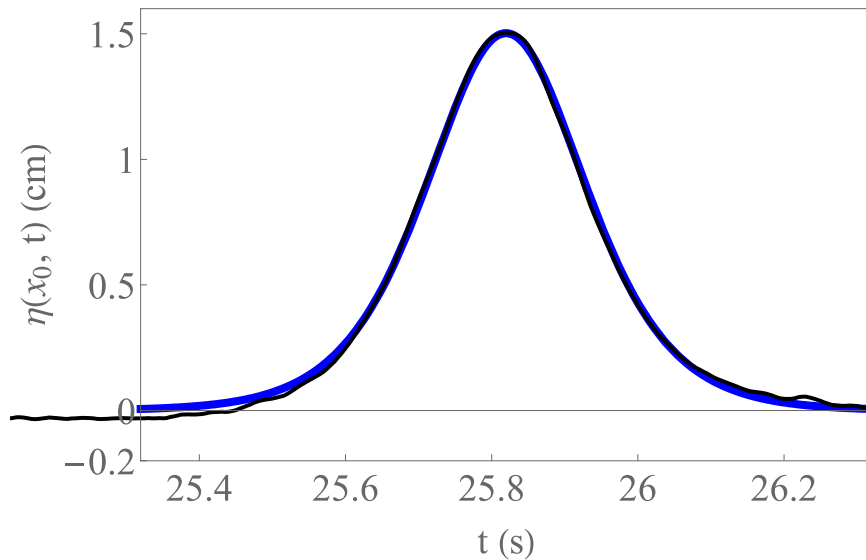
Figure 9—Closer Look at the E2 Data

In E5-E9, we consider a train of waves developed under different initial conditions. For E5, we held the box entirely above the surface of the water and abruptly pushed the long edge (25.4 cm) of the box down to the bottom of the tank and let go, allowing it to float back up. Figure 10 shows the soliton shape of the wave generated in this experiment.
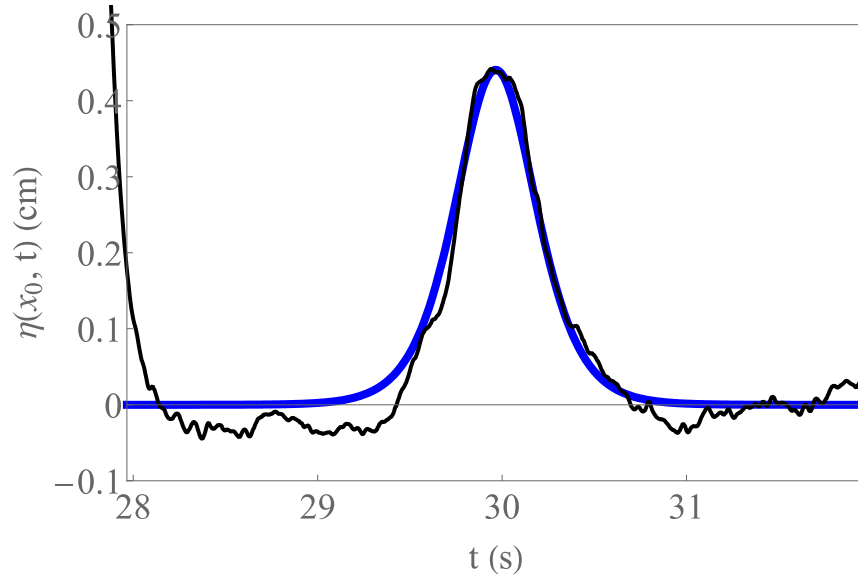
Figure 10—Comparison of Experiment 5 and the Soliton Solution (2.7)

In E6, we repeated the previous experiments method for creating waves by the lowering of a box but held the box fixed on the bottom. Here, we observe two individual solitons evolving along with a train of waves. Figure 11 shows the measured time series. The initial movement is upwards because of an initial negative displacement from dropping the box into the water. E7 considers waves generated by plate depression involving the short edge (10 cm) of the plastic box. The waves in this experiment initiate with a soliton followed by a dispersive wavetrain. Figure 12 portrays the data collected from this experiment.
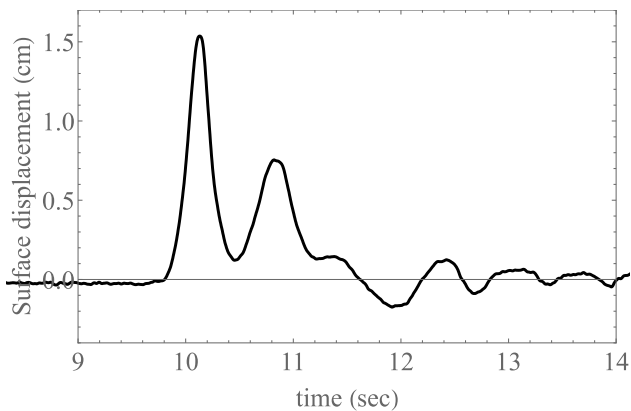
Figure 11—E6
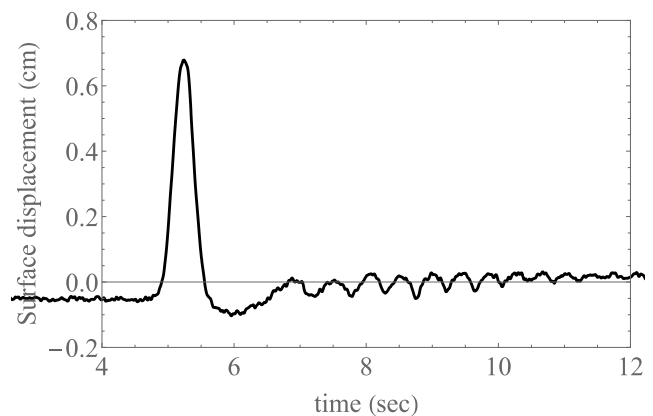
Figure 12—E7

For E8 and E9, we abruptly lifted the box out of the water to generate waves in the tank. We placed the box vertically in the water and lifted it straight out of the tank. We notice an initial downward movement of the water caused by lifting the box. This is the opposite effect observed in the initial downward movement conditions. Figure 13 provides a look at the data collected from E8, where the box was lifted away from the corner of the tank, so that reflections occurred. Figure 14 shows the experimental observations of E9, for which the box lift occurred in the corner of the tank, so that reflections did not occur. The initial positive wave for a negative initial condition and negative wave for a positive initial condition is consistent with predictions from our solutions from (2.27).
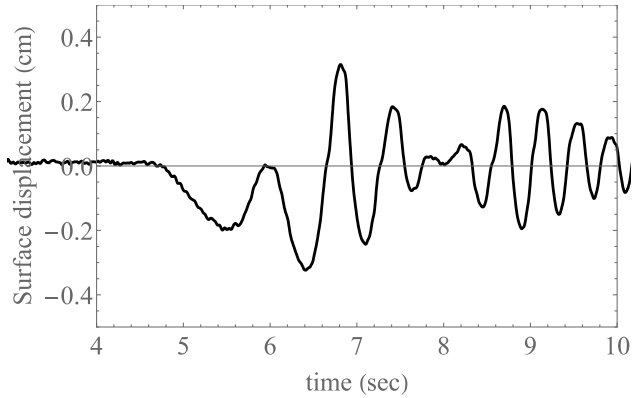
Figure 13—E8
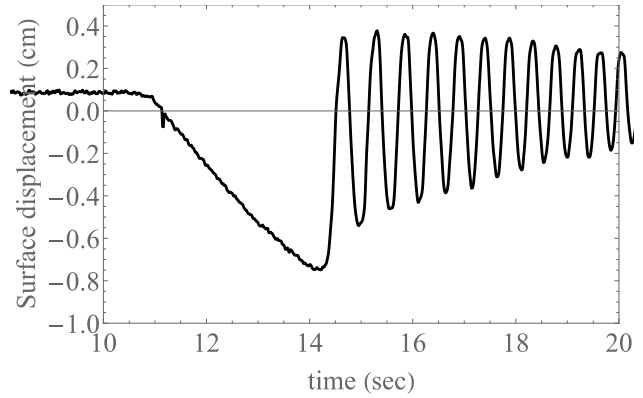
Figure 14—E9

Discussion

Through our investigation, we developed an understanding of the dispersion of waves in various depths and the evolution of shallow-water waves. Solutions to the linearized version of the boundary value problem for water waves provide insight into the behavior of a train of waves at a water surface. Various limits of the solution reveal the relationship between wave speed and wavelength, which explains the non-dispersive property of shallow-water gravity waves. Evaluation of the KdV equation for shallow-water waves provides a theoretical insight into the stable form and speed of a soliton. The data from the experiments that generate a soliton agree reasonably well with the soliton solution of the KdV equation. For the experiments that consider wave propagation caused by abruptly pushing a plastic box down into the water, the measurements of surface displacement agree qualitatively with our predicted solution for initial conditions as do waves obtained from the abrupt raising of the box out of the water.

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Disparities in Healthcare Access Among the Scranton Latino Community

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BACKGROUND

Scranton is the sixth-largest city in Pennsylvania and the largest in the northeastern region of PA. It is a metropolitan city (Norcross, 2016). It once flourished due to the success of the coal and garment industries. Now, tourist attractions such as the Steam Town National Historic Site are hallmarks of the city. In the 20th century, Scranton saw a large influx of immigration, especially European immigration. Italian and Irish were the biggest ethnic groups that immigrated to the area in the 20th century (Parsons, 2007). Up until the late 1980s, the Hispanic immigrant population was relatively small; however, that began to change as increasing numbers of Spanish-speaking immigrants created a second wave of immigration throughout the area (Parsons, 2007).

Yet Scranton, as well as other cities in Pennsylvania such as Hazleton and Wilkes Barre, has been apprehensive about the second wave of immigrants migrating into the city over the last 40 years (Parsons, 2007). For example, in 2006 Hazleton passed a law declaring English as the city's official language, provided strict guidelines for the deportation of undocumented immigrants, and promised harsh punishments for those who hired them (Parsons, 2007). Scranton, on the other hand, seems to have (at least at a governmental level) distanced itself from such overt divisiveness; yet it does not take much effort to discover that similar prejudicial sentiments prevail in the city as well (Parsons, 2007).

In a study looking at racial/ethnic segregation and spatial isolation, Scranton ranked among the top five most racist metropolitan areas out of 287 studied (Rugh, 2014). The term "spatial isolation" refers not simply to the racial composition of communities and neighborhoods; but also to the spatial proximity of such communities (Reardon, 2004). One study conducted an analysis of Google trends measuring the volume of pejorative terms regarding Hispanics and Non-Hispanic Blacks used in the area of Scranton as well as other metropolitan areas (Rugh, 2014). Scranton had one of the highest volumes of pejorative terms toward these minority groups and ranked among the top five. The Google trend method was previously proven effective by its ability to predict voter turnout for President Obama across market areas in the 2008 presidential election (Rugh, 2014). Hispanic segregation, and especially Hispanic spatial isolation, have risen over the last three decades (Rugh, 2014). Anti-Hispanic sentiment also materializes in many forms, including restrictions on density zoning.

For example, limiting the density of residential construction in predominantly non-Hispanic White communities, which raises the costs of housing and creates both income and racial segregation, is consequential in slowing down or stopping integration (Rugh, 2014).

Given that racial prejudice has been documented in Scranton, it is reasonable to presume that density zoning and other activities that slow or stop racial integration have also taken place.

The issue of healthcare access within the context of racial discrimination is also important and has been illustrated by numerous studies. For example, Greer's study on metropolitan racial segregation and deaths due to cardiovascular disease found that among non-Hispanic Blacks in metropolitan areas, segregation (as well as other factors) was positively associated with heart disease mortality (Greer, 2014). Haas' study (2004) also demonstrates that among a national sample, non-Hispanic Blacks who reside in segregated metropolitan areas have significantly higher rates of death from heart disease. These findings suggest that spatial isolation and residential segregation could be factors negatively contributing to a multitude of health determinants, including access to quality healthcare (Haas, 2004). Moreover, Hispanics residing in Pennsylvania are more likely than non-Hispanic Blacks and Whites to report no usual source of care, as well as to report having no doctor visits in the past two years (KFF, 2016). About a quarter of Hispanics in Pennsylvania report being in fair or poor health generally. Furthermore, non-Hispanic Blacks and Hispanics are approximately three times as likely to be poor than Non-Hispanic Whites (KFF, 2016).

The effect that socioeconomic status has on healthcare access is impossible to overlook. Low socioeconomic status (SES) is a contributor to an array of factors that adversely affect healthcare outcomes, including access to healthcare and the quality of care that is received. Individuals with lower SES have more chronic conditions, self-report worse health, and have lower life expectancy than higher SES individuals (Arpey, 2017). In addition to having fewer access to healthcare due to high expenses and coverage, lower SES individuals receive fewer medications and diagnostics for their chronic diseases than higher SES individuals (Arpey, 2017). Furthermore, because lower SES individuals are more likely to lack health insurance, they often receive late treatment for their conditions. Lack of health insurance can cause individuals to forego primary care, which can result in preventive issues turning into severe medical problems due to inconsistent care (Morrisey, 2008).

Study Aim

Oftentimes, however, studies lack direct and open input from individuals who are experiencing the impacts of issues such as low SES, spatial isolation, and geographic segregation. Although many studies have established the link between those factors and negative health outcomes due to access or other health disparities, not many have gone out of their way to solicit community members' perspectives on their situations, which are important to collect to benefit the community. For example, organizations may want to help the community, but without direct insight from the people living in those communities, they may cause unforeseen damage or use resources ineffectively. Through the use of both quantitative data (analyzing health care access outcomes) and qualitative data (analyzing self-assessment of community needs), this study will gain insight into perceptions of need among residents living in the southside of Scranton. The confluence of both structural inequalities and individual disparities may result in this community experiencing unequal access to health care. It is imperative, therefore, to better understand the effect of segregation and isolation among Scranton's Hispanic and low-SES community. The Southside of Scranton, whether purposely segregated or isolated, is a majority

Hispanic and low-SES community that is likely to suffer from low levels of healthcare access and utility.

The primary goal of this study is to examine the factors that are significantly related to healthcare access among Scranton's Hispanic population. Specifically, the study examines the following three research questions. First, we ask: To what extent do Hispanics in the Southside of Scranton report difficulties accessing healthcare, including access to physicians, specialists, and medications? Second, we ask: To what extent does access to healthcare difficulties vary by gender? It is likely that Hispanic women have lower access to healthcare than Hispanic men, due to a variety of social factors. Social status, gender norms, and low-skilled work opportunities are some contributors to women accounting for the biggest proportion of those living in poverty (Puentes-Markides, 1992). Low-paying jobs may render many women unable to afford quality healthcare, as well as cause stressors that may influence health-seeking behavior (Puentes-Markides ,1992).

Finally, we ask what perspectives do Hispanics residing in the southside of Scranton have regarding their community's health care needs? The study will examine patterns and themes that emerge from the perception of need of Hispanics in the southside of Scranton.

Study Implications

The study aims to show the results of the survey as they relate to the broader healthcare, historic, and socioeconomic environment of Scranton PA. This research can be the foundation for future research in the area. If inequity is shown to be a pattern, other studies can be carried out to understand the causalities behind those inequalities. Policy shifts, although driven by a variety of influences, can happen because of research. Academic literature often focuses on ways in which rigorous research was unable to make such changes, but there are examples of the opposite (Philpott, 2002). The Mwanza trial I is a prime example of this, the results of this study were proven to be incredibly effective in changing policy (Philpott, 2002). Treatment services with regard to sexually transmitted infections (STIs) improved significantly in Tanzania. Management of STIs in rural areas saw improvements, and the rate of incidence of HIV dropped around 40% (Philpott, 2002). The incredible changes that happened as a result of this study, were due to of various reasons, as stated in the Philpott case study: "The policy environment was favorable, researchers and policymakers formed strategic alliances for policy shift and it was possible to present the data in an easily understandable form" (Philpott, 2002). It is not always possible for this to happen, nor is it likely that will be the case for Scranton, given its history. Nonetheless, as we see recent social movements produce significant change throughout the country (e.g., racial justice advocacy), this may be the most favorable environment for health access policy changes in Scranton. In consequence, it is extremely important to share the results of this study with community leaders, local organizations, and citizens of the area.

METHODOLOGY
Data Source

The study will conduct secondary data analysis of survey data collected by the Geisinger Commonwealth Medical School's Center of Excellence program. The data was collected from July 6th until the 14th of 2018. Respondents were recruited from two locations in the southside of Scranton: a Farmer's Market and a United Neighborhood Center Language Class. Individuals age 18 and older were eligible to participate in the study. The survey was delivered via electronic and paper surveys and were available in both English and Spanish. A total of 119 respondents participated in the survey.

The anonymity of the respondent was reassured before delivering each survey. The respondents were also reminded that they could skip any questions that they did not want to answer. The survey received exempt IRB approval.

Measures

The study's first primary outcome includes a set of binary responses to the following six questions measuring health care access difficulties: 1) *Do you have access to a primary care doctor or primary care services?* 2) *Was there a time in the past 12 months when you or anyone in your household needed to see a doctor but could not?* 3) *Was there a time in the past 12 months when you or anyone in your household needed to see a medical specialist but could not?* 4) *Was there a time in the past 12 months when you or anyone in your household needed to see a dentist but could not?* 5) *Was there a time in the past 12 months when you or anyone in your household needed prescription medication(s) but could not get them?* and 6) *Was there a time in the past 12 months when you or anyone in your household wanted or needed counseling or therapy but could not get it?* The respondents answered "yes" or "no" to each of the questions.

To account for the number of health care access difficulties a respondent reported experiencing, a numerical scale was created ranging from 0 to 6 based on the number of positive responses reported to each of the six questions above. Moreover, respondents with missing data on two or more questions were excluded from the analysis (n=10).

The study's secondary outcome is the respondents' perceptions of needs. To measure the populations' perspectives regarding ongoing needs, the survey included an open-ended response item that asked the following question: *"Please provide any comments that you have regarding the needs of Hispanics and Latino(a)s who live in the area."* Thematic content analysis was conducted to identify common themes and patterns that emerged within respondents' perceptions of need for their community. Emerging themes were captured and categorized. These dominant themes were then analyzed for relevance and data representation and contextualized to the study. Analysis also included identifying any differences in themes appearing within different genders.

Sociodemographic Characteristics

Respondents were stratified by gender to note whether one gender reports better or worse access to healthcare than the other. This was done by looking at the total distribution of responses to the survey questions. The study also examined other sociodemographic factors such as age, income, and employment status to obtain a better picture of the social determinants that may affect respondents' ability to access healthcare, information that may help us make inferences about the populations' access outcomes.

Analysis

The study applied descriptive statistical methods to analyze the data. A p-value of 0.05 was used to measure whether significant associations between gender and access difficulty existed. GraphPad prism (version 7.04, GraphPad software, San Diego, CA) was used to perform the described procedures. Results from these procedures demonstrate the different levels of access to care in the sample and provide a window into the significance of gender as it pertains to the levels of care.

RESULTS
Quantitative Results

Table 1 describes sociodemographic characteristics of the sample population. Respondents were majority female and comprised 56% percent of the population. Nineteen percent of the respondents described themselves as unemployed, while 14% were part-time workers. The category "Other", which makes up 21% of the respondents, includes students and stay-at-home respondents. Most of the sample population falls under the income bracket of $10,000 to $24,999 per year. In addition, 14% of the participant's income is less than $10,000 a year. Moreover, almost half of our participants said they had difficulties accessing a dentist when needed, and more than one-third of the participants had difficulties accessing a doctor when needed.

Table 2 demonstrates the type of healthcare access difficulties by gender. For example, the number of respondents who indicated that they lack access to a primary care provider is marked as n, a percentage, and a p-value For each of the healthcare access issues examined, the p-value suggests there were no significant differences in the type of healthcare access issue experienced by males or females.

Table 3 illustrates the number of access difficulties experienced by gender. If we zoom in to healthcare issues experienced by the respondents, we can see that there are some differences in the number of issues that affect each gender. In general, we can see that a higher percentage of females experienced more than 2 access issues compared to male respondents, although this difference is not statistically significant.

Qualitative Results

The survey included one open-ended question that provided the respondents with an opportunity to comment on their perception of the community needs: "Please provide any comments that you have regarding the needs of Hispanics and Latino(a)s who live in the area." Thirty-one respondents, or 26% of the sample, provided commentary. Sixty-one percent of the answers were written in Spanish. Comments were reviewed by the first author and a second coder, two themes emerged from the responses. Following a grounded theory approach, a total of two dominant themes emerged from the data including, "Health Access" and "Social Determinants of Health". Twenty-six comments or 84% of the comments expressed needs while 5 comments (16%) were unrelated to needs such as "I'm not sure" or "Loves Geisinger".

The first theme, Health Access, relates to comments that expressed the need for improvement in areas of acquisition of health or health delivery. For example, one respondent stated, "Necesitamos más personal para que atiendan la comunidad hispana y puedan atender mejor y allá una mejor comunicación y mejor trato la que muchas de las beses (sic) el idioma es un gran obstáculo". The comment explains the need for more personnel that can tend to the Hispanic community. In addition, it expresses the need for better treatment and communication with the community, pointing out that sometimes language can be a big obstacle for Hispanic individuals residing in the area. In healthcare, it is essential to address those barriers. Situations such as misunderstandings due to language can have fatal consequences.

There were a few subthemes that emerged within the dominant theme of "Health Access". For instance, translation was quoted a few times as a barrier for access to care in the comments. One respondent wrote via a translator, "She would like more translators in areas that are offering health services. For example, when she goes to the dentist there is no one to translate." Important decisions about a patient's health can be compromised when they are

unable to communicate their needs to the provider. Difficulty obtaining insurance was a second subtheme that is important to note. When asked about the needs of the community, one respondent noted "Problems getting insurance" as an issue affecting Hispanics in the area. Lack of insurance creates access issues that then lead to, in some cases, severe medical illness (Morrisey, 2008). Improving access to healthcare was the issue that participants mentioned the most (n=16), with comments such as "Mas programas con acceso a salud a bajo costo" and "Más seguridad Y médicos a nuestro alcance", which translate to "More programs for accessing healthcare at low cost" and " (More safety/security/insurance) and more (available/accessible) doctors" respectively. The volume of comments related to healthcare access may be an indicator of prevalence for access issues within the community.

The second dominant theme, the Social Determinants of Health, include views related to education, job security, and housing. For this theme, the topics addressed by participants were more diverse. Some respondents (n= 4) talked about job opportunities and housing. For example, one respondent wrote, "Escasos empleos, apartamentos o casas para rentar". Other respondents (n=5) discussed the need for educational programs such as English classes and programs for children. For example, one respondent expressed, "I feel that we have the need of more schooling for people to learn English and be able to FEND FOR THEMSELVES". Another participant wrote, "Hispanic needs better housing". Although these issues may seem to not be directly related to healthcare, they are factors that could affect health outcomes. For example, a misunderstanding due to language barriers can cause a patient to misuse medication or not understand her condition correctly. Lack of adequate living conditions can produce illness. In addition, scarce work opportunities can affect people's ability to access healthcare, as well as healthy foods.

DISCUSSION

This study investigated healthcare access in the Hispanic population residing in the southside of Scranton, PA. Several areas within the study need to be further researched to provide conclusive statements about the issues discussed. One of those areas is the difference in difficulties experienced by gender. Further research on other sociodemographic characteristics of the population may be insightful in understanding health access in the community.

Conversely, much of the information obtained suggests access difficulty within the population. In 4 of the 6 access issues examined in this study, more than 30% of the population described access difficulties. Female participants seemed to experience a greater amount of issues simultaneously. Fifty percent of female participants experienced more than 2 access issues, while 42% of males experienced more than two access issues. Nineteen percent of the population was unemployed, 14% worked part-time, comprising 33% of the population that did not have a full-time job. In addition, much of the sample population falls under the income bracket of $10,000 to $24,999 a year. Fourteen percent makes under $10,000, which may suggest low levels of access to healthy foods, and even a high rate of uninsured people within the population.

Health care access was the number one theme throughout the responses to the open-ended question (16 comments were about health access). This finding, as well as the socioeconomic data, suggest that lack of health access may be an essential factor affecting health outcomes of the population. Lack of insurance emerged as an important subtheme of health access. In addition to difficulty obtaining insurance, the lack of resources to help with the process was also raised by participants. Lower socioeconomic status individuals are more likely to lack insurance coverage, and 56% of the sample population makes under $25,000 a year.

Behavioral determinants of health can be affected negatively when individuals lack financial stability. They may not be able to afford healthy foods, doctor visits, or even necessary medical procedures.

Further research may need to be conducted with regard to discrimination and tension. Comments addressing tension and discrimination were not sufficient to consider them a theme. On the other hand, the lack of Hispanic personnel, translation, and mistreatment of Hispanics in the area could be influenced by racial tensions within the city. Healthcare organizations may benefit from patient-centered approaches in order to better meet the needs of the population. Other social determinants of health that could be influenced by racial tension are security, jobs, and housing opportunities. This is particularly germane given that ten out of the twenty-six respondents who wrote about concerns expressed a need regarding housing, job security, and education.

In conclusion, further investigation into these issues with a larger sample is needed to draw conclusive statements from the data. Even so, both qualitative and quantitative data seem to indicate that many individuals are having difficulty accessing healthcare. Sociodemographic characteristics, as well as racial tensions, could be negatively impacting health outcomes for Hispanics in the Southside of Scranton. In addition, there are indications that Hispanic women may be experiencing a larger spectrum of access difficulties than Hispanic men within the community.

Table 1. Descriptive Statistics of the Study Sample

	N = 119	Percentage
Gender		
Male	47	44%
Female	60	56%
Age		
18-30	34	31%
31-55	49	45%
55+	8	7%
Employment Status		
Employed- full time	46	43%
Employed – Part time	15	14%
Unemployed	20	19%
Other	23	21%
Income		
Less than 10k per year	15	14%
10k to 24,999k per year	45	42%
25k to 50k per year	21	19%
50k to 75k per year	9	8%
75k+	1	0.9%
Healthcare Access		
Primary care access	37	34%
Access to doctor when needed	38	35%
Access to medical specialist when needed	35	32%
Access to dentist when needed	49	45%
Access to counseling/therapist when needed	28	26%
Access to medication when needed	26	24%

Table 2. Types of Healthcare Access Difficulties by Gender

Healthcare Access Issue	Male		Female		*P*-value
	n	Pct.	n	Pct.	
Primary care access	19	40%	18	30%	0.2057
Access to Doctor when needed	14	30%	24	40%	0.2057
Access to Medical specialist when needed	14	30%	21	55%	0.3181
Access to Dentists when needed	25	53%	24	40%	0.3181
Access to Medication when needed	13	28%	15	25%	0.7607
Access to Counseling/Therapy when needed	11	23%	15	25%	0.7607

Table 3. Number of Healthcare Access Difficulties Experienced by Gender

Number healthcare access issues	Male		Female		*P*-value
	n	Pct.	n	Pct.	
0	15	31%	16	27%	0.5228
1	5	10%	9	15%	0.5965
2	4	8%	13	22%	0.1099
3	5	10%	6	10%	0.8549
4	5	10%	3	5%	0.2588
5	5	10%	5	8%	0.6548
6	2	4%	3	5%	0.8993

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Age Differences in Young Children's Strategies
for Regulating Frustration

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Abstract

In early childhood, effortful self-regulation, including self-regulation of emotions, first emerges. Our lab defines self-regulation as the influence of the engagement of intrinsic (e.g., cognitive) resources on changes in prepotent responses. We tested theoretically driven hypotheses that there are age differences in young children's intensity of frustration (less intensity with age), extent of cognitive resources in their strategic efforts (use of more cognitive resources with age), and the relation between these (more related with age). The participating 154 children were between the ages of 30-60 months old. Video records of their behavior during the Transparent Locked Box (LB) procedure, which induces mild frustration, were later coded by two independent teams to rate (a) anger and sadness intensity and (b) extent of engagement of cognitive resources. Results indicate that sadness increased as age increased, and their relationship was modestly significant. Increasing age revealed a positively correlated relationship with anger. Age and engagement of cognitive resources in strategies used had no relationship. Anger decreased as engagement of cognitive resources increased and one partial effect for sadness decreasing with engagement of cognitive resources was also found. The results are discussed in relation to both prior and future research.

Background

For the past few decades, self-regulation has become a focal point of empirical research in the social sciences and particularly in psychology. Much of this scientific attention can be attributed to the evidence that self-regulation plays a central role in psychological functioning. Namely, self-regulation is a central factor among all age groups and in relation to multiple areas of human functioning, including physical and mental health and adaptive functioning in relationships and in work and academic performance. For example, across different ages, self-regulation plays a role in psychopathology (Kring & Sloan, 2009), academic achievement (Graziano et al., 2007), interpersonal functioning (Rawn & Vohs, 2006), and both school readiness and academic achievement (Blair, 2002; Blair & Diamond, 2008; McClelland & Cameron, 2012) to name a few prominent outcomes. In sum, the evidence establishes self-regulation as a crucial aspect of overall human functioning and growth.

Within the American society, there is a general expectation that children learn how to effectively self-regulate their emotions, at least in terms of common, frequent challenges, by the time they are school age. Thus, a developmental perspective is essential to a full understanding of self-regulation. The prevailing developmental viewpoint is that children's emotion regulation can be managed extrinsically or intrinsically (Grolnick & Ryan, 1989). Specifically, in the earliest years of life, extrinsic, or external, factors drive regulation of well-being, e.g., resolving distress, and with development intrinsic, or internal, factors contribute to effortful self-regulation. This developmental shift from reliance on extrinsic factors to the emergence of autonomous, self-initiated efforts drawing on intrinsic factors marks the beginning of self-regulation (Kopp, 1982). Evidence largely supports this developmental framework, for example, 5-month-old infants engage in some spontaneous but highly limited self-regulatory efforts (August et al., 2017), by age 36 months children begin to engage in autonomous effortful self-regulation (e.g., Cole et al., 2011), and self-regulation continues to develop even throughout adulthood (Gross & John, 2003). Our study focuses on one specific age period—early childhood. This period is important because it is when effortful self-regulation has been observed to initially emerge, between children's third and fourth birthdays. Moreover, we are specifically interested in testing predicted relations between age and emotional reactions to challenges, age and strategy use during those challenges, and importantly, age and the relation between emotional reactions and strategy use.

Whereas prior research on young children's strategy use describes the strategies they attempt (e.g., Grolnick et al., 1996), we broadly consider the fact that strategies changes across age are due, in part, to intrinsic factors, namely the development of a range of cognitive resources, including language, inhibitory control, and planning, to name a few. Related concepts such as emotional regulation, executive attention, inhibitory control, and other concepts are often invoked when considering self-regulation (Kopp, 2009). These related concepts can be regarded as constituent components of self-regulation (Gagne, 2021, Carlson & Wang, 2007; Liew, 2012). Most studies focus on constituent components, such as the components of executive functioning (Blair & Diamond, 2008) or executive attention, which involves the ability to control attention regardless of environmental conditions (Posner & Rothbart, 2000). Another example is effortful control or the ability to carry out a secondary response in the place of a primary response (Rothbart et al., 2003). All these constituent components develop substantially throughout early childhood.

More importantly for this paper, Kopp (1982) provided a widely used framework for self-regulation from a developmental lens. She described the roles that intrinsic and extrinsic factors play in the emergence of self-regulation in children. Generally, extrinsic factors, such as caregivers, provide expectations and socialize children through modeling, reacting, and teaching about self-regulation. These extrinsic influences include caregiver efforts to help children draw on their own intrinsic factors, until children can autonomously draw on their internal, i.e., cognitive, resources without caregiver assistance. With experience and maturation, young children begin to achieve self-regulation and rely less on the influence of others.

Self-Regulation of Emotion

Our lab defines self-regulation as the influence of the engagement of intrinsic (e.g., cognitive) resources on changes in prepotent responses. Where most child development research focus on differences between children, this is a within-person approach that locates regulation in the *relation* between engaging those resources and prepotent responses. This ability is important in meeting social demands through a set of culturally normative behaviors. There is no set list of appropriate behaviors, but studies highlight different apposite behaviors that should be appropriate in particular situations. There is a substantial history of research on children's self-control or self-regulation, and these have taken varied approaches to defining and measuring self-control or self-regulation. Most however focus on children's ability to begin or end behaviors to meet caregiver expectations or to modulate those behaviors in terms of strength, reoccurrence, and length (Kopp, 1989). This wide range of behaviors establish the scope of self-regulation, but the diversity of approaches has made it difficult to reach a single standard definition of self-regulation.

To try to move research towards a single standard, the National Institutes of Health (NIH) called for research to address this problem. In our lab, we tackled this need by drawing a common theme in many models of effortful, "top-down" self-regulation in the adult social and child developmental subdisciplines of psychology (Cole et al., 2019). That is, our lab defines self-regulation as the influence of the engagement of intrinsic (e.g., cognitive) resources on changes in prepotent responses. Whereas some prior studies interpret more frequent or more intense negative emotion as evidence of poorer emotion regulation, and some studies interpret more frequent or more varied use of strategies as evidence of better emotion regulation, our perspective focuses on the relation between those cognitive resources, as indexed by strategies, and prepotent responses, as indexed by the emotions that structured laboratory tasks are designed to elicit.

Prepotent responses are behaviors that are highly likely given the situational circumstances (Arnold, 1960). These responses are spontaneous and relatively automatic, occurring without much effort. For example, in the situation of a sudden, imminent car collision, the prepotent responses include spontaneous slamming on the brakes or swerving into another lane, i.e., spontaneous withdrawal from threat. These are adaptive responses that do not require time to recall, reason, or plan. The surge of fear that one feels in such a threatening situation is an example of a prepotent emotion. Situations that block a person from achieving a goal, e.g., after depositing money, your snack gets stuck in a vending machine, elicit prepotent anger. Notably, depending on the situation, however, prepotent responses like fear or anger can be troublesome if they challenge or do not conform to family or cultural norms. For example, in the event of an imminent car collision it would be culturally inappropriate to collide with the other vehicle and

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then drive off immediately. Thus, it is important for persons to be able to regulate prepotent responses in accordance with social constraints and cultural norms.

To engage in *self-regulation* of prepotent responses, i.e., to not act on a prepotent response or to change it by reducing or resolving it, children must draw on their own resources. Infants can draw on some spontaneous, less effortful strategies such as gaze aversion, e.g., looking away when a stimulus increases state arousal beyond a comfortable point. However, effortful self-regulation requires engaging cognitive resources, i.e., recruiting intrinsic capacities that can serve to modulate prepotent responses. For example, in the situation of a sudden imminent car collision, an effortful self-regulation strategy could include checking the blind spot before swerving into another lane. The transition from acting on unmodulated prepotent responses to actively regulating them is marked by using executive cognitive processes (Hoffman et al., 2012; Miyake et al., 2000). In early childhood, this transition is marked by the emergence of top-down regulation involving cognitive resources that serve as executive processes rather than reliance on more automatic bottom-up regulation, such as infant gaze aversion, or on caregiver behavior (Bridgett et al., 2015; Eisenberg et al., 2013).

As noted, emotions can be prepotent responses. In early childhood, children may display negative emotions when their circumstances elicit prepotent anger and sadness, such as not receiving what they expected and wanted (Cole, 1986) or not being able to do what they want (Vaughn, Kopp, & Krakow, 1984; Ramsook et al., 2019). Both negative and positive emotions are adaptive, enabling humans to cope with a range of circumstances (Mandler, 1982). Recognizing this is crucial as it acknowledges that emotions offer their own set of benefits. However, prepotent negative emotions can lead to actions that are troublesome (Kopp, 1989). In early childhood, children learn to differentiate when emotions can and should not be expressed, including in situation involving common disappointments and frustrations (Saarni, 1998). Effortful self-regulation requires the use of strategies that can modulate—forestall, minimize, or resolve—prepotent emotional reactions (Cole et al., 2019).

Given the role of cognitive resources in serving as an executive influence on enacting prepotent responses, we propose an alternative approach to measuring self-regulation. As we discuss, rather than describe whether children engage in strategies or which strategies they appear able to initiate, we take a dimensional approach, assessing the extent to which any strategy draws on intrinsic cognitive resources. That is, building on work that suggests that specific strategies are useful in specific situations, we do not describe strategies but rate them on the extent to which cognitive resources are being utilized. Next, we discuss further the conceptualization and measurement of strategies,

Age Differences: Emotions and Strategies

The term strategy refers to the behaviors that young children enact, which have potential to influence their emotions (Grolnick et al., 1996). Ample evidence exists that young children engage in behaviors that are putative strategies, supporting Kopp's (1989) postulation that effortful self-regulation of negative emotions and distress first emerges in early childhood. To summarize her developmental framework, around the third to fourth year of life, children become able to draw on their developing internal resources, largely cognitive advances, to attempt to engage in effortful self-regulation. Those internal resources, coupled with learning through socialization experiences, enable them to attempt to self-regulate prepotent responses including prepotent emotions.

Negative emotions, particularly anger, frustration, and sadness, are imperative for adaptive coping (Mandler, 1982; Kopp, 1989). Children must integrate these experiences to continue to develop their self-regulation skills. Successful integration should result in a decrease in negative emotion reactivity with increasing age. Mechanisms that allow for this transition away from negative emotions vary between ages. The decline in emotional reactivity, particularly of negative emotions, is thought to be due to the increase in the capacity to engage in "regulatory" strategies.

So-called regulatory strategies develop with age over the course of the first five years of life (and beyond). Infants must rely primarily on their caregivers to regulate negative emotions; they have only a few self-regulatory strategies that occur automatically and are limited in effectiveness. Specifically, strategies such as thumb-sucking (Gunnar, 1986; Gunnar, Fisch, & Malone, 1984) and spontaneous gaze aversion are observed during infancy (Braungart & Stifter, 1991; Field, 1977; Fogel, 1982; Gianino & Tronick, 1988; Waters, Matas, & Sroufe, 1975).

As children transition into toddlerhood, they display what Kopp (1982) called self-control, the ability to alter their behavior when adults require it of them. Self-regulation, she posited, emerges around age 3 to 4 years, when children have more internal resources to engage to behave in ways that conform with social expectations and constraints. Kopp's (1982) view that infants engage simpler, more automatic, strategies and more complex, effortful strategies emerge as children reach the preschool age years, is largely accepted (Calkins should also be referenced here; Fox, 1989; Gianino & Tronick, 1988). Therefore, we predict that there should be age differences in children between the ages of 30 months and 60 months in the extent to which they engage cognitive resources in their behavior when coping with frustration

Negative emotions, and behaviors, have been observed to be related to developmental changes (Saarni, 1984; Liebermann et al., 2007). Distinctively, older children modulate the intensity of their emotions more successfully than younger children. This inverse correlation between emotion intensity and age is due to the variation in engagement of cognitive resources. We hypothesize that with increased age this correlation will strengthen because children with have more strategies to employ for self-regulation. This prediction is based on previous data that points to possible age-related changes in self-regulation (Kopp, 1989).

The Present Study

The significance of understanding more about how age relates to self-regulation in early childhood stems from societal expectations. When children begin kindergarten, it is expected that they are appropriately prepared to handle school demands. Self-regulation of basic frustrations is an important aspect of socioemotional school readiness. When these children are not able to manage ordinary frustrations, like not receiving something they want, it is often identified as problematic by teachers and parents. This study should reveal the average age at which children are able to manage frustration when their goal, to retrieve a toy, is thwarted and how much age variation there is in this skill.

In early childhood, effortful self-regulation, including self-regulation of emotion, first emerges as I mentioned earlier. This study seeks to test age differences in the extent to which young children engage internal cognitive resources to cope with frustration. There are three hypotheses: (1) children will be less angry during the Lock Box task as they age; specifically, the overall anger intensity during the task will be inversely associated with child age in months, (2) children's use of strategies that engage their internal cognitive resources will occur more

frequently with age, and (3) the more frequently children use higher order strategies, the less frequently they will express frustration.

Methods

Participants

Participants in this cross-sectional study of how emotion regulation develops across early childhood (Dynamics of Self-Regulation Study; Cole et al., 2019) were 154 children (49.1% female) age 30 to 60 months (M_{Age} = 44.73, SD_{Age} = 8.24) and their caregiver(s). Families recruited from communities in central Pennsylvania had on average, annual income of $89,665 ($SD_{Income}$ = $50,210). The children mostly resided in two-parent homes (89.9%) and were described by their parents as White (94.3%), Asian (2.5%), Black (1.3%), and Native American (0.6%). The parents mostly had at least some college education (83.35%) and described themselves as working full-time (65.4%), working part-time (11.95%), working, and attending school (1.85%), attending school full or part-time (1.6%), or unemployed (13.8%).

Both caregivers (mother and father in most cases) were encouraged to participate in the study visit. While baseline questionnaires were completed by both parents in XX% of families, only 64.8% of study visits were attended by both parents, 34.6% were attended by mothers only, and 0.6% were attended by fathers only.

Procedures

The RA asked the child to choose a toy they would like to take home. The options included small toys such as cars, animals, Disney characters, and Care Bears. The RA then put the chosen toy inside a transparent box with a padlock, locked the box, and instructed the child how to open the box using a key. After giving the child the opportunity to unlock the box on their own (which ensured that they understood the instructions), the RA locked the box again, and told the child that she needed to leave to do some other work. Before leaving the room, the RA said, "Okay great, I will be back in a little bit. Now you can open the box and get [name of toy]. Remember, you have to open the box to get [name of toy]. I'll be right back." and handed the child the key ring, which unbeknownst to the child had been swapped with keys that would not unlock the box. The child was left alone to try to open the box for 2 minutes. Then, the RA returned, commenting on the fact that the box had not been opened yet. told the child to keep trying, and left for another 2 minutes. The RA entered the room again, commented that the box had still not been opened, and gave the child a different wrong key to try, and left again. After an additional 2 minutes, the RA returned to the room and asked the child, "Did you open the box? Why couldn't you?" before giving the child the correct key and explaining that she must have accidentally given them the wrong key before. She then helped the child use the correct key to open the box and retrieve the desired toy. Children's behaviors were videotaped throughout the task.

Results

This study focused on three hypotheses. The first two hypotheses predicted that (1) the intensity and dominance of frustration—i.e., anger and sadness—would decline with age and (2) the extent of engagement of cognitive resources would increase with age. Third, we predicted that as the engagement of cognitive resources increased, frustration intensity and dominance would decrease, and that this association would be moderated by age, specifically strengthened with age.

To test these hypotheses, we used bivariate correlations and partial correlations to test the moderation hypothesis. The results yielded some support for the hypotheses, revealed significant relations that were not predicted, and did not support other predictions.

Descriptive statistics for all study variables are presented in Table 1. In general, the preschool age children in this sample expressed relatively low levels of anger and sadness and did not express high levels of frustration (e.g., tantrums) during the Lock Box task, although across the children the full range (0-200) was observed in most segments. Similarly, the children in general did not engage in high levels of cognitive resources in coping with the locked box, although again the full range of scores (0-4) was used. The skew and kurtosis statistics indicate that the distributions were not normal and so the hypotheses were tested with Spearman *rho* bivariate correlations.

Table 1. Means, Standard Deviations, and Ranges for Main Study Variables

1a. Age, Negative Emotion Intensity, and Strategy Level

	M (SD)	Range
Age in months	44.99 (08.24)	29.7-60.3
Anger Expressions per Segment		
1	6.57 (08.06)	.00-149.65
2	8.40 (11.67)	.00-162.05
3	7.25 (12.88)	.00-200.00
Sadness Expressions per Segment		
1	17.79 (24.41)	.00-200.00
2	35.72 (34.53)	.00-200.00
3	39.01 (33.10)	.00-200.00
Strategy Rating per Segment		
1	1.82 (0.20)	0-4
2	1.93 (0.20)	0-4
3	1.93 (0.22)	0-4

1b. Emotion Dominance

	M (SD)	Range
Anger Expressions per Segment		
1	.194 (.209)	.00-0.808
2	.215 (.259)	.00-1.000
3	.176 (.236)	.00-0.966
Sadness Expressions per Segment		
1	.278 (.279)	.00-1.000
2	.507 (.336)	.00-1.000
3	.550 (.313)	.00-1.000

Frustration intensity and dominance and child age. As seen in Table 2, Spearman bivariate correlations present a mixed picture in terms of the hypothesis that frustration intensity and dominance decrease as child age increases. Seven of the 12 correlations between age and emotion intensity or dominance reached significance. However, only one of the seven significant correlations was in the predicted direction.

First, contrary to prediction, anger increased in intensity and dominance as child age increased. Specifically, there is small but significant associations between child age and anger intensity and dominance in Segment 1 and these appear to get somewhat stronger in Segments 2 and 3. In contrast, only one of the 6 correlations between age and sadness reached significance. A small but significant inverse association emerged for child age and sadness intensity but only in Segment 3. Although this association is consistent with the hypothesis, one must consider that this could have occurred by chance given the number of correlations conducted.

Extent of cognitive resources engaged and child age. Table 2 also reveals that, contrary to prediction, Spearman bivariate correlations yielded no support for the hypothesis that older children would engage more cognitive resources when coping with the Transparent Locked Box procedure. There are two correlations that approach significance – in Segments 1 and 2 – however, the direction of the relation changes between these two segments.

Table 2. Spearman correlations for age with negative emotion intensity and dominance and with strategy level

Lock Box Segment	1	2	3
N	154	154	153
Age * Anger			
Intensity	**.147**	**.267**	**.253**
p	.035	.001	.001
Dominance	**.179**	**.275**	**.253**
p	.013	.001	.001
Age * Sadness			
Intensity	-.013	-.094	**-.146**
p	.322	.123	.037
Dominance	-.038	-.112	-.131
p	.053	.084	.322
Age * Strategy Level			
Intensity	-.118	.122	.096
p	.073	.067	.119

Note. One child is excluded from segment 3 because the child was so distressed the segment was terminated. Correlations that were significant at $p < .05$ are bolded.

Relation between frustration intensity and dominance and extent of engagement of cognitive resources in strategy use and moderation by age. Table 3 provides the Spearman bivariate correlations testing relations between the extent of engagement of cognitive resources, i.e., strategy level, and anger and sadness intensity and dominance. The results support the hypothesis that strategy use that engaged more cognitive resources is associated with less

frustration but only for sadness, both in terms of intensity and dominance. Contrary to prediction, the more intense and dominant children's anger, the more children engaged cognitive resources in their coping with the Locked Box.

Finally, we predicted that age may strengthen the relation between increased engagement of cognitive resources in strategy use and decreased frustration. Table 3 provides both bivariate and partial correlations, which treat age a third variable, between the extent of cognitive resources and negative emotions. The results support the hypothesis that increased engagement of cognitive resources in strategy use decreases sadness, but only in terms of intensity and not dominance.

Table 3. Correlations for strategy level by frustration intensity and dominance for each task segment

	Child Strategy Rating Across Lock Box Segments		
Lock Box Segment	1	2	3
Anger (Spearman bivariate)			
Intensity	**.268**	**.352**	**.135**
p	.001	.001	.048
Dominance	**.240**	**.365**	**.158**
p	.001	.001	.026
Anger (Partial)			
Intensity	**.253**	**.191**	.071
p	.001	.009	.193
Dominance	.067	**.190**	.054
p	.205	.010	.254
Sadness (Spearman bivariate)			
Intensity	**-.275**	**-.411**	**-.316**
p	.001	.001	.001
Dominance	**-.248**	**-.377**	**-.331**
p	.001	.001	.001
Sadness (Partial)			
Intensity	**-.527**	**-.428**	**-.378**
p	.001	.001	.001
Dominance	-.007	-.114	**-.177**
p	.468	.082	.015

Note. One child is excluded from segment 3 due to extreme anger intensity. Correlations that were significant at $p < .05$ are bolded.

Discussion

This study is among the first to test the hypothesis that there are age-related differences in the association between young children's frustration and the extent to which their self-regulation strategies engage cognitive resources. We were guided by Kopp's (1982) framework, which states that in addition to socialization and learning (external resources), the emergence of self-regulation also depends on children's internal resources, i.e., cognitive advances that they can draw on to engage in autonomous self-regulation of their emotions and actions. This led us to predict that age would be associated with a decline in the intensity and dominance of frustration, with an increase in the engagement of cognitive resources, and with an inverse relation between frustration and engagement of cognitive resources. Some predictions were supported, some were not, and some were unexpected.

First, the prediction that frustration about not being able to unlock a box that contained a chosen toy would decline with age, during the period between 30 and 60 months, was partially supported. Specifically, children's sadness intensity increased as child age decreased, but only during the end of the task and the association was of small magnitude. Contrary to prediction, anger – both in terms of intensity and dominance – increased with child age. These results are also consistent with Tan and Smith's (2018) study using the same procedure. They postulated and found that problem solving skills were related to increased anger rather than increased sadness. That is to say that increased anger supports persistence, or maintains effort, to reach a goal. This is also consistent with the theoretical view that the function of anger is to increase effort to achieve a goal (Barrett & Campos, 1987), which has been shown in other studies of preschool age children (Dennis et al., 2009).

Their study also supports age related differences in relation to child sadness. Namely, decreased child sadness was found to be significantly correlated with increased child age.

Second, the prediction that engagement of cognitive resources increases with age was not supported. Contrary to our predictions, strategy level and age showed no support for the prediction that older children would engage in higher order strategy use with the Transparent Locked Box procedure. A consistent pattern also did not appear, as the direction of the relations changed across segments.

Third, as predicted, the more children were able to engage their cognitive resources in how they strategized to open the locked box, they were less sad. Both the intensity of sadness and its dominance in each segment decreased as children engaged cognitive resources, although the effects for sadness dominance diminished when age was entered as a control variable.

However, anger intensity and dominance increased as the engagement of cognitive resources increased, contrary to prediction. When age was added as a control variable, these associations were largely unchanged. Comparable relations between anger and age have been found in a few other studies (Ramsook et al., 2019; Tan & Smith, 2018; Dennis et al., 2009). For example, at age 4 but not age 3 low intensity anger expressions predict task persistence (Ramsook et al., 2019). The expected inverse relation between anger intensity and/or dominance and the sophistication of young children's strategy use may be specific to more intense, enduring angry episodes. The task used in the present study, the Transparent Locked Box, may only elicit lower intensity anger, which then appears as a determined effort to open the box. Low intensity anger may be identified as a brow furrow or lips pressed together while higher intensity anger could be a screaming outburst.

Limitations and Future Directions

Our study included two main limitations that restricted the generalizability of our results. First, the present study was a single short lab observation that solely relied on the Transparent Lock Box procedure. Children were told to try to open the box to achieve a goal, i.e., retrieve a toy they had selected to keep. This task differs from other studies of self-regulation in which children must wait for something they want. Whether the same relations would emerge for those tasks remains to be determined. Future studies could focus on analyzing several different tasks to investigate the generalizability of the functional value of lower intensity anger.

Secondly, our study investigated age differences using a between person cross-sectional design, comparing younger and older children. A more powerful test of a developmental hypothesis that lower intensity anger becomes functional, at least in certain types of tasks, over the course of early childhood requires a within person longitudinal design. To our knowledge there are few direct tests of the association between children's frustration and the degree to which their strategies engage cognitive resources in delay tasks with a parent present (Ravindran et al., 2021) and none using a task like the Lock Box task where a child is alone. Finally, the sample was not representative of all young children in the U.S. and extending the study to different samples and considering the relevance of the questions and methods for children from different backgrounds is needed for a full documentation of the development of self-regulation in early childhood.

As part of future studies, replication of standardized protocols should be implemented. For example, the present study did this by using three specified two-minute perturbations during the Transparent Lock Box Task. The re-presentation of the stimulus problem reminds children of the task demands, a method for circumventing the potential for the task demands to change in children's minds as time passes.

Conclusion

First and foremost, our findings highlight the importance of examining how age moderate's anger. Few studies have investigated how the beneficial aspects of negative emotions impact various aspects of child development including self-regulation. Mainly because societal expectations inhibit a perspective in which negative emotions can be seen as acceptable to an extent. The current study also demonstrates that strategy use, and negative emotions have relationships that impact the degree of self-regulation. Future studies should continue to explore the magnitude of these relationships as well as their implications on child development as a whole.

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Ethical Analysis of Emergency Allocation Protocols and Their Impact on Vulnerable Populations

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Abstract

In this article, I will use conceptual analysis to examine theoretical frameworks in ethical scholarly works on resource allocation in healthcare crises such as the COVID-19 pandemic, namely utilitarian, egalitarian, and justice theories. By centering on the key concepts in these ethical frameworks (i.e., equality, greatest happiness, justice), I will submit to criticism current allocation methods such as the Sequential Organ Failure Assessment (SOFA) score. Specifically, I will explore the limitations of these methods concerning their failure to consider vulnerable populations, in particular African Americans. To conclude, by focusing on this population group, I will identify ethical principles that healthcare providers must consider in designing ethical allocation methods. **Keywords:** pandemic ethics, utilitarianism, resource allocation, egalitarianism, justice.

Introduction: Resource Allocation in Healthcare Emergency Situations

Resource allocation is crucial in a healthcare emergency where the demand for resources is greater than the available supply of resources. Despite numerous past healthcare emergencies, such as the influenza pandemic of 1918, healthcare providers in the United States lack a standardized protocol for fair and ethical resource allocation (Antommaria et al., 2020; Tabery & Mackett, 2008). Many studies have proposed different ideas for distributing scarce resources in an emergency, such as a triage review board, utilitarian-based triage, and egalitarian-based triage (Baker & Strosberg, 1992; Geale, 2012; Tabery and Mackett, 2008). However, these proposed solutions have various shortcomings. Among them is the failure to account for vulnerable populations, which become more at-risk during emergency situations due to lack of jobs, healthcare, and basic resources. Indeed, by failing to account for such populations, current allocation methods may exacerbate health disparities (Elbaum, 2020). To analyze this problem, I center here on African American individuals and communities, investigating ways in which they are at risk in health emergencies such as the COVID-19 pandemic and identifying ethically relevant aspects that healthcare providers must take into account to develop ethical resource allocation methods.

Demographic data shows that African Americans are overrepresented in coronavirus cases, deaths, or both (Elbaum, 2020). Numerous factors contribute to these statistics, including, but not limited to, systematic injustices, the high percentage of essential workers coming from African American communities, and the utilization of utilitarian resource allocation methods (Elbaum, 2020). For example, systematic injustices negatively affect African American communities' socioeconomic status, increasing their risk for chronic conditions and earlier death compared to their white counterparts (Elbaum, 2020). The preexisting chronic conditions that disproportionally affect African Americans make this population less likely to receive scarce resources under many current allocation methods used across the nation. In addition to being less likely to receive lifesaving resources, individuals in this population group are at a higher risk of contracting the virus due to their working "essential" jobs (i.e., any employment that remains open during the pandemic for in-person services) (Elbaum, 2020). The disproportionate number of African American "essential" workers have to choose between providing for their family or being protected from the virus (Elbaum, 2020). Thus, social justice advocates and public health experts argue that resource allocation methods must account for the differences between African American individuals and members of privileged population groups. They also must consider a resource allocation plan that prevents widening health disparities gaps in inevitable future global and national emergencies to come (Elbaum, 2020).

Over 50% of hospitals in the U.S. reported not having a triage policy, which has numerous negative consequences (Antommaria et al., 2020). Allocation protocols are crucial to respond to a healthcare emergency successfully. Even if manufacturers could eventually produce all needed lifesaving supplies (e.g., ventilators, personal protective equipment), this will take time, making allocation necessary until sufficient resources become available. Also, protocols relieve healthcare professionals of the tough decisions and psychological burden that accompany deciding which patients should receive lifesaving resources when the demand for these resources is much greater than the supply (Emmanuel et. al, 2020). Beyond the psychological burden that the lack of protocols places on medical professionals, the absence of objective and fair standardized allocation methods will likely exacerbate health disparities, for medical professionals' bias may affect allocation decisions. Additionally, many individuals from vulnerable communities lack trust in healthcare policies and professions (Vergano & Goba, 2020). One way to rebuild the trust that these individuals place in the healthcare system is to create transparent protocols that account for systematic injustice and disadvantage and fairly distribute scarce resources. [1]

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[1] Beyond finding a fair and ethical protocol to allocate resources, there needs to also be a protocol for taking resources away from a patient. Little has been done to determine when individuals should be removed from a ventilator, ICU bed, or other life-saving supplies. After extensive review of who should receive resources, it is also important to consider when to stop giving a person resources or remove an individual from a ventilator. One algorithm "suggest that we leave the question of whether and when to remove people from ventilators to [these] health care professionals" (Brambel, 2020, p. 113). It is illogical to follow a detailed allocation method and have no protocol to follow regarding decisions to remove someone from a ventilator, which is just as harder, if not harder, than deciding who should receive scarce resources in the first place. Many hospitals and healthcare facilities are for-profit businesses leaving room for unethical allocation decisions that may have ulterior monetary motives to be made when removing patients from resources if no protocol is put into place. This is something that should be addressed in future proposed allocation methods.

In this article, I proceed as follows. I first offer a definition of triage and analyze triage methods used in past emergency situations where the demand for resources was greater than the available supply of resources. Then, I identify three allocation frameworks that draw on ethical principles, namely utilitarian, egalitarian, and justice-based frameworks. Lastly, I examine limitations of each framework to highlight what to consider when designing a standardized allocation method for resource distribution during a healthcare crisis.

Triage in healthcare emergency

In the case of a healthcare emergency, numerous patients will need care simultaneously, which results in higher demands for resources than available. The lack of available resources forces healthcare professionals to triage. Triage is a means of allocation used to sort patients according to the urgency of their need for care (Geale, 2012). This allocation method prioritizes patients with less severe cases to free up resources quicker and attend patients with more severe cases who require care for a longer period. Under existing triage allocation methods, patients with more severe cases receive care last, if they do at all (Geale, 2012). Emergency triage and day-to-day triage (i.e., under non-emergency circumstances within a healthcare setting) significantly differ because the number of victims that need care increases drastically (Geale, 2012). In day-to-day triage, the sickest victims have priority to treatment and lifesaving supplies even if the likelihood of survival is low because fewer victims need care. This contrasts with emergency triage that prioritizes victims who receive treatment quickly to enable healthcare providers to treat more people (Geale, 2012).

Unforeseen emergencies are commonplace in U.S. history. The influenza pandemic of 1918 in Pittsburgh, at its peak, had roughly one new flu-related case every 90 seconds and one flu-related death every ten minutes (Tabery and Mackett, 2008, p. 114). Other influenza pandemics such as the A(H3N2) in 1968 and A(H2N2) in 1957 have also had significant public health implications (Tabery and Mackett, 2008, p. 114). During these emergencies, healthcare providers and experts implemented the Sequential Organ Failure Assessment (SOFA) score to triage scarce resources (Khan, Hulme, & Sherwood, 2009). SOFA scores are determined based on a patient's age, sex, premorbid conditions, presenting symptoms, organ system support, ventilated days, length of stay in intensive care unit, and mortality (Khan et al., 2009). Individuals with higher SOFA scores are considered worse off than individuals with lower SOFA scores, and these scores, in combination with medical judgment, guide resource distribution decisions (Khan et al., 2009).

Healthcare providers often justify using SOFA scores on utilitarian grounds, arguing that the scores produce maximum benefit for the greatest number of people when resources are limited (Khan, Hulme, & Sherwood, 2009). However, the SOFA method is not inherently utilitarian and can be applied in different ways aligned with other ethical principles. For example, if healthcare practitioners use the SOFA score to determine their patients' condition and prioritize the worst-off patients, they draw on egalitarian principles by not focusing on the greater good of all individuals but rather on individuals' needs. Similarly, if they use the score to give patients with equal scores access to the same resources, while patients with unequal scores receive different resources, they apply a justice-based approach to triage. In this case, individuals who are "equal" are treated equally by getting access to the same resources, and individuals who are unequal (have relevant differences such as differences in health) are treated unequally by getting access to different

resources. In sum, the SOFA score is simply a tool that healthcare providers can incorporate into their allocation methods.

Using the SOFA score to triage has shortcomings, including its limited practical reliability and success. Little evidence supports the "predictive validity" (e.g., the ability of the score to accurately predict the health and who would benefit the most from resources) of the score (McGuire et al., 2020). Although the score offers guidance when the scores among patients differ significantly, it provides limited information on how to allocate resources when patients have similar scores. Additionally, medical professionals must use the SOFA score in conjunction with clinical judgment, which opens the door for potential bias in allocation decisions (McGuire et al., 2020). This may widen existing health disparity gaps. In addition, the score can contribute to widening such gaps by failing to account for individuals who are disproportionately impacted by comorbid conditions and are at greater risk of dying during a health crisis. These shortcomings demonstrate the need to include ethical principles into triage (Khan et al., 2009; McGuire et al., 2020; Rubinson, Knebel, & Hick, 2010).

To address these shortcomings, the UPMC Triage Board proposed a triage review board (TRB), that is, a decision-making panel led by medical professionals and prominent community members such as chief medical officers, physicians, legal representatives, and business leaders.[2] The panel would not oversee every allocation decision but rather serve as an aid to track levels of scarce resources and provide communication between frontline staff and administration (Tabery and Mackett, 2008). The TRB would meet before, during, and after a pandemic. Pre-emergency meetings help the board better prepare hospitals and healthcare providers for unforeseen emergencies by addressing complaints and errors observed in past emergencies, continuously considering community feedback and overseeing triage processes (Tabery and Mackett, 2008). Post-emergency meetings allow the board to evaluate areas that need improvement and continuously find better ways to handle a crisis situation where scarce resources are in high demand. Another benefit of the TRB protocol is that it incorporates individuals from various disciplines, such as medicine, law, and business, bringing together the many dimensions that interact during healthcare emergencies or crises.

Despite the potential benefits of the TRB proposal, this allocation method encounters limitations. First, the panel could be biased if composed of primarily medical professionals and prominent community members, which poses the risk that financial and political agendas may affect medical decisions. Second, because the panel cannot and does not intend to oversee every individual allocation decision, individual physicians and medical professionals lack a protocol to guide deliberation (Tabery and Mackett, 2008). Leaving allocation decisions up to individual healthcare providers places the burden of making tough choices regarding which patients should receive scarce lifesaving supplies from medical professionals. Third, by only having prominent community representatives and medical professionals on the TRB, individuals from low-income

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[2] "[A] chief medical officer or vice president for medical affairs, a critical care physician, an emergency medical physician, an ethicist, a family care physician, an infectious control nurse, an infectious disease physician, a legal representative, public representatives (e.g., clergy, business leaders, representatives of underserved or vulnerable populations), a nurse administrator, a palliative care physician, and a pediatrician." (Tabery and Mackett, 2008, p. 117)

African American communities, who are often most affected during a healthcare crisis, may not have a voice within it, failing to be considered during resource distribution. Fourth, the TBR may be less likely to give resources to members from the communities above because of the presence of preexisting conditions, among other reasons, which could potentially exacerbate health disparities. The implementation of a TRB is a step forward. However, it must be used in conjunction with ethical principles that guide allocation decisions and help account for all morally relevant aspects.

Utilitarian Resource Allocation Methods

Bioethicists and public health experts who advocate for the inclusion of ethical principles in triage split into two sides, namely utilitarian and egalitarian (Geale, 2012). The former argue that triage should seek to produce the greatest amount of good for the largest number of people, for instance, by freeing up limited resources as quickly as possible (Baker & Strosberg, 1992). This method was favored during the World Wars. The quicker soldiers were treated, the sooner they could return to the battlefield (Geale, 2012). Beyond its use in warfare contexts, emergency triage for the general public may also be utilitarian. In the case of an emergency where resources are limited, a patient who requires a large number of resources may take resources from numerous patients who could be treated quicker. While this could save the more ill individual, it could also disadvantage the many less ill patients who can free up resources more quickly (Geale, 2012). Because triage is only required when the supply of resources does meet the demand, giving resources to one individual instead of many disadvantages a large number of people, which is why many accept the idea that emergency triage is inherently utilitarian (Geale, 2012).

Although utilitarianism has a positive goal of maximizing good, this means of triage has its limitations. First, nothing guarantees that one patient may use a resource for less time than another patient. For example, if a patient arrives at the hospital and appears relatively healthy, doctors may treat this patient first under the assumption that resources will be available again soon. However, doctors can hardly know how fast patients will recover. Take the following example. When a new strand of a virus, such as the coronavirus, first emerges, healthcare professionals know little to nothing about how contagious the virus is, what course of infection the virus causes, which ways can best prevent transmission of the virus, etc. This lack of knowledge makes it hard to determine what patients will free up limited resources the quickest. Additionally, healthcare providers can hardly predict who has the greatest chance of survival and who will produce the greatest amount of good for the greatest number of people. Take the case of two kids who contract coronavirus, one Caucasian from a family of high socioeconomic status and the other African American from a family with low socioeconomic status. From a utilitarian standpoint, the kid who will produce the greatest amount of good should receive the lifesaving supplies. The Caucasian child who has a plethora of resources available and parents with successful careers allegedly has the means to produce greater good than the African American child whose parents live paycheck to paycheck. However, nothing guarantees that this will be the case. Healthcare providers who encounter situations similar to this would be unable to ethically and objectively determine who should receive access to limited lifesaving supplies because they cannot foresee all possible future consequences. Moreover, this absence of knowledge about possible consequences opens the door for biased healthcare decisions that may disproportionally affect vulnerable populations. Basing resource allocation decisions on a prediction raises concerns regarding personal bias. Leaving these decisions to healthcare providers' "best predictive abilities" could significantly impact the

frequency that individuals from vulnerable populations, specifically African American individuals and communities, receive the scarce, potentially lifesaving, resources they need.

Egalitarian Resource Allocation Methods

Despite having limitations, many scholars still defend the utilitarian triage method as the best way to allocate resources in healthcare emergencies (Geale, 2012). However, Surgeon General Dr. Larrey challenged utilitarian triage methods and implemented a different method rooted in egalitarian ethical principles, which require that everyone in a society is treated equally (Baker & Strosberg, 1992). One way healthcare providers have applied this method is by prioritizing individuals who most need medical attention (e.g., those in the worst health condition) and postponing treating those with less severe injuries, regardless of their military rank or status (Baker & Strosberg, 1992). For example, an individual who is enlisted and a general will both be judged solely on their health condition and treated equally regardless of their rank. By requiring that all individuals are treated equally based on the severity of their health condition, egalitarian-based allocation methods overcome the limitation of their utilitarian counterparts concerning the effect of bias in clinical judgment. Furthermore, this egalitarian approach to triage eliminates the need to predict which patient will benefit the most if given access to scarce resources. Deciding who, between two patients, should receive scarce resources can place unfathomable burdens on healthcare providers, especially when faced with hard consequences such as patient death. By prioritizing the worst-off, healthcare providers will no longer face tough decisions related to the lack of grounds to evaluate which patients should receive care.

Egalitarianism also encounters limitations. Suppose the worst-off individuals always receive the resources they need. In this case, these individuals may still not survive due to their condition, and better-off individuals may also die because of the unavailability of lifesaving resources. (Baker & Strosberg, 1992). Another limitation of egalitarian's emphasis on treating all patients equally is the failure to consider that individuals in vulnerable communities have different needs (e.g., fewer opportunities to access healthcare) that may make them deserving of differential treatment. For example, if a Caucasian individual gets very ill due to coronavirus, this individual may seek medical attention immediately, be accepted into a hospital, and receive resources right away due to their severe condition. Suppose the hospital only has six ventilators, and all six are taken up by individuals who have good access to healthcare through health insurance. If individuals from vulnerable communities fall sick to the coronavirus, and are in similar condition as the individuals occupying the six ventilators in the hospital, the former will be unable to receive treatment because of their inability to access healthcare resources as quickly as their more privileged counterparts.

Multidimensional Allocation Methods

Given the limitations of utilitarian and egalitarian triage methods, building an allocation protocol entirely upon one of those ethical frameworks is problematic. Combining these two types of ethical principles enables healthcare providers to capitalize on the strengths of each principle while reducing the negative effects resulting from their shortcomings. Multidimensional methods may "strive to incorporate and balance saving the most lives, saving the most life-years, and giving individuals equal opportunity to live through life's stages." (White, Katz, Luce, & Lo, 2009, p.135)

Saving the most lives and saving the most life years are the utilitarian aspect of this multidimensional approach, which seeks to produce the greatest amount of good by trying to provide the largest benefit (e.g., saving the most life years) for the highest amount of people (e.g., saving the most lives). Giving individuals an equal opportunity to live through life stages, is the egalitarian aspect of this multidimensional approach, which seeks to provide all individuals, regardless of external factors (e.g., social class, ethnicity, etc.), equal opportunities.

A multidimensional approach better accounts for the complexity of situations considered in lifesaving allocation processes. For example, from a utilitarian perspective, a young man with preexisting conditions who gets very ill from the coronavirus should receive care last due to the severity of his symptoms and because he could occupy resources for a long period of time. By using resources for an extended period, others with less severe symptoms could not benefit from these resources, which from a utilitarian perspective fails to produce the greatest amount of good. In contrast, using egalitarian ethical principles, this same patient may receive treatment first because he is in greater need of the resources than others and deserves an equal opportunity to these resources despite the severity of his symptoms. A combined approach, such as the one mentioned above, would consider the age of the man to determine how many life years would be saved if he survives, the severity of his symptoms and his overall likelihood to survive if given the proper resources, and his right to the opportunity to go through all life stages. While this combines the utilitarian and egalitarian principles and attempts to draw on the beneficial aspects of each, multidimensional approaches may not be practical or useful for healthcare professionals.

Utilitarian and egalitarian ethical principles have different goals. Thus, combining them into one multidimensional approach might undermine healthcare professionals' ability to achieve the goals from each ethical framework. For example, if there are four 60-year-old patients and two 6-year-old patients, but the former patients are experiencing less severe symptoms than the latter, it may be impossible to save the most lives, the most life years, and provide an equal opportunity of living through life stages simultaneously. This means that healthcare professionals will be left to decide what matters most (lives, life years, or life stages). Additionally, multidimensional frameworks that combine utilitarian and egalitarian principles fail to account for vulnerable populations. By having goals such as saving the most lives and the most life years, such populations, who are disproportionally affected by comorbid conditions, may not receive lifesaving resources, despite the goal of providing equal opportunity to live through all life stages.

Justice-Based Allocation Methods

In addition to utilitarian and egalitarian ethical principles, justice is another ethical principle to allocate resources in healthcare emergencies. Justice requires that people be treated equally unless there are morally relevant difference between them. (Miller, 2017) This principle helps to account for systematic injustices and targets disadvantaged communities in a time of crisis. Systematic injustices throughout history have lasting impacts still prevalent today. These impacts are morally relevant grounds for developing allocation protocols that provide additional support for individuals from these specific communities. One approach to justice is that of Rawls, which establishes two sets of principles to allocate "primary social goods" (i.e., liberty, opportunity, income, and wealth). First, the principle of equal liberties states that everyone is entitled to the same basic liberties. Second, the principle of fair equality of opportunity and the

difference principle states that "social and economic inequalities are to satisfy two conditions: 1. they are to be attached to offices and positions open to all under conditions of fair equality of opportunity, 2. they are to be to the greatest benefit of the least advantaged members of society." (Rawls, 2001, pp. 42–43)

Rawls theory's method of allocating resources uses a top-down approach to justice by providing a set of principles to be used across all specific resource allocation situations. This is why commentators such as Madison Powers and Ruth Faden (2006) refer to the theory as "ideal." While Rawls' theory may provide insight on justice and guide allocation decisions in certain situations, his theory fails to consider the complexity of applying justice in a situation, such as the COVID-19 pandemic, where multiple disciplines and policies have combined effects and impact one another. Non-ideal theories of justice consider these complexities and emphasize how inequalities interact and affect one another in real-world situations. The non-ideal theory of justice uses a bottom-up approach to justice by looking at the specific conditions of communities and individuals that need care, considering numerous relevant, concrete factors to guide allocation decisions fairly. For instance, Powers and Faden (2006) highlight that "social institutions, practices, and policies" can impact justice independently and in combination (p. 5). When social injustices and inequalities from multiple dimensions such as economics, law, access to resources, and geographical location combine, they can have a greater impact on an individual or situation cumulatively than they may have had alone.

African Americans, as well as other vulnerable populations, often are subjected to numerous disadvantages that together impact their wellbeing. For example, if an African American woman is working an essential job, has low socioeconomic status, and has children, all of these factors affect one another. By working an essential job, she cannot stay home and quarantine to decrease her risk of contracting the coronavirus. Her low socioeconomic status interferes with her access to healthcare, healthy food options, and the ability to work remotely or take a leave from work. Lastly, she has also to support her children, which can increase stress especially due to her financial situation. This example illustrates why it is important to evaluate justice holistically, considering how different factors influence one another. Allocation protocols must consider this cumulative impact of disadvantage, seeking to address the effects of disadvantage as experienced by individuals from vulnerable populations and provide support or compensation to these groups to prevent existing disparities from becoming significantly exacerbated during health emergencies (Faden & Powers, 2011; Marks, 2020).

In response to the coronavirus pandemic, Bramble (2020) proposes a multidimensional approach to distributing resources that uses a point system to respond to some of the limitations discussed above. This proposed allocation protocol first assigns patients points based on expected years remaining for a particular age group. For example, "for each expected year remain in their 20s, a patient receives 30 points" and "for each expected year remaining in their 30s, a patient receives 15 points", and so forth (Bramble, 2020, p.102). This drastic point value difference between years remaining in a patient's 20s compared to years remaining in a patient's 30s is justified because "it is a much bigger harm to miss out on your 20s than your 30s, to miss out on your 30's than your 40s." (Bramble, 2020, p. 103) This allocation method also assigns extra points to essential workers. Emergency doctors and nurses could receive an extra 100 points each, and other essential workers (e.g., bus drivers, food workers, cleaners, etc.) could receive an additional

50 points each. This method also assigns extra points to individuals with children and/or lower socioeconomic status. The last factor that contributes to a patient's score is the "chance of survival and expected length of treatment" (Bramble, 2020, p. 111). If a patient is half as likely to survive than "the average patient" due to having other health conditions, their score should be halved.

This allocation protocol algorithm does not explicitly reference justice. Yet, it draws on many aspects of the ethical principle of justice. By assigning different points to account for many of the individual differences among people, it treats people unequally based on morally relevant differences. For example, an essential worker who has a child and is of low socioeconomic status will receive a different score and, thus, different resources from a wealthy individual with no children and a higher socioeconomic status. This resource allocation method incorporates aspects of the "ideal theory of justice" by considering each criterion independently. For instance, it assigns different point values for things such as being a healthcare professional, having children, having a certain socioeconomic status, but does not necessarily consider the interaction of numerous factors like the "non-ideal theory" would. The non-ideal theory would likely have a "combo package" where, if patients have three or more disadvantages, they may get extra points to account for the greater negative impact of experiencing multiple disadvantages simultaneously, and how these disadvantages interact with one another, than experiencing just one disadvantage at a time.

The algorithm above has drawbacks though it allows for objective resource allocation and considers socioeconomic status, essential workers, etc., often failed to be addressed in many other protocols. First, the algorithm assumes that individuals value younger years more than older years. However, this fails to consider that many individuals spend their 20s and 30s working in hopes of retiring and living the best years of their life when they are older and more financially stable. Individuals from less affluent communities often spend younger working in hopes of financial freedom in the future. This is why an algorithm guiding resource distribution cannot draw on the idea that younger years are more valuable. This is just one example of a real-world situation that ideal principles of justice fail to capture. Additionally, being younger is not a sheer guarantee that one has more years to live in itself. For example, an individual in their 20s could get a chronic illness or get into an accident. Because of these uncertainties about what years individuals value the most or what could happen in the future, scores for individuals in different age categories should not differ drastically. Secondly, this protocol gives doctors and nurses an extra 100 points, but only 50 points to other essential workers. This algorithm does not clearly define what jobs/careers are considered essential. It also fails to consider that doctors and nurses would be unable to do their job without manufacturing company workers to continue making supplies and truck drivers or pilots to transport these supplies. The roles essential workers perform are highly important and provide grounds for them to receive more than half of the points that doctors and nurses receive. This algorithm does assign extra points to socioeconomically disadvantaged individuals. Specifically, it gives 12 extra points to African Americans. Yet, these 12 extra points will still not provide many African Americans from disadvantaged and underrepresented communities a fair shot at receiving resources. Their score may be impacted by shorter life expectancy resulting from conditions and diseases that disproportionally affect these communities. Lastly, this algorithm alters the patients' score based on their chance of survival and can go as far as cutting the score in half. African American communities are disproportionally affected by various conditions, that alongside COVID-19, could have significant impacts on perceived chance of survival, resulting in individuals from certain communities disproportionally getting their score

reduced. This shortcoming was also seen in SOFA score triage, and must be addressed by future allocation protocols.

The impact of trust on allocation method implementation

Even if an ideal allocation protocol that considers vulnerable individuals and communities is found, lack of trust in the healthcare system could significantly impact the success of implementing the protocol. In the COVID-19 pandemic, African Americans are contracting and dying of coronavirus in percentages greater than their demographic percentage. For example, in Washington, DC, only 46% of the population is black, yet black people account for 80% of the coronavirus cases (Vergano & Goba, 2020). These statistics could be related to African American's mistrust in the healthcare system because this population may be less likely to follow health recommendations (e.g., wearing a mask, social distancing), putting them at an increased risk for exposure to coronavirus (Vergano & Goba, 2020). This lack of trust is the result of the historical past of medical racism that persists until today. African Americans are continuously let down by medical professionals, which is seen in the Tuskegee experiment, the performance of cruel surgical experiments, and medical racism (e.g., physicians assuming African Americans experience less pain) (Vergano & Goba, 2020). Even if the majority of healthcare professionals do not mistreat or discriminate against African Americans, just one instance of subpar treatment towards an individual from this community (or any other vulnerable community) can be spread to other members of the community, creating mistrust throughout a community or demographic (Cuevas, O'Brien, & Saha, 2016). People from disadvantaged communities have never been a priority before, so if an allocation protocol suddenly begins to provide this population with resources and shows this population group they are valued, it will raise suspicion among its members. Lack of trust in medical professionals and healthcare among vulnerable, disadvantaged communities must be addressed for allocation methods to be effective.

Conclusion

Current allocation methods in the scholarly literature have numerous limitations ethically, including failure to account for vulnerable populations. Future allocation methods should consider the systematic injustice that puts certain populations at an increased risk and consider existing health disparities. Additionally, resource allocation methods should avoid exacerbating health disparities during non-emergency circumstances. The lack of any standardized protocol in the United States and the neglect of certain communities within healthcare emphasize the urgent need to develop allocation protocols that consider vulnerable populations and their needs and address the shortcomings highlighted throughout this paper. While there are numerous proposals on how to allocate resources, some include extensive algorithms and ideas to account for the complex nature of triage.

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The Effects of Racism on the Development of Black Children

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Abstract

Prior research suggests that racism adversely affects children by negatively impacting the environment surrounding them. This can include social support available to them, including parental relationships. Under conditions of stress, the diminished access to support may potentiate known impacts on mental health and socioemotional development. The overarching goal of this project is to discuss the ways in which racism may affect the development of black children. As an initial empirical test of my larger model, I relied on a state-wide self-report assessment to examine the relation between race and sex, familial support, and the experience of bullying on feelings of sadness or hopelessness. As expected, Black children, female children, and children experiencing bullying all expressed higher levels of sadness. In addition, among children who had experienced bullying, Black children experienced significantly lower levels of familial support. The discussion places the specific findings of the current study within the context of broader literature.

The Effects of Racism on the Development of Black Children

The environment in which children are raised helps to mold the way they grow cognitively, physically, and emotionally. There are various factors that contribute to a child's development, including health care, mental health, environment (home and school) and parental care. The form and function of these factors can all be affected by racism, which is a system that structures the allocation of resources and opportunity within communities based on race, leaving certain groups of individuals at a disadvantage compared to others (Trent et al., 2019). Racism has serious detrimental effects on those who experience and observe it. A social determinant of health is characterized as "the condition in which people are born, grown, live, work, and age" (World Health Organization, 2020). Racism can affect components of health through determinants linked to sociopolitical and economic systems. The specific concern of this study is how racism adversely influences the environment of Black children, focusing on their relationships with their parents, their behavior and mental health, their access to health care and the condition of their home life. As a preliminary statistical test of these relations, the paper will examine the interactions between parental support, race, bullying (as a proxy for discrimination) and the mental health outcome of sadness and despair.

Low SES and Health Disparities

Socioeconomic status (SES) encompasses an individual's occupational experience, education level and income. These factors that can be adversely affected in specific communities due to racism. According to Williams and Collins (1995), discrepancies within SES due to racism can result in varying health outcomes, alter the quality and abundance of healthcare, and impact daily psychological and physiological functioning. African American children are at a higher risk of experiencing parental unemployment and living in lower income households, presenting difficulty in acquiring opportunities and resources that optimize health (Trent et al., 2019). Low SES environments have limited access to resources, education and finances that not only impact childhood development and health but can result in poorer outcomes in adulthood. Specifically, gaps in childhood development and readiness for school are associated with weak academic achievement and long-term productivity (Knudsen et. al, 2006). Racism is a major determinant of health that perpetuates health inequities. Clark et al (1999) illustrates the ways in which racism alters health as a stressor, where it may lead to negative biopsychosocial outcomes in minority groups. Considering that racism can constitute a stressor, prolonged exposure to stress hormones lead to inflammatory reactions that leave certain individuals more inclined to chronic disease (Cohen et al. 2012). Geronimus' (1992) "weathering" theory proposed that the health decline within African American people was a result of political marginalization and cumulative economic or social adversity considering stress-related biomarkers are more prevalent in Black people compared to white people.

The impact of racism has been linked to birth complications as well as mental health issues in children and adolescents. For instance, complications of low birth weight has been associated with maternal stress as well as perceived racial discrimination (Dominguez et. al, 2008). A study conducted with a small sample of low-income Black mothers found an association between self-reported episodes of racism and low birth weight (Collins et al., 2000). Racial prejudice can influence the quality of healthcare services based on the patient's perception of discriminatory treatment or implicit bias of the clinician, amongst other aspects.

Parental Experiences effect Socioemotional Development

Linked lives is a central theme of life course theory (Elder, 1994), emphasizing the interdependence of an individual's life on their social networks like family members. When changes, stress, or traumatic experiences occur in one person's life, it can affect the lives that surround them. This concept is important in explaining how the experiences of family, specifically parents, can influence how their children develop emotionally. There is a continuing association between poor maternal health and adverse child outcome, with maternal depression being correlated to cognitive, socioemotional and physical health through reduced interactions and trouble maintaining authority (Downey and Coyne, 1990; Goodman and Gotlib, 1990). Discrimination experienced by parents may influence parenting through beliefs, attitudes and behaviors or from parental mental health (Cheng et al., 2014).

Since child health and behavior are ingrained within various relationships, the effects of racism can have a rippling effect on children. In a study of African American children between the ages of 10 and 11, a relation between mother's perception of racial discrimination and poor parent physiological function, adversely affected parenting styles (Murry et al., 2001). Another

study of African American mothers found that factors such as low education, food insecurity, lack of money and poor housing was associated with maternal depression.

However, when racial discrimination was accounted for, none of those factors remained significant (Siefert et al., 2007). The Millennium Cohort Study (MCS) examined a longitudinal association between maternal, family, and area-level experiences with racial discrimination and socioemotional development of children. The findings unearth the harm racial discrimination causes overtime both directly and indirectly, showing that poor maternal health is linked to slower response in children's verbal/physical interactions (Zilanawala et al., 2015; Bécares et al., 2015).

Mothers' increased exposure to stressors can impede their mental health and lead to more punitive or harsh parenting tactics (Simons et al., 2002). A study of African American adolescents conducted by Gibbons et al (2004), exemplified an indirect relation between racism and child development, where parental racial discrimination was associated with child anxiety and depression independent of the child's own personal experiences of racism. Other scholars have proposed that parental emotional support and sensitivity towards their children decreases as they become more stressed by their own experiences of racial discrimination (Sanders-Phillips et al., 2009), and that experienced racial discrimination decreases parents' likelihood of providing an environment that is nurturing and affectionate (Landrine and Klonoff, 1996; Sanders-Phillips et al., 2009).

Children's Mental Health and Behavior

Most of the studies that focus on the effects of racism on child health refer to mental, behavioral, and emotional health. There are several ways racism influences how children develop and research findings highlight the detrimental effects on children's mental health and behavior. A 5-year longitudinal study of 714 African American adolescents from ages 10-12 showed that perceived racism led to increased depression and conduct disorder (Brody et al., 2006). Another study showed that black youth demonstrated an increased level of distress regarding racist experiences, which resulted in internalizing and externalizing coping mechanisms (Scott & House, 2005). Internalized behavior is characterized as anxiety, depression and distress, while externalized behavior encompass behaviors such as delinquency and aggression. Stress from discrimination has been implied to be a central factor for the distinct health disparity amongst the Black population in the United States (Williams et al., 2003).

As discussed in previous studies, perception of racism can lead to mental health issues in children and adolescents but can also give rise to risky behaviors like drug and alcohol use. Anger as a result of racial discrimination was found to be a predictor of the average number of drinks consumed by back adolescents (Terrell et al, 2006). African American girls ages 11-19 reported a correlation between racial discrimination and tobacco smoking, implying it was mediated through stress (Guthrie et al, 2002). As reported by Gibbons et al (2007), children who reported adverse exposure to discrimination very early in life are more likely to demonstrate premature conduct problems and drug use.

Gibbons (2004) also found that 91% of Black 10-year-olds report occurrences of discrimination, which may have a critical impact on behavior later in life. Studies such as these additionally support the argument that racism hinders the growth and development of Black

children through multiple means. As an initial analysis of the core questions of interest, this study will examine how racial discrimination (bullying) may influence parent-child relationship through emotional support and depressive symptoms such as self-reported feelings of sadness within adolescents. The following hypotheses were proposed: (1) Perceived discrimination based on race will be associated with more frequent reports of sadness or hopelessness (a proxy for mental health) for African American adolescents. (2) African American students will report lower sense of familial support compared to their white counterparts. There are no specific predictions regarding how participant demographics other than race will influence results, but they will be considered because they could act as potential confounding factors.

Methods

Participants

PAYS is a survey completed every two years with students in the 6th, 8th, 10th and 12th grades in Pennsylvania. The participants in the current study are from the 2019 Pennsylvania Youth Survey (PAYS), using the 10th grade survey results.

Procedure

Participants were asked to complete the survey after receiving consent from their guardian at home. The survey is anonymous, voluntary, and confidential. The survey includes numerous questions that range from the topics of experiences, knowledge, attitudes and behaviors. The survey was given out in the classroom setting. Once completed the school sends them back to the administrators of the survey.

Measures

To examine our core questions of interest, I focused on central variables that may impact a child's overall sense of well-being. In line with my research question, I focused on race, gender, the child's report of family support and report of having been bullied in the last 12 months. My initial research question wished to examine the impact of bullying due to race in the analyses. However, the distribution of positive responses to the question did not allow for a robust analysis.

Sex. Children were asked to report their sex as either male (N=35,425) or female (N=35,411).

Race. Children were asked to report their race across five categories. Based on my initial hypotheses, and the need to simply the analyses, I focused on the two largest groups completing the survey, white (N=55,466) or African American (N=8,426).

Family Support. Students (N=66,868) reported on their relationship with their parents across 11 questions, such as "Do you enjoy spending time with your mother?" and "If I had a personal problem, I could ask my mom or dad for help." I created a composite score of family support by averaging across the questions, with higher scores reflecting greater perceived support. Scores ranged from 1 to 4, with a mean score of 2.95 (SD=0.68).

Bullying. Students were asked if they had ever been bullied, responding as "Never", "Yes, very rarely," "Yes, now and then," "Yes, several times per month," "Yes, several times per week," "Yes, almost daily." Since 73.6% (N=40,894) of the students reported never having been bullied, I collapsed all of the "Yes" responses into a single category (N=14,697).

Sadness or Hopelessness. This measure served at the dependent variable for the study. Students were asked "Did you ever feel so sad or hopeless almost every day for two weeks or more in a row that you stopped doing some usual activities?" Initial analyses found that 29.1% (N=15,984) endorsed the question.

Results

My first step examined the descriptive statistics (Table 1) for the student population. This allowed me to characterize patterns in our variables of interest. To illustrate the pattern, Figure 1 shows the distribution of bullying self-reports by children. To aid in comparison given the large discrepancy in raw counts across white and African American children, the figure converts the raw numbers to percentages calculated based on the total number of African American and white children separately. I then examined the extent to which our variables of interest predicted endorsement of sadness or hopelessness using a logistic regression. I then probed any emerging relations using chi-square analyses and univariate ANOVAs.

Table 1. Distribution of race, sex, and bullying (Yes/No) for the students assessed in grade 10 in 2019 as a function of Sadness response (Yes/No). Percentages are calculated separately for each comparison category within each Sadness response group.

	Race		Sex		Bullying	
	African American	**White**	**Female**	**Male**	**Yes**	**No**
Sadness-Yes	1871 (13.1%)	12430 (86.9%)	10488 (66.7%)	5244 (33.3%)	7428 (46.7%)	8473 (53.3%)
Sadness-No	3928 (11.3%)	30937 (88.7%)	17154 (44.6%)	21302 (55.4%)	7035 (18.1%)	31727 (81.9%)

Figure. 1. Report of bullying as a function of race and reports of Sadness. In order to account for the large imbalance in sample size when comparing African American and white children, the percentages are calculated within each group separately.

Report of Bullying
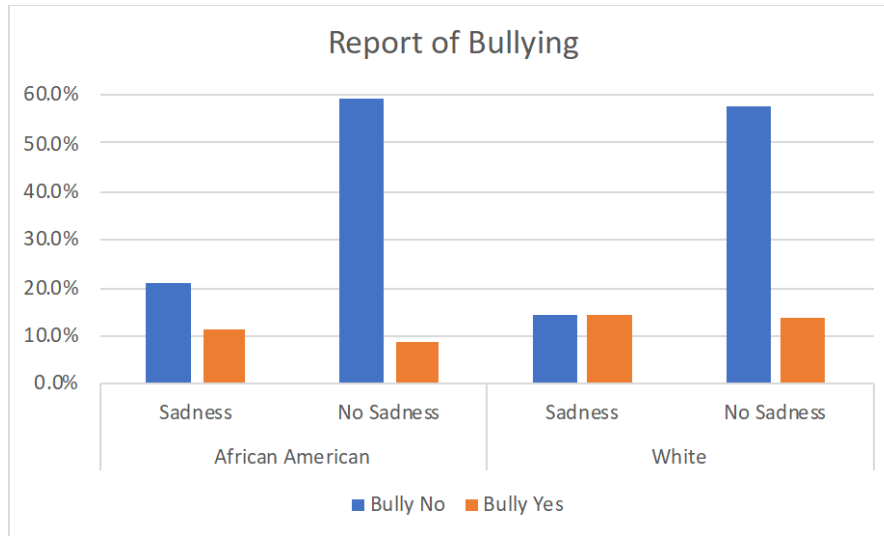
The core analysis was a logistic regression predicting endorsement of sadness as a function of race, gender, bullying, and family support. The findings (Table 2) indicated that race, family support, sex, and bullying all significantly contributed to the probability of reporting sadness, in line with our descriptive statistics. Of interest, there was a 2-way interaction between family support and race, *p* <0.001. In particular, the univariate ANOVAs suggests that while both white and African American participants report more family support when not bullied (white: 3.08 vs. 2.80; African American: 2.81 vs. 2.61), the overall scores were lower for African American children and the gap somewhat smaller (Figure 2).

Table 2. Findings from logistic regression predicting Sadness response.

	Beta	Standard Error	Wald	*p*
Race	0.690	0.140	24.45	0.000
Family Support	1.398	0.060	538.84	0.000
Sex	0.855	0.023	1343.86	0.000
Bullying	-1.283	0.091	199.29	0.000
Support * Race	-0.296	0.050	35.10	0.000
Bullying * Race	0.068	0.112	0.367	0.545
Bullying * Race*Support	-0.002	0.032	0.004	0.953

Figure. 2. Report of Family support as a function of race, sex, and bullying.

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Family Support
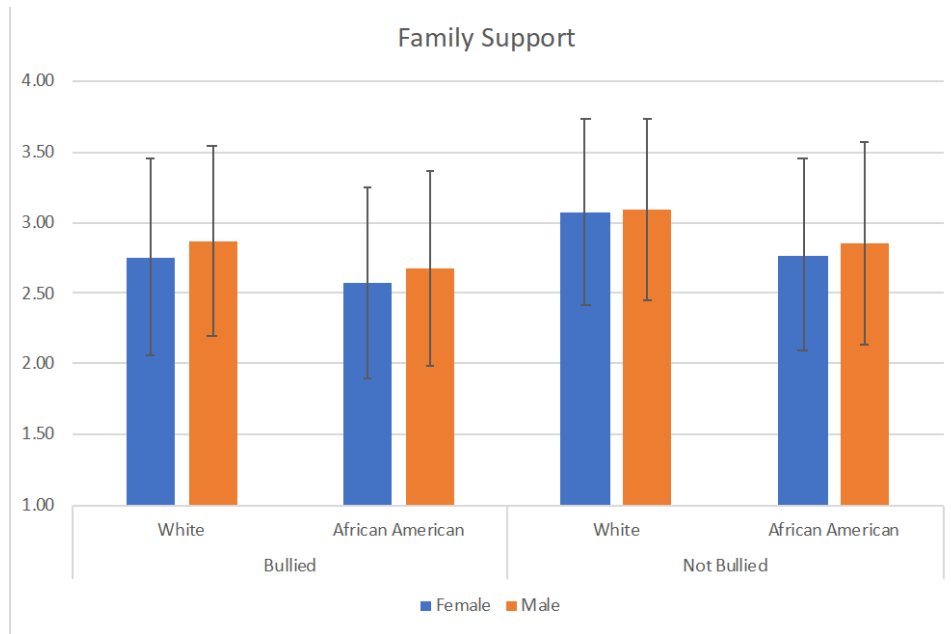
Discussion

Environmental factors play a significant role in how children interact, behave, and process emotions as they grow. Experiencing racism can influence different aspects of the environment and potentially obstruct psychological growth. Institutionalized racism is a multidimensional construct that involves oppression and domination of a race or ethnic group, creating barriers to minority advancement and inclusion. Consequently, children in African American communities live in households with significantly lower incomes relative to white children in the United States. This circumstance poses as a threat to well-being through unequal access to services and opportunities that optimize health (Dominguez et al., 2008). Birth disparities along with mental health problems have been linked to racism (Cohen et al., 2012).

Racial discrimination can also affect parents' interaction with children through mechanisms involving low-quality verbal and physical interactions (Downey & Coyne, 1990). This study examined the relation between familial support, bullying as a proxy for both discrimination and stress, and mental health outcomes. Here, we used the child's self-report of sadness and hopelessness to reflect an overall sense of well-being and psychological functioning. In line with my core area of interest, the study focused on race as a potential moderator of the underlying relations. The rationale was that African American adolescents' exposure to discrimination may be connected to increased reports of sadness, particularly if they have experienced social stress (i.e., bullying).

The results indicate that race is linked to familial support and discrimination among students with respect to child's perception of support and bullying. In line with the hypothesis, African American students reported overall lower rates of support from family compared to white students. These findings should be accounted for when considering the reason for less support from family for African American students. It can be implied that racial discrimination experienced by family members can detrimentally influence parent mental health.

Poor parental mental health may have an impact on parenting by impacting parental attitudes, behaviors and beliefs (Cheng et al., 2014), as it has been linked to an increase in punitive parenting tactics (Simmons et al, 2002). Other scholars have proposed that parental support and sensitivity to children decrease when parents are dealing with their own experiences of racism. Less warm and caring home environments can harm children's socioemotional development which accounts for the relationship between family support as a predictor of sadness (Bécares, Nazroo, & Kelly, 2015).

Students report of sadness were attributed to variables such as race, family support, and bullying. African American children reported higher rates of sadness compared to white children. There was a strong association between race, bullying, and support that contributed to students report of sadness. Bullying and race were significant contributors to sadness. Consistent with previous literature, perceived racial discrimination is linked to depressive symptoms amongst African American adolescents. Some studies have shown that appraisal of racism led increased depression and conduct disorder (Brody et al., 2006). Increased distress in response to racist experienced has also resulted in internalization and externalizing coping mechanisms (Scott & House, 2005).

There are some limitations of the current study. The reliability of the results is limited due to self-reported measures of mental health and familial support. Self-reports are subject to certain biases or retrospective constraints. The use of proxy variables data could possibly limit the reliability of findings. The results are nonetheless valid because they correspond to previous studies and each variable was still accurately measured. The significant relations noted were also in line with prior empirical work and theory. Future studies should consider that children's self-reports were measured but we had no indicator of parental experiences of racial discrimination. Many studies have focused on parental reports of discrimination, and some have accounted for children, but few have included data collected from children as well as their parents. Further research should focus on racial discrimination, mental health and interpersonal relationships of both child and parents. Gaining more understanding about impacts of racism on family dynamic and individual development could improve life quality for marginalized ethnic groups and reduce racial health disparities.

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Effects of Interfering Speech in a Foreign Language on Speech Understanding

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Abstract: Measuring language proficiency is a challenging process that typically includes a combination of standardized test and self-reporting assessments. The disadvantage of these assessments is that the standardized test can be time consuming, and the self-reported measures can be biased. To address these disadvantages, current research has studied the effects of interfering speech in a foreign language and language proficiency levels on speech understanding. To evaluate whether there is a correlation between language proficiency levels and performance scores on speech-in-speech recognition task we must first test the validity of speech-in-speech recognition task. To do so, we had monolingual English listeners participate in a speech-in-speech recognition task to see if they demonstrate a linguistic release from masking. We use monolingual English listeners because we hypothesize that bilingual listeners with high proficiency in their second language will have similar scores to the monolingual listeners. So, monolingual listeners scores must be included to compare with the bilingual listeners. We then plan on having bilingual participants take part in two tasks. In the first task will be the speech-in-speech recognition task, where participants will hear a target sentence in the presence of foreign and native background noise, with the job of correctly identifying the color and number heard from the target. The next task will be a standard language proficiency task. We expect to see a positive correlation with higher language proficiency levels correlating to higher performance scores on speech-in-speech recognition task. Making speech-in-speech recognition task an alternative way of measuring language proficiency,

I. Introduction

Schools and businesses need to be able to measure an individual's language proficiency. Public Schools also rely on language proficiency tests for the academic placement for their bilingual students. For example, international students planning to attend a college or university in the United States, must take an exam prior to starting classes to assess their level of language proficiency. During the hiring process, companies may also consider language proficiency. According to the Corporate Finance Institute, CFI, potential employees are assessed on their language proficiency on a 0-5 language proficiency scale. With 0 being no/limited proficiency and 5 being native/bilingual proficiency (CFI Education Inc, 2015). With the reliance on language proficiency exams in the public and private sector for schools and business, there needs to be an efficient approach to assessing language proficiency.

The current approach to testing language proficiency is through standardized assessments. The most common method used is the Test of English as a Foreign Language, also known as TOEFL. Other common Language Proficiency exams include the International English Language Testing System (IELTS), Certificate of Advanced English (CAE), and the Certificate of Proficiency in English (CPE). These proctored exams are administered to assess one's proficiency level in English (Academic Positions, 2020).

The TOEFL consist of 4 sections: reading, listening, speaking, and writing. In the reading section, participants read passages and respond to questions. In the listening section, participants listen to a brief lecture or classroom discussion and then answer questions about what they heard. In the speaking section, participants have a conversation about things already discussed in the exam and other familiar topics. In the writing section, participants read a passage, listen to a recording, and then type out a response. This test takes approximately four hours to complete (TOEFL iBT® Test Content, 2021). Another method of assessing language proficiency is through self-reported measures such as language history questionnaires (LHQ) or language experience and proficiency questionnaires (LEAP-Q). Both the TOEFL and self-reported measures, LHQ and LEAP-Q, have disadvantages. The TOEFL takes an extended amount of time to complete, and the self-reported measures could be unreliable if the person underreported or overestimated their language proficiency level. Therefore, goal of this research is to determine if a correlation exist between language proficiency levels and performance scores on speech-in-speech recognition task to find an alternative way of measuring language proficiency that does not rely on self-reported measures.

Current research has assessed the effect second language proficiency has on speech-in-speech recognition tasks (Francis et al., 2018). Speech-in-speech recognition task are when participants are assessed on their ability to comprehend target speech in the presence of background noise, also known as a masker. The widely studied phenomenon, Linguistic Release from Masking (LRM), also looks at which situations make completing speech-in-speech recognition tasks easier. LRM is when participants have an easier time recognizing target speech when the competing speech is in a different language (Calandruccio et al., 2010; Brouwer et al., 2012). The research also shows that language familiarity plays a role in the performance scores of speech-in-speech recognition task. If a participant is proficient with both languages, they will demonstrate a greater linguistic release from masking than individuals who are less proficient with one or both languages (Francis et al., 2018).

This study looked at the performance scores of monolingual English listeners on a speech-in-speech recognition task. Before identifying a correlation between language proficiency levels and speech-in-speech recognition scores, validity of the speech-in-speech recognition task had to be established. Past data had to be replicated by having monolinguals listeners complete a speech-in-speech recognition task. The participants showed a higher performance score when the target sentence was in a different language than the masker compared to when the target and masker were in the same language. The purpose of using monolingual listeners was to analyze their scores and compare them to the scores of the bilingual listeners. Past research has showed that monolingual listeners tend to have higher performance scores on speech-in-speech recognition task when the target and masker differ in language. By comparing the data, we hypothesize that bilingual participants who are highly proficient in their second language will have similar performance scores to that of the monolingual listeners.

To expand upon this study an assessment of the correlation of language proficiency and speech-in-speech recognition scores will be completed by Dutch-English bilinguals. To assess

the correlation, Dutch-English bilingual participants will complete a language proficiency battery followed by an LRM quick test. Past research suggests that when bilingual individuals have high proficiency in their second language they perform similarly to monolingual listeners on speech-in-speech recognition tasks (Miller, 2019). We hypothesize that Dutch-English bilinguals with high English proficiency will have a greater amount of linguistic release from masking that is similar to the amount of linguistic release from masking monolingual listeners experience. We also hypothesize that Dutch-English bilinguals with low English proficiency will have a low amount of linguistic release from masking. In other words, when the target and masker are in different languages, versus when they are in the same language, there will be similar performance scores and it will show a low amount of linguistic release from masking.

I. Experiment I: Pilot Study of Coordinate Response Measures

Experiment 1 used Coordinate Response Measures (CRM) as the speech-in-speech recognition task on English monolinguals to see if they would demonstrate a linguistic release from masking when the target and background speech differ. The purpose behind using monolingual English listeners was to have comparable results from known individuals with high proficiency levels in English.

A. Methods

Participants

a. Listeners. Participants included three English Monolingual women from the Speech, Language and Cognition Lab at The Pennsylvania State University.

B. Stimuli

a. *Talker Stimuli* – The Coordinate Response Measure (CRM) wavefiles are in the "broadband" format with 44.1 kHz sampling rates. The CRM wavefiles consist of eight talkers and have the sentence structure of: "Ready [Call sign] go to [Color] [Number] now. The talker stimuli were presented at 65dB to constitute normal conversation conditions.

b. *Masker Stimuli* – All stimuli were recorded in a sound booth at 44.1 kHz sampling rate and a 16-bit resolution. Both maskers were presented at 71dB creating a signal to noise ratio, SNR = -6dB. Both masker stimuli were composed of semantically anomalous sentences to focus the linguistic properties of the masking language. In this study, a syntactically normal sentence test (SNST) was used for the maskers. Dutch translations of these SNST sentences came from Brouwer et al. (2012).

C. Procedures

Participants completed the experiment on Labvanced®, a browser-based experimental software. This task consisted of a headphone evaluation, practice trials, following by the actual experiment.

In the headphone evaluation, participants had to listen to three pure tone sounds and determine which sound was the softest. If they were able to identify the softest sound, they were allowed to move on to the practice trial and the actual task.

Written instructions were provided, stating that participants would hear a female talker who would say a call sign, color, and number. The format was, "Ready [call sign], go to [color] [number] now." The task was for the participants to identify the color and the number stated in each trial by selecting the button of the correct color and number. The possible colors included: Red, Blue, Green, and White. The possible numbers included in this study were numbers one through eight.

II. Experiment II: Dutch-English Bilinguals Language Proficiency Battery and CRM task

In a future experiment, we will examine the English language proficiency level of Dutch-English bilinguals through a series of five tasks. We will also examine the Dutch-English bilinguals' ability to recognize target speech in the presence of background speech.

A. Methods

Participants

a. *Listeners.* Participants will include Dutch-English Bilinguals. Participants will be selected through Prolific. Prolific is a Research Participant Repository that allows researchers to quickly find participants by launching studies to thousands of participants in minutes. The participants in the study will fill out a questionnaire with a series of questions about their language history.

B. Stimuli

a. *Boston Naming Task* – This task consists of 30 black and white drawings that depict everyday objects and items arranged in an order where they begin to increase in difficulty. (Kaplan et al., 1983)

b. *Verbal Fluency Task* - In the letter task we will use the standard letters: "B, M, D, and T" These letters are used due to the large number of words that begin with these letters. In the category task, there were four categories selected. Those four categories were: "*Animals, Clothing, Musical Instruments, and Vegetables.*"

c. *Nonword Repetition Task* - Here participants will hear 1-syllable words ranging in length from three, four, five, up to six words. All participants will hear the words in the same order, starting with the shortest list of words and going up to the longest list of words. Participants will listen to 16 sets of utterances.

d. *Lexical Decision Task* - Words for this task are from www.lextale.com. The task will include 60 words. The words within the lexTALE will range from 4 to 12 letters with a mean of 7.3 letters. According to the CELEX database, the words will also have a mean frequency that was between 1-26 occurrences per million with a mean of 6.4 (Baayan, Piepenbrock, & Guilkens, 1995).

e. *Talker Stimuli* – The Coordinate Response Measure (CRM) wavefiles are in the "broadband" format with 44.1 kHz sampling rates. The CRM wavefiles consist of eight talkers and have the sentence structure of: "Ready [Call sign] go to [Color] [Number] now. The talker stimuli will be presented at 65dB to constitute normal conversation conditions.

f. *Masker Stimuli* – All stimuli will be recorded in a sound booth at 44.1 kHz sampling rate and a 16-bit resolution. Both maskers will be presented at 71dB creating a signal to noise ratio, SNR = -6dB. Both masker stimuli will be composed of semantically anomalous sentences to focus the linguistic properties of the masking language. Syntactically normal sentence test (SNST) will be used for the maskers. Dutch translations of these SNST sentences will come from Brouwer et al. (2012).

C. Procedures

Participants will access the experiment using a browser-based experimental software, Labvanced®. Participants will receive written instructions on Labvanced®. They will be informed that they are taking part in the first task which will include five sections. The task will begin with the first section, the Boston Naming Test (BNT). This test is an instrument used to assess naming ability and the ability to retrieve words. (Kaplan et al., 1983). Participants will be exposed to 30 black and white pictures representing everyday objects that are organized in a way

that will increases in difficulty as time passes. The participants will be asked to name each item shown in the picture.

The next section will be the Verbal Fluency Task. The Verbal Fluency Task will assess verbal functioning (Lezak et al., 2012). This task will provide insight into the participant's verbal ability such as lexical retrieval ability and lexical knowledge and assess their executive control. (Lezak et al., 2012). Through this assessment, we will be able to predict deficits in executive control or verbal ability. The Verbal Fluency Task will be comprised of two parts, the letter task, and the category task. In the letter task, participants will see four letters: B, M, D, and T. For each letter they will have 60 seconds to list as many words that begin with the letter. In the category task, participants will see four categories: Animals, Clothing, Musical Instruments, and Vegetables. Then they will be given 30 seconds to list items within each category.

Following the Verbal Fluency task is the Nonword Repetition Task. For this task, the participants will hear a string of one syllable nonwords and repeat each nonword to the best of their ability. There will be 16 trials of nonwords sentences that will get longer as the experiment continues. The task will begin with a string of three words and will increase up to a string of six words.

Finally, the first part of the experiment will conclude with the Lexical Decision Task. The purpose of this task will be to measure the participants' vocabulary knowledge in English. The task will consist of 60 words including nouns, adjectives, verbs, verb participles, and adverbs. Some of the words in the list will be English words and the rest will be nonwords that do not exist in English. In this task, the word will appear on the screen and participants will determine whether the world is a real English word or not. They will be instructed to press the 'A' key if they believe the word is a real English word and the 'L' key if they believe it is not a real English word.

The second part of the experiment will be a speech-in-speech recognition task. This task will consist of a headphone evaluation, practice trials, and the speech-in-speech recognition task. In the headphone evaluation, participants will listen to three pure tone sounds and determine which sound is the softest. If they can identify the softest sound, they will be allowed to move on to the practice trial and the actual task.

Written instructions will be provided, stating that participants will hear a female talker who will say a call sign, color, and number. The format will be, "Ready [call sign], go to [color] [number] now." The task will require the participants to identify the color and the number stated in each trial by selecting the button of the correct color and number. The possible colors included are: Red, Blue, Green, and White. The possible numbers included in this study are numbers one through eight.

Table 1

Percentage of Words Correct with English Targets

Participants	Dutch Maskers	English Maskers	Expected
Participant #1	86%	88%	No
Participant #2	86%	78%	Yes
Participant #3	81%	81%	No
Participant #4	84%	82%	Yes
Average	85%	81%	Yes

Note. Speech-in-speech recognition performance scores (percent correct) for 4 listeners in the presence of single-talker Dutch maskers and single-talker English maskers with an SNR of -6dB.

The column shows the percentage correct with Dutch maskers, the percentage correct with English maskers, and if those results were expected by stating either "Yes" or "No".

IV. Expected Results

Before gathering data from all subjects, four pilot trials were conducted and analyzed. Table ` depicts performance scores (percent of color and number correctly identified) in each condition, English target with English Masker and English target with Dutch masker. The intensity level of the target sentence was 65dB and the masker sentence was 71dB, contributing to a Signal to Noise Ratio, SNR = -6dB. The results, however, were not as expected. Some participants received a linguistic release from masking, which can be shown by higher percentages in Dutch versus English masker and a "Yes" in the expected column. Yet, some participants either had higher percentages with the English masker or the same percentage regardless of the language the masker was in. Leading to the conclusion that the single-talker masker made the task too simple, causing there to not be a linguistic release from masking. However, if the difficulty of the experiment is increased by making the maskers two-talkers instead of a single talker, we expect there to be a greater linguistic release from masking. After increasing the difficulty level of the experiment, we expect a greater linguistic release from masking where all four monolingual participants will have a higher percentage correct score with the Dutch masker compared to the English masker. Leading to our hypothesizes that Dutch-English bilinguals with a higher English proficiency will score similarly to the monolingual participants. The similarities being that participants will have a higher percentage correct when maskers are in Dutch rather than English. We also hypothesize that Dutch-English bilinguals with a low English proficiency will score significantly lower with respects to the bilinguals with higher English proficiency, depicted in figure 2. If a correlation between proficiency level in second language and performance scores is found, the CRM task can be used as a speech-in-speech recognition task such as the CRM task as an alternative method to measuring language proficiency that does not rely on self-reported measures.

Figure 2

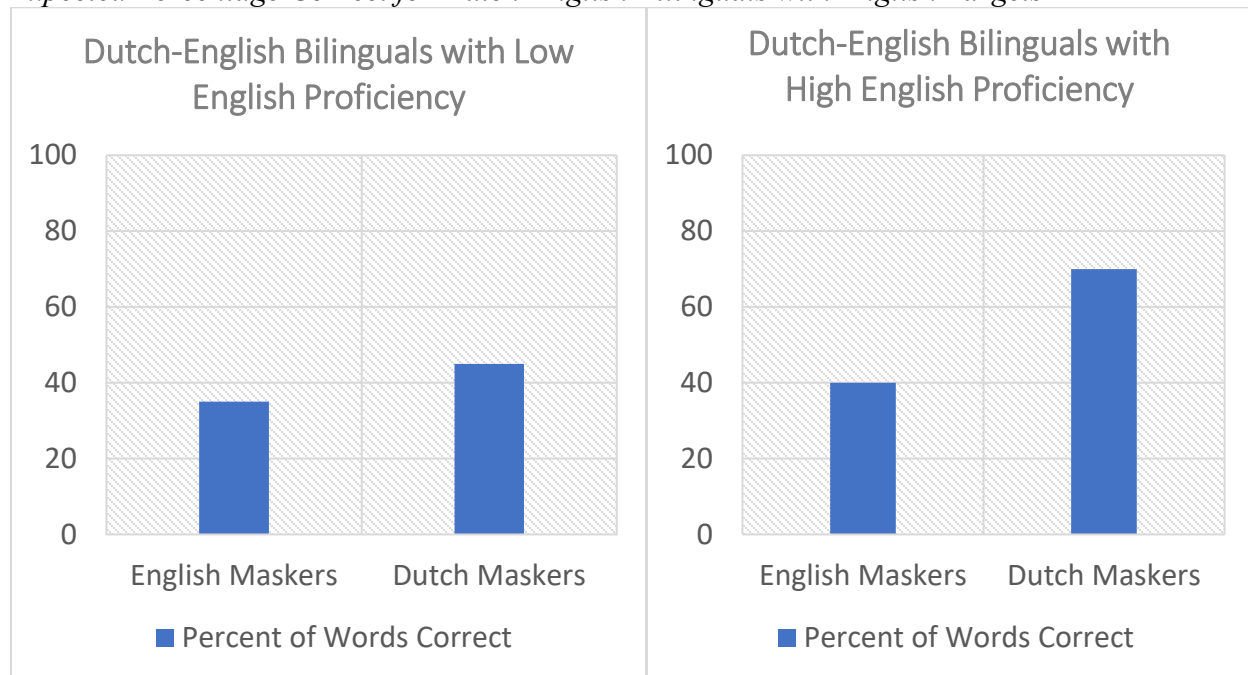*Expected Percentage Correct for Dutch-English Bilinguals with English Targets*

Fig. 2. Due to Linguistic Release from Masking we expect to see a greater performance score percentage when the masker is in Dutch with an English target than a masker in English with an English target. These boxes depict the expected results when Dutch-English bilinguals with varying levels of English proficiency complete a speech-in-speech recognition task with two maskers and an SNR = -6 dB.

V. Discussion

Previous studies have demonstrated that listeners receive a benefit, or a linguistic release from masking, in speech-in-speech recognition task when the target speech and masker differ in language (Calandruccio et al., 2010; Brouwer et al., 2012). Other studies have looked at the effects second language proficiency has on recognition of speech in native and nonnative competing speech (Francis et al., 2018)? Through this study we will expand on past research to investigate if there is a correlation between the amount of LRM a participant receives and their level of proficiency in a second language. This question will be addressed by analyzing participants scores on a two-part experiment, utilizing a language proficiency task and a speech-in-speech recognition task.

From the piloted data, we found that monolingual English speakers had a slightly higher performance score when target and masker differed, showing that LRM exist. In future studies, we will increase the amount of LRM a participant experiences, by having the participants listen to a two-talker masker instead of a single-masker during the experiment. Where there will be two sentences of background noise along with the target sentence. With the goal of increasing the difficulty level of the experiment and showing a greater LRM. To conclude, we hope to expand our pool of participants to Dutch-English bilinguals to see if there is a positive correlation between higher English proficiency level and higher performance scores on the speech-in-speech recognition task leading to a greater LRM. Proving that the amount of language proficiency is a factor that contributes to the performance score of the speech-in-speech recognition task while also allowing the speech-in-speech recognition task to be an alternative method to measuring language proficiency.

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