# The Penn State McNair Journal

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THE PENN STATE MCNAIR JOURNAL

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** Research conducted in summer 2015
* Research conducted in summer 2016

# *Welcome*

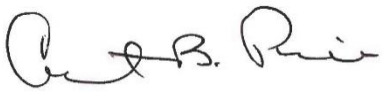
Since 1991, the Penn State McNair Scholars Program has enriched the lives of students at Penn State. The McNair Program holds a very special place in our lives, as well as in the lives of the faculty and staff who work with our students. This publication celebrates their achievements and we offer it to our readers with pride and pleasure.

This is the twenty-second issue of the Penn State McNair Journal. We congratulate the Penn State McNair Scholars and their faculty research advisers! This journal presents the undergraduate research conducted by participants in the Penn State McNair Scholars Program during the summer of 2017. In addition, the journal presents research conducted by McNair Scholars from the summers of 2015 and 2016 who research papers were under consideration for publishing in another peer journal.

The articles within this journal represent many long hours of mutual satisfying work by the scholars and their professors. The results of their research are published within the journal and will also be presented at various research conferences around the country. We are especially proud to see how these students have grown as researchers and scholars. The hard work, dedication and persistence required in producing new knowledge through research is most evident in these articles.

We very much appreciate the guidance, expertise, caring and patience of our fine group of Penn State faculty research advisers. For their ongoing support and assistance, we thank Eric Barron, President of Penn State; Nicholas Jones, Executive Vice-President and Provost; Regina Vasilatos-Younken, Vice Provost for Graduate Education and Dean of the Graduate School; Michael Verderame**,** Senior Associate Dean; Suzanne Adair, Associate Dean for Graduate Student Affairs, and Stephanie Danette Preston, Assistant Dean for Graduate Educational Equity, the administrative home of the McNair Scholars Program.

We are also fortunate to have the support and encouragement of many faculty and staff members who have worked with our students as social mentors or who have presented workshops and seminars on the many aspects of graduate and faculty life. You give the most precious of gifts to our students – your time in volunteering to support, encourage and nurture our Scholars' hopes and dreams.



*Curtis B. Price*
*Program Director-Ronald E. McNair Scholars Program*

## *TRIO Programs at the National Level*

Federal TRIO Programs (TRIO) are outreach and student services programs designed to identify and provide services for individuals from disadvantaged backgrounds. TRIO programs are targeted to serve and assist low-income individuals, first-generation college students, and individuals with disabilities to progress through the academic pipeline from middle school to post-baccalaureate programs. The history of TRIO is progressive. It began with Upward Bound, which emerged out of the Economic Opportunity Act of 1964 in response to the administration's War on Poverty. In 1965, Talent Search, the second outreach program, was created as part of the ***Higher Education Act***. In 1968, Student Support Services, which was originally known as Special Services for Disadvantaged Students, was authorized by the Higher Education Amendments and became the third in a series of educational opportunity programs.

Over the years, the TRIO Programs have been expanded and improved to provide a wider range of services and to reach more students who need assistance. The Higher Education Amendments of 1972 added the fourth program to the TRIO group by authorizing the Educational Opportunity Centers. ***Amendments in 1986 added the sixth program, the Ronald E. McNair Post-Baccalaureate Achievement Program***. Additionally, in 1990, the Department created the Upward Bound Math/Science program to address the need for specific instruction in the fields of math and science.

## *TRIO Programs at Penn State University*

There are eight TRIO programs housed at Penn State including the McNair Scholars Program. ***Educational Opportunity Centers (EOC)*** provides counseling and information on college admissions to qualified adults who want to enter or continue a program of postsecondary education. Penn State EOC serves 1,000 students in the cities of Reading and York, Pa. ***Student Support Services (SSS)*** provide opportunities for academic development, assist students with basic college requirements, and motivates students toward the successful completion of their postsecondary education. The SSS programs at the Penn State Greater Allegheny and Wilkes-Barre campuses combined serve over 330 students. ***Education Talent Search (Talent Search)*** provides academic, career, and financial counseling to participants and encourages graduation from high school and to continue to and complete their postsecondary education. Talent Search serves over 1,900 students among their program located in school districts in southwestern Pennsylvania and York, Pa. ***Upward Bound Programs (UBP)*** which consists of Upward Bound, Upward Bound Migrant, and Upward Bound Math and Science; provides opportunities for participants to succeed in their precollege performance and ultimately in their higher education pursuits. UBP serves about 250 students from six school districts throughout the Commonwealth of Pennsylvania.

## *The McNair Scholars Program at Penn State*

Designed for low-income and first-generation college students, and students from groups underrepresented in graduate education, the McNair Scholars Program at Penn State encourages talented undergraduates to pursue doctoral degrees. The program works closely with these participants through their undergraduate career, encourages their entrance into graduate programs, and tracks their progress to successful completion of advanced degrees.

The goal of the McNair Program is to increase graduate degree attainment of students from the above-mentioned underrepresented segments of society. McNair Scholars are presented with opportunities to study and do research in the University's state-of-the-art facilities in order to hone those skills required for success in doctoral education. Through both academic year and summer program components, McNair Scholars are required to complete a series of steps that lead to their application and enrollment in a graduate program of their choice.

Since 1991, the McNair Scholars Program at Penn State has helped 288 students earn their baccalaureate degrees. Of these graduates, 245 (85 percent) have gone on to attend graduate school. 59 graduates (26 percent) have earned their academic or professional doctorates; and 31 graduates also earned their master's degrees prior to the doctorate. Another 161 (66 percent) have now earned their master's degrees. Currently, there are 52 (21 percent) who are still enrolled in graduate programs. Among the institutions McNair alumni have attended or currently attend are: Arizona State, Boston University, Columbia, Cornell, Harvard, Howard University, Indiana University, Iowa State, Johns Hopkins, New York University, Ohio State, Penn State, Purdue, Stanford, Temple, Texas A&M, University of California-Berkeley, University of California-Davis, University of California-Los Angeles, University of Chicago, University of Florida, University of Illinois-Urbana Champaign, University of Maryland-College Park, University of Michigan, University of North Carolina-Chapel Hill, University of Pennsylvania, University of Texas, University of Wisconsin, and Yale University.

## *Summer 2017 McNair Scholars and Program Staff*

Penn State McNair scholars and program staff gather during the 2017 Penn State McNair-SROP Summer Research Symposium held July 24-25, 2017 at University Park, Pennsylvania.

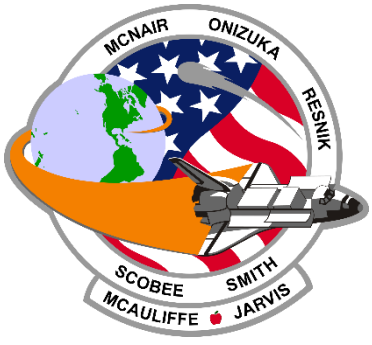
# *About Ronald E. McNair*

*"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. McNair displayed an early aptitude for technical matters, earning the nickname "Gizmo." 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.

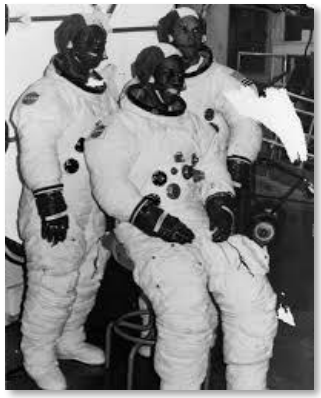
An outstanding student at Carver High School, McNair starred in baseball, basketball and football and played saxophone for the school band. He graduated as valedictorian of the class of 1967, earning a scholarship to attend North Carolina Agricultural and Technical State University (NC A&T). After initially 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. Adjusting to the new environment proved a challenge for McNair. 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. Additionally, he was highly skilled in karate and won the 1976 AAU Karate Gold Medal and five regional championships, eventually achieving the rank of fifth-degree black belt.




By this point, McNair was a recognized expert in the fields of chemical and high-pressure lasers. He went to work for Hughes Research Laboratories in Malibu, California, where he focused on such tasks as the development of lasers for isotope separation and conducted research on electro-optic modulation for satellite space communications.

McNair was a member of several organizations during his professional career, including the American Association for the Advancement of Science, the American Physical Society and the North Carolina School of Science and Mathematics Board of Trustees. Among his many honors, he was named a Distinguished National Scientist by the National Society of Black Professional Engineers in 1979 and received the Friend of Freedom Award 1981. He also garnered honorary doctorates from NC A&T State University, Morris College, and the University of South Carolina.



In 1978, McNair was selected as a mission specialist astronaut by NASA. He, along with Guion S. Bluford, Jr., and Frederick Gregory, were the first African Americans selected as astronauts. His first spaceflight was on the STS-41B mission. McNair operated the shuttle's robotic arm to move a platform on which an astronaut could stand. This method of placing an astronaut in a specified position using the robotic arm was used on subsequent shuttle missions to repair satellites and assemble the International Space Station.

McNair was then assigned to the STS-51L mission of the space shuttle *Challenger* 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. The program prepares low-income and first generation students, and underrepresented students in graduate education for doctoral study. Currently, there are 187 McNair projects across the nation serving more than 5,200 students.

Left to right are Christa McAuliffe; Gregory Jarvis; Judith A. Resnik, Dick Scobee, Ronald E. McNair, Mike J. Smith, and Ellison S. Onizuka,

## *Special Acknowledgements*

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# *A High-Precision Radiocarbon Chronology for the Rise and Fall of a Classic Maya Noble Household*

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***Abstract***
Classic Maya civilization (AD 250-800) declined during the 9$^{th}$ century with a rapid disintegration of divine lineages at multiple urban-ceremonial centers. Construction of temples and stone monuments describing kingship halted at the largest Maya centers during this time. Questions remain about what happened to the noble and commoner households surrounding these centers. Here I establish a high-precision Accelerator Mass Spectrometry (AMS) radiocarbon ($^{14}$C) chronology for the decline of one noble household (House of the Bacabs) in the Copan Valley (Honduras). Direct AMS $^{14}$C dates on purified bone collagen from human skeletal remains excavated from this elite household parallel the rise and fall of Copan's dynastic lineage from historical monuments. These data suggest a rapid decline of at least one noble household that was part of this kingdom. Comparable AMS $^{14}$C work will be required at other noble and commoner households to determine if decentralization and population decline occurred more broadly in the Copan Valley as the kingdom fell.

**Introduction**

The Classic Maya were never a unified into a single state or empire. Broadscale cultural traditions were shared throughout the region, today represented by Mexico, Guatemala, El Salvador, Belize and Honduras (Figure 1), but urban Maya centers were more like city-states, with dynastic lineages controlling individual sites and forming alliances with other centers through political marriages (Ebert et al 2014). These urban areas were civic-ceremonial centers that attracted large residential populations composed of nobles and commoners. During the Classic Maya Period (AD 250-800) dynastic rulers commissioned the construction of temples and stone monuments. Hieroglyphic inscriptions on stone monuments recorded commemorative events, such as the installment of new kings, using Maya Long Count dates. Long count calendar dates were recorded with historical information on stone monuments at centers throughout the Maya region and this

allows for precise dating of political activities through the Classic Period (Coe 2011; Kennett et al. 2013).

The "collapse" of the Maya during the Terminal Classic Period (AD 800-925) refers to evidence indicating the rapid decline of political systems, dynastic lineages and the cessation of monumental constructions at most of the major population centers throughout the region (Kennett et al 2012). However, the chronology of the collapse is still debated (Webster 2004, Braswell 1992). One argument is that an abrupt disintegration of the Maya political system occurred around the time the final long count date was recorded (AD 909), which also led to an abrupt population collapse among lesser elites and commoners (Martin and Grube 2008). Others have argued for a more gradual decline and that the vast majority of the population, mostly commoners, persisted throughout the region for a century or two after the polities failed (Webster et al 2000).

Supporting evidence for these hypotheses has proven problematic based on the methods used previously to construct collapse chronologies. Ceramic dating methods can be imprecise and inaccurate (Hoggarth et al 2014). Additionally, inscribed long count calendar dates on stone monuments do not accurately reflect the day-to-day actions of the entire population, especially commoners who vastly outnumbered the elites. Direct dating techniques such as obsidian hydration methods can provide more precision but can lack in accuracy (Antoviz et al 1999; Braswell 1992).

Similar issues of chronology present themselves at Copan. In this paper I present AMS $^{14}C$ dates on human skeletons from the one elite Maya household at Copan, House of the Bacabs (9N-8), and compare these results with other datasets from this Classic Period civic ceremonial center. This work contributes to our understanding the collapse with a robust chronological dataset from an elite household located away from the Main Group of the site occupied by the dynastic lineage.

**Site Background**

Copan was a major population center located on the southern boundary of what was once the extent of the Maya region during the Classic Period (AD 300-900). Today, it is a designated UNESCO World Heritage Site located in the Copan Valley in western Honduras near the edge of the Guatemala border (Figure 1 and 2). It is well known for the elaborate building in the civic-ceremonial core, including the Hieroglyphic Stairway, the longest inscribed text in the Maya region (UNESCO World Heritage List).

The ruins of Copan sit in a river valley cut by the Rio Copan (Figure 2). There are five alluvial plains or pockets within the valley and the civic-ceremonial center was placed in one of the larger pockets (12.5 × 4 km). Rainfall is strongly seasonal and rotational swidden cultivation was used widely in the region to allow the land to recover during an extended fallow period after use for a year or two (Webster 2000: 14-16).

Several large excavations at Copan have revealed large temples and structures on the main acropolis or Main Group (Webster 2000: 31-40). William T. Sanders and David Webster (Penn State) conducted major excavations outside of the

Main Group (PAC II: Proyecto Arqueologico Copan) between 1980 and 1984 to better understand the social, political and economic institutions of Late Classic Copan. One of the primary goals of PAC II was to excavate a series of noble households outside the civic ceremonial core known as Las Sepulturas. (Webster 2000: 34-35). These excavations unearthed several major household areas in Las Sepulturas, one of which was designated 9N-8, also known as "House of the Bacabs" (Figure 3).

PAC II excavators established that 9N-8 was most likely occupied by a second-tier noble lineage (Webster 1989:13). Some of the structures at 9N-8 were modular and served a variety functions. These structures lacked order and uniformity seen at more elite compounds and suggest a more continuous and organic growth pattern unique to this part of the site (Webster 1989: 13). Additionally, the elaborate architecture and impressive reliefs at 9N-8 indicate that the noble lineage was prominent in the Late Classic period and was either allied or competitive with the dynastic lineage occupying the Main Group (Webster 1989: 15).

Group 9N-8 contains several plazas within the compound. Plaza A is the largest with four buildings surrounding a central plaza. It is the most complex in terms of architecture and iconography when compared to other plazas (Webster 1988). Plaza B is comparable to Plaza A in terms of size and complexity. Like Plaza A, Plaza B was also built on an artificial platform. Plazas E and F are adjoined and are surrounded by decorated buildings constructed during the Late Classic (Webster 1988). Plaza H underwent major renovations near the end of the Classic Period and evidence suggests economic activity occurred around the structure (Webster 1988). Plaza D may have served as a ritual structure with buildings adjacent to it dating to the Late and Post-Classic (along with Plaza K), although it is suspected that this plaza dates sometime during the 8$^{th}$ century (Webster 1988). Plaza J and C both show evidence of earlier construction, though some of the buildings surrounding Plaza C could be Late Classic or later (Webster 1988).

**Methods**

One hundred and eighty two burials were recovered from the House of the Bacabs during PAC II excavations and 28 were selected for AMS $^{14}$C dating based on sample quality and location within the household group (see Figure 3). Collagen was extracted and purified for AMS$^{14}$C dating in the Human Paleoecology and Isotope Geochemistry Laboratory at Penn State. Well-preserved collagen extracts were purified using the modified Longin method with ultrafiltration (Brown et al. 1988) and XAD purification was used for highly degraded samples (Lohse et al. 2014; modified from Stafford et al. 1988, 1991). Initial sample selection was largely based on the overall appearance of the available bone samples. Samples that had a white and chalky appearance were not selected nor were bones that had been burned or were coated with preservatives.

Bone samples (1000 mg) were cut and cleaned using an X-Acto®blade and demineralized in 0.5N HCl for 24-72 hrs at 7°C. The remaining pseudomoph was transferred into a 13x100mm culture tube and gelatinized in 0.01N HCl for 10 hrs. The gelatin solution was then extracted from the tube, frozen in liquid nitrogen and freeze-dried. If a pseudomorph remained it was gelatinized a second time following the same procedure.

Lypholization (freeze-drying) of the samples took approximately 48-72 hours and then percent gelatin yield by weight with respect to the original sample were calculated and recorded. Modern bone contains roughly 22% collagen by weight, while archaeological bone is usually less than 3% collagen (van Klinken 1999). Samples with very low yield (i.e., <1%) or of poor quality were processed by the XAD method, and the others with higher yield were processed by ultrafiltration (UF). For UF, gelatin samples were pipetted into pre-cleaned Centriprep® 30 ultrafilters to retain gelatin larger than 30kDa or kiloDaltons (1 Da=1 amu) (McClure et al 2010). Samples were then centrifuged 3 times for 20 min at 3000 rpm, diluted with nanopure $H_2O$ and centrifuged 3 more times for 20 minutes to remove any remaining salts from the solution. The ultrafiltered collagen was lyophilized and weighed to determine yield.

Established methods were used to remove foreign carbon contaminants such as humectants (such as glycerol, glycerin, etc.) or filter material (reconstituted cellulose from the ultrafilters before use (Ramsey et al 2004, McClure et al 2010). Glycerol coating the Centriprep filters was removed by sonicating the filters at 60°C filled with 0.01N HCl for 1 hour and then rinsed with nanopure $H_2O$. Filters were centrifuged with nanopure water for 3 times for 20 minutes and the inner and outer portions were refilled with nanopure $H_2O$ and sonicated for 1 hour at 60°C. The filters were kept wet until needed after cleaning.

Samples that were not processed by ultrafiltration were processed by XAD chromatography (Stafford et al. 1988, 1991; Lohse et al. 2014). The samples were hydrolyzed in 1.5 mL of 6N HCl for 24 hours at approximately 100°C to dissolve the gelatin material. Before the samples were filtered, syringes were treated to remove a silicone-based lubricant by using 70% methanol to clean the rubber plunger of the syringe as well as drawing and expelling methanol into and out of the syringe 10-12 times. Columns of Supelco ENVI-Chrom Solid Phase Extraction (SPE) with 0.45 µm Millex Durapore filters attached were equilibrated with 50mL 6N HCl. The collagen hydrolysate as HCl was then pipetted onto the SPE column and 10mL 6N HCl was added dropwise with a syringe to force the sample into a 20 mm culture tube. Finally, the sample was dried by passing UHP $N_2$ gas over the sample heated at 50°C for 12 hours. Samples (XAD: 3.5-4.5 mg; UF: 2.0-2.5mg) were then collected in silver foil and placed inside a vacuum-sealed quartz tube with CuO powder and Ag wire and combusted at 800 (XAD) or 900 (UF) °C for 3 hours to produce sample $CO_2$.

Sample $CO_2$ was reduced to graphite at the University of California, Irvine (KCCAMS) at 550°C using $H_2$ and Fe catalyst with reaction water drawn off with $Mg(ClO_4)_2$ (Santos et al 2004). Graphite samples were pressed into Al boats and loaded on a target wheel to make the AMS measurement. Radiocarbon ages are $\delta^{13}C$-corrected for mass dependent fractionation with measured $\delta^{13}C$ values (Stuiver and Polach 1977), and compared with samples of Pleistocene whale bone (background, >48k `$^{14}C$ BP), late AD 1800s cow bone, and OX-1 oxalic acid standards for calibration. Sample quality was evaluated by % crude gelatin yield.AMS $^{14}C$ dates were calibrated with OxCal 4.2 (Ramsey 2009) using the IntCal 13 radiocarbon age calibration curve (Reimer et al 2013).

**Results**

The Copan skeletal remains (N=26) from 9N-8 yielded calibrated dates that largely parallel the rise and fall of the dynasty based on the dedication of stone monuments in the Main Group, but the probability distributions extent to ~AD 900. Figure 4 shows calibrated 2σ dates (2 standard deviations) 21 of which fall in the Late Classic Period (AD 600-900) while the remaining 5 dates fall in the Early Classic Period (AD 250-600). In general samples in the northeast part of 9N-8 were well preserved (see Figure 3) and 10 out of the 13 in Plazas B, D, H, I and K were ultrafiltered. Conversely, samples in Plaza A, E and F were not as well preserved and more than half failed. Out of the remaining samples, most were processed using XAD methods and only one had yields suitable to be processed using ultrafiltration (Webster 2000: 169).

Burials from Plaza A were predominantly Early Classic in age (see Figure 3). Burials from Plaza C were split between Early and Late Classic and Plaza B had one sample that dated to the Early Classic. Late Classic Period burials were present in each plaza. Plazas D, E, F, H and K were composed of all Late Classic materials.

The summed probabilities of the calibrated AMS $^{14}C$ dates from 9N-8 were calculated in OxCal and compared to other chronological datasets from Copan (Figure 5). OxCal combines the probability distributions to create a rough estimate of the number of burials dating to different intervals. Obsidian hydration chronologies were calculated in a similar manner and divided into commoner and elite households for all of Copan, as well as the subset from 9N-8. Monument dates are transcribed from stone monuments dedicated by the Copan Dynasty and binned into 25-year intervals.

Population estimates for the Copan Valley were modeled using ethnographic data based on the assumption that nuclear families in the Copan region averaged five people (Webster et al 2000: 159). Population estimates in this figure were reconstructed from previous demographic studies in Copan and clustered in fifty-year intervals (Webster et al 2000: 161). A similar study was conducted using agricultural based on soil type based on maize production (Webster et al 2000: 170; one of the main staple crops in the Maya region), dietary intake, soil-slope classes, annual rates of population change and recovery periods of the soil.

**Discussion & Conclusion**

Radiocarbon AMS $^{14}C$ dates from twenty-six human burials at the House of the Bacabs (9N-8) in Copan span the Early Classic and Late Classic periods. Normalized probability sums of the House of Bacabs closely parallel the rise and fall of the Copan Dynasty based on the number of stone monuments dedicated through time. The number of burials in the House of the Bacabs peaked during the 8th century and declined significantly during the 9th century. Two burials possibly date to the 9th century, but these fall on a plateau in the radiocarbon calibration curve so it is impossible to know if these individuals date to the late 8th or early 9th centuries AD. Regardless, there is a decline in the number of individuals buried in this elite household after AD 800 and this is consistent with decline or dispersal of this noble group at this time. Comparable work will be required at other elite and commoner households to reconstruct the complexities of the collapse in the Copan Valley.

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## Appendix

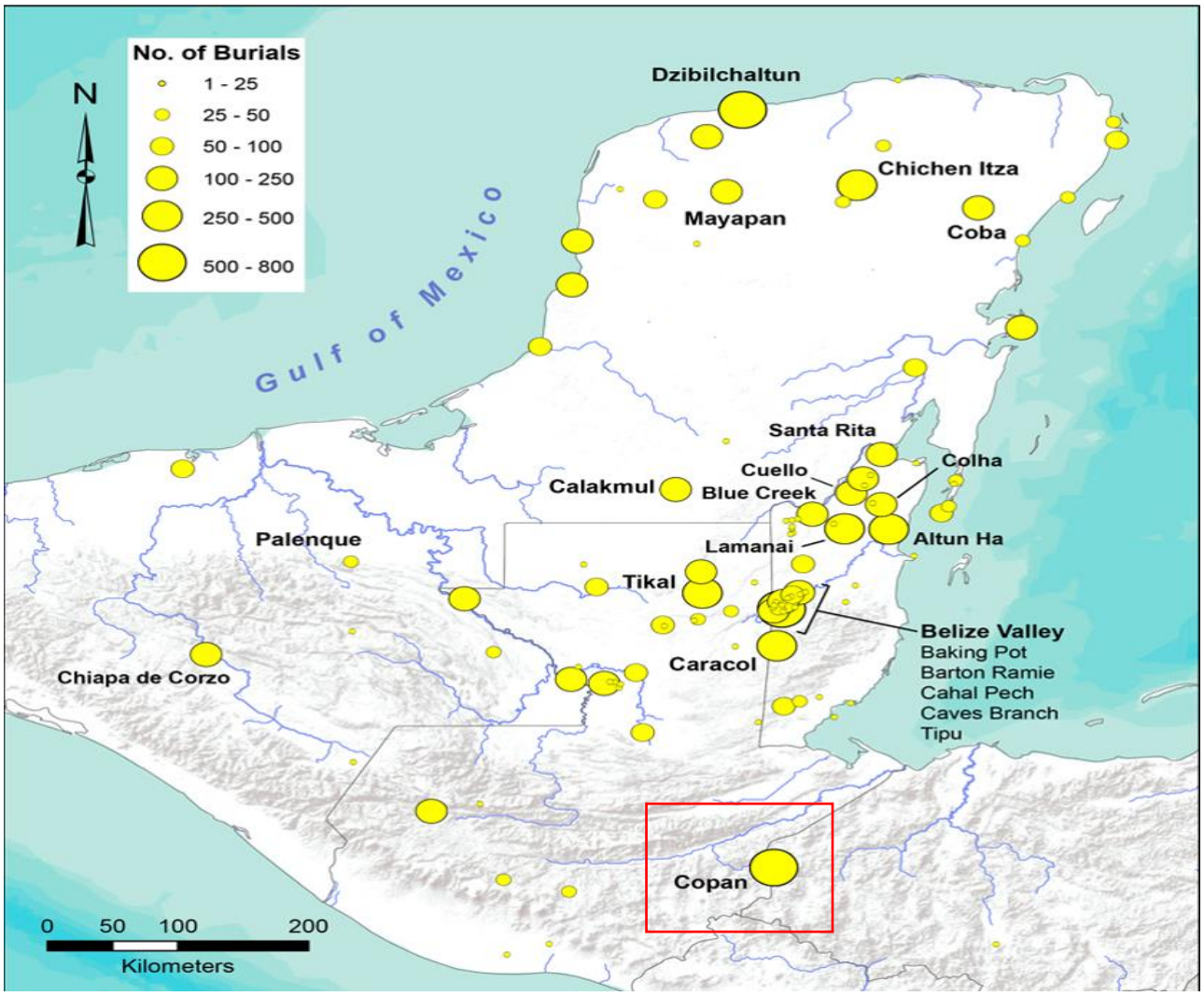



*Figure 1 Map of the Classic Maya Region (AD 250-900). Copan is marked inside the red box. Courtesy of Douglas Kennett*

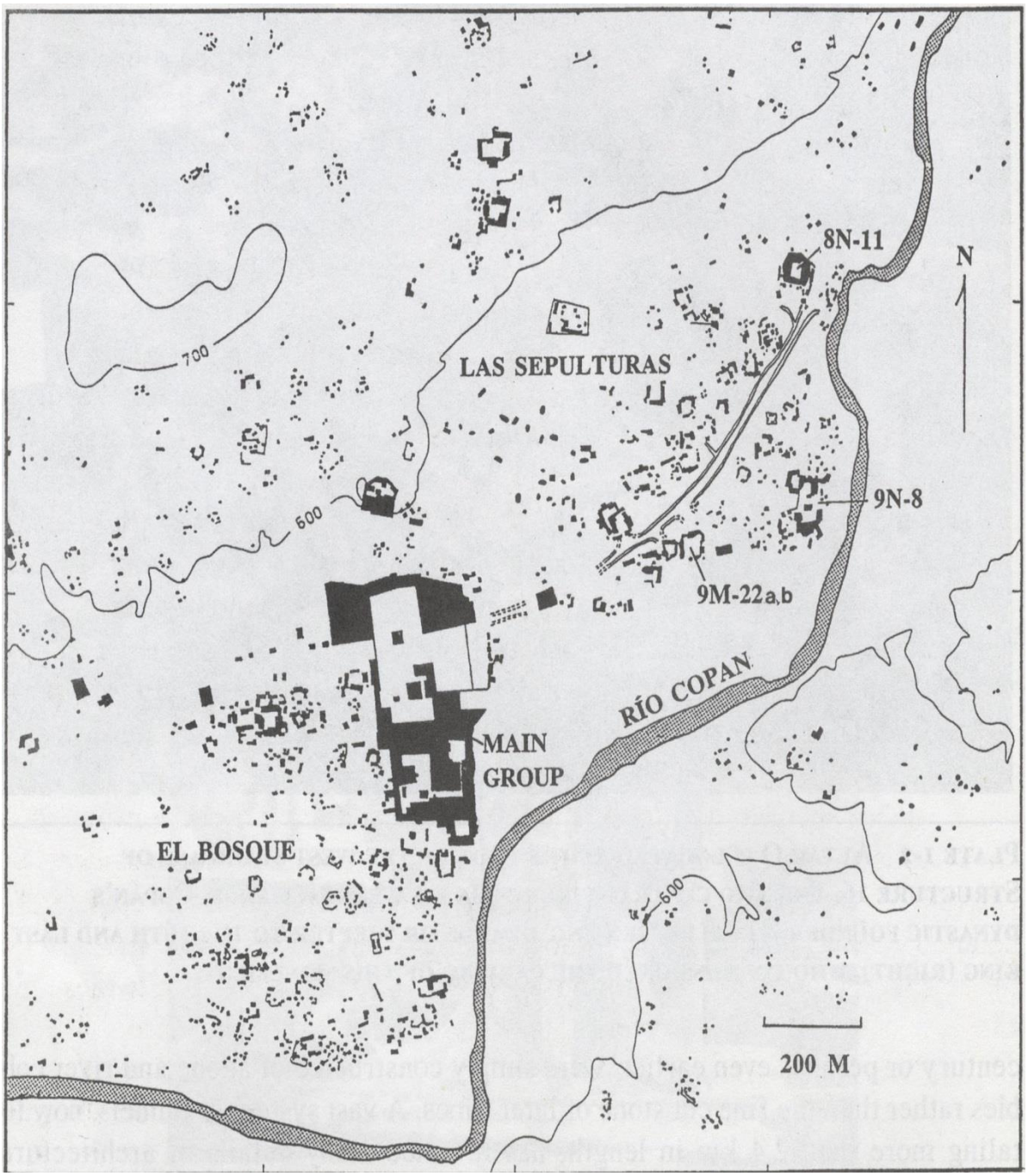
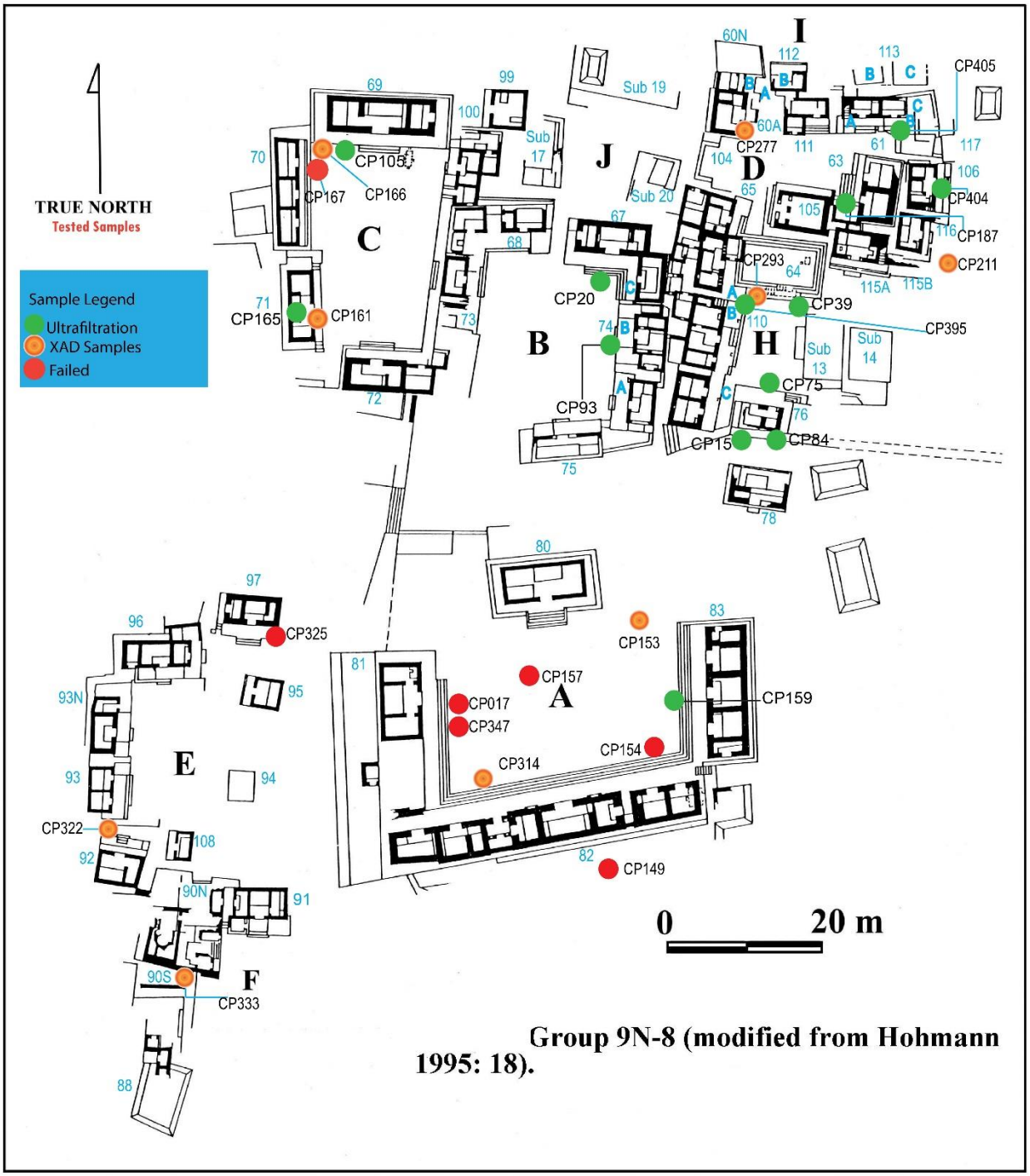



*Figure 2 Map of Copan with The House of Bacabs marked in a red box (Webster 1989)*




**Group 9N-8 (modified from Hohmann 1995: 18).**

*Figure 3 House of the Bacabs (Map Courtesy of Dr. David L. Webster)*

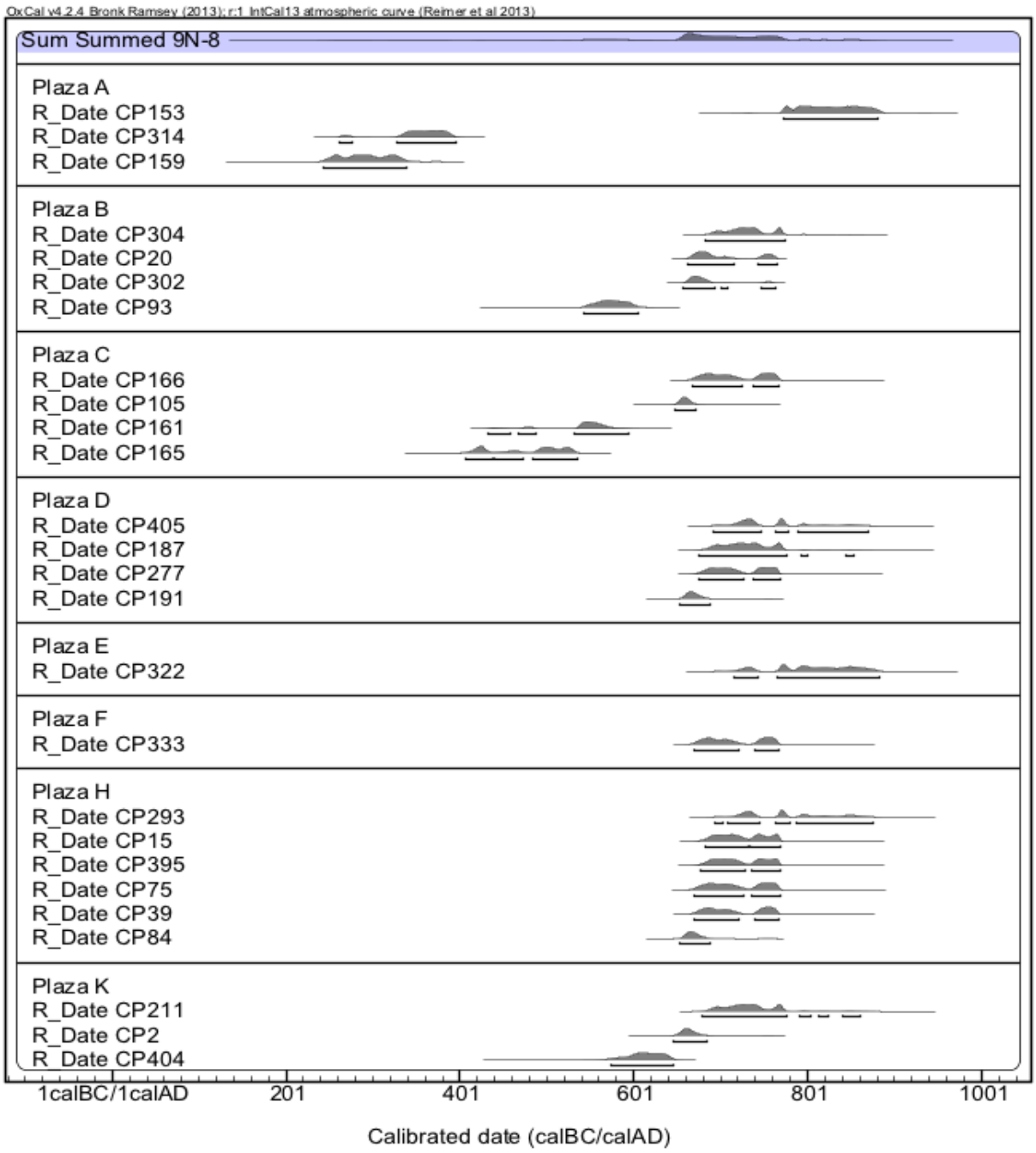



*Figure 4 Calibrated AMS14C Dates. N=26*

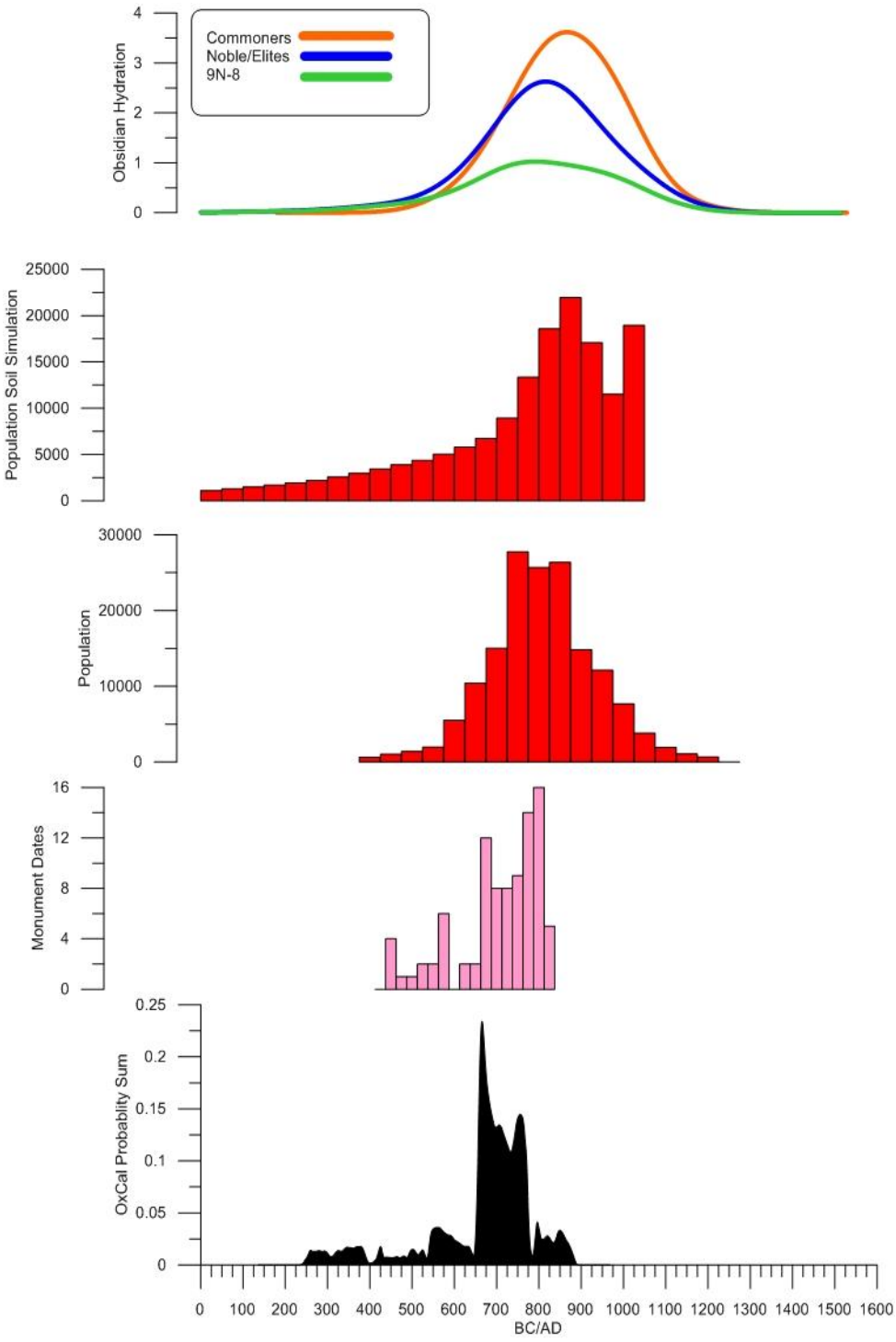



*Figure 5 OxCal Sum compared to Population, Monument and Obsidian Datasets*

| | Gel Yield | Sex | Age | Position | Burial Type | Single/Multiple | Context |
|---|---|---|---|---|---|---|---|
| CP2 | 4.07% | u | child | flex | pit | single | cranial deformation, under front stairs of str 107 |
| CP15 | 4.96% | u | child | flex | pit | single | in indistinguishable midden deposit behind str. 76 and str. 78 |
| CP17 | 3.1% | F | adult | | | | |
| CP20 | 5.60% | F | adult | flex | pit | single | several inlay jades, str. 67 |
| CP39 | 4.16% | M | adult | flex | pit | single | plazafill, good preservation, str. 64 SE corner |
| CP75 | 4.35% | F | adult | flex | cisttop | single | along N base of str. 76 good preservation |
| CP84 | 3.32% | u | child | flex | pit | single | midden area near S wall str. 76 and 78 |
| CP93 | 4.24% | F | adult | extended | pit | single | plaza W fonrt str 74C |
| CP105 | 2.25% | F | adult | extended | pit | single | |
| CP149 | 1.6% | u | child | | pit | single | 60 cm below plaza I |
| CP153 | 6.3% | u | child | flex | crpyt | single | crypt capped by unworked flat lajas |
| CP154 | 2.4% | u | child | | | | 54 cm below plaza III |
| CP157 | 1.4% | M | adult | extended | pit | | |
| CP159 | 3.86% | M | adult | extended | simple tomb | single | El Brujo |
| CP161 | 6.1% | M | und | disart | none | | bones scattered over with ceramics mixed in |
| CP165 | 4.12% | F | adult | tombsimp | complex tomb | multiple | Looted |
| CP166 | 9.3% | M | adult | extended | tombcomp | single | poorly preserved, four central niches |
| CP167 | 1.3% | M | adult | extended | pit | single | pit lined with four faced stones east of body |
| CP187 | 8.1% | M | adult | flex | cisttop | multiple | mixed w OP170-2 |
| CP191 | 5.33% | M | adult | flex | none | single | mixed w OP170-2 lower extremeties |
| CP211 | 4.2% | u | child | flex | none | single | artifacts above OP17-17 |
| CP277 | 10.3% | M | adult | flex | cistline | | cobble lined put |
| CP293 | 6.1% | F | adult | flex | pit | single | found while restoring adjacent to top of OP22-15 chamber |
| CP302 | 4.00% | M | adult | flex | cistline | single | S of str. 68 S terrace |
| CP304 | 4.09% | F | adult | flex | pit | single | E of NE corner of str 75 |
| CP 314 | 5.2% | F | Adult | | | | |

*Table 1 Dated Samples List*

# *Detection of Pathogenic E. coli Using Fluorescence-Based Maltose Coated Gold Nanoparticles*

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*Abstract*

Urinary tract infections (UTIs) result in over 10 million doctor visits each year. 80-90% of these infections are caused by pathogenic *E.coli* bacteria. Current diagnostic methods take at least 2-3 days and are quite labor-intensive. The delay in diagnosis can lead to empirical, rather than evidence-based, management of UTIs, leading to the rise of antibiotic resistant bacteria. Developing a sensitive, specific, and affordable point-of-care biosensor device is imperative in delivering a speedy and accurate diagnosis. Processing clinical samples is one of the most time-consuming steps of diagnosis, and recently, there have been successful attempts to internalize nanoparticles coated in maltoheptaose by *E. coli*, avoiding the sample processing step altogether. This study analyzes the potential of maltose-coated gold nanoparticles attached to a double stranded DNA (dsDNA) probe system to detect complementary 16S rRNA as a biosensor for different strains and species of bacteria.

## Introduction

Bacterial pathogens that cause infectious disease are important targets for detection and identification in healthcare and medicine. For example, urinary tract infections (UTIs) result in over 10 million doctor's visits each year, where the uropathogenic bacteria *E. coli* cause 80-90 % of infections (other bacteria include *P. aeruginosa* and *S.epidermidis* among others).[1] As of now, the process from sample collection to diagnosis of these types of infections takes at least 2-3 days using the current "gold standard" methods of culturing, microscopy, and antibiotic susceptibility testing (AST). The absence of a diagnosis in a timely matter results in the over and misuse of antibiotics, which could lead to the emergence of antibiotic resistant bacteria, as well as spread of the infection if left undiagnosed. The development of point-of-care testing with rapid, sensitive, and cost-effective detection methods is essential in evidence-based, rather than empirical, management of UTIs and other infectious diseases as well as the development of a proper patient treatment plan.

Currently, biosensors have shown much promise in the field of pathogen detection due to their portable size, sensitivity, and rapid analysis. They allow for earlier and more sensitive detection, less than $10^3$ CFU/ml, without sample processing, significantly expediting the process. This is especially important considering that many bacterial infections are caused by as low as 10 organisms.[2]

Specifically, nanoparticles have important applications in biosensing due to their optoelectronic, magnetic, and size-dependent properties. Gold nanoparticles (GNPs), in particular, possess additional light-scattering and absorption properties that are 4-6 orders higher than that of organic dyes and

fluorophores.[3] Moreover, GNPs are biocompatible and can be easily conjugated to biomolecules, including nucleic acids and carbohydrates.[4]A recent facile and eco-friendly procedure to synthesize maltose, a G2 carbohydrate similar to maltoheptaose, a G7 carbohydrate known to promote nanoparticle internalization by pathogenic *E. coli* [5], coated GNPs has recently been discovered.[6]

Additionally, GNPs conjugated to double stranded DNA (dsDNA) probes have been widely used as optical biosensors to detect targets. Some current methods work via a competitive displacement mechanism. In this mechanism, a single stranded DNA (ssDNA) detector probe (usually 24 base pairs) that could bind to a biological target analyte is first hybridized to a short (usually 12-18 bp) ssDNA synthetic target sequence and then conjugated to the nanoparticle. GNPs, due to their luminescent quality, can effectively quench the fluorescence of these probes when they are in close proximity. When the detector probe is exposed to the biological target, a longer sequence that is more thermodynamically and kinetically favorable, the biological target competes with and eventually displaces the synthetic target to restore fluorescence through release of the GNP and rehybridization of the detector strand with the biological target analyte.[7]

The same strategy can be applied for bacterial detection using 16S rRNA as the target analyte due to its high copy number, highly conserved genetic sequence within a species, and hypervariable regions that differ greatly between species.[8] This study incorporates the competitive displacement mechanisms of dsDNA probes with MGNPs as a quencher into pathogen detection using 16S rRNA. The general experimental scheme can be seen in **Figure 1.** The results from this study will serve as a comparison to current pathogen detection methods.

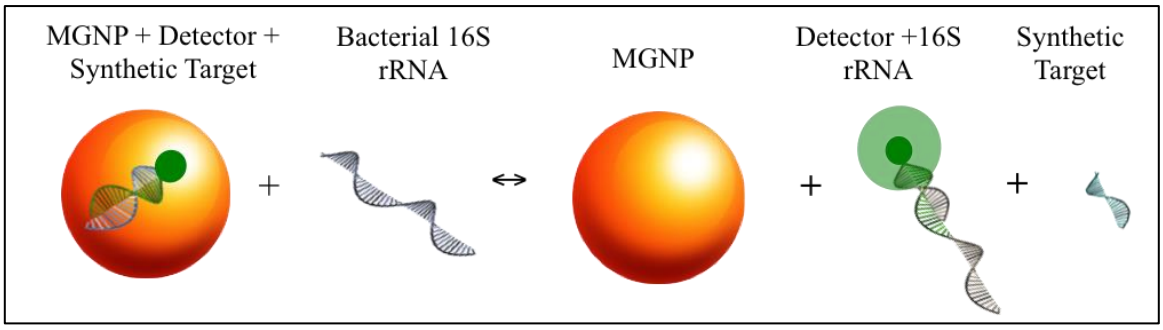



**Figure 1**: Competitive Displacement of Nanoparticle and Synthetic Target by 16S rRNA

## Materials and Methods

*Bacterial and clinical urine samples.* Uropathogenic clinical isolates, including *E. coli*, *P. aeruginosa*, and *S. epidermidis*, were obtained and collected with the approval from Stanford University and VA Palo Alto Health Care System (VAPAHCS) Institutional Review Board. Identification of microorganisms was performed in the VAPAHCS clinical microbiology laboratory. Both bacteria were inoculated with Luria broth (LB) in a shaker at 37 C and grown until the $OD_{600}$= 0.5. The bacteria were then mixed with 40% glycerol and stored at -80°C. S. Samples were pelleted by centrifugation for 5 minutes at 7,000 RPM (microfuge), the supernatant was removed, and washed with PBS buffer (0.5 M, pH = 7.4). For the controlled lysis experiments, the bacteria were heated at 90°C for 10 minutes in PBS buffer (0.01M, pH =7.4) and then cooled down for 5 minutes before incubation with MGNPs.

*Molecular probe design.* Probes were designed using the following workflow. A target sequence was designed by alignment against 16S rDNA sequences from NCBI using GenBank. The detector probe was designed to binid to the loop region of the 16S rRNA. The loop was designed by: folding the target sequence, picking the loop sequence, and checking the loop specificity using *mfold* and NCBI BLAST). Finally, the stem was designed by: picking the stem sequence, folding the molecular beacon (MB), checking the MB self-dimer, and checking MB specificity using IDT OligoAnalyzer 3.0. The sequences were ordered from Integrated DNA Technologies Inc (Coralville, IA, USA). The buffer solution for the dsDNA probe contains 1X TE buffer. A 100 nM concentration of the probe was used.

| Probe Name | Label | Sequence | Base Pairs |
|---|---|---|---|
| ***E. coli* Detector** | 5'-FITC | 5'-CTG CGG GTA ACG TCA ATG AGC AAA-3' | 24 |
| ***E. coli* Target** | Unlabeled | 5'-TTT GCT CAT TGA CGT TAC CCG CAG- 3' | 24 |

*Synthesis and functionalization of maltose-conjugated GNPs with dsDNA probes.* Maltose conjugated gold nanoparticles were synthesized based on the facile and eco-friendly procedure by Katti et al. (2009) using sodium citrate, instead of THPAL, as the reducing agent. Nanoparticles were left to incubate with dsDNA probes for 10 minutes at 37°C and cooled down to room temperature for 5 minutes before incubating with bacteria. The dsDNA probes were previously mixed in a 4:1 target to detector ratio for 10 minutes at 37°C. The final samples were all 200 µl.

*Incubation of functionalized MGNPs with Bacteria.* The functionalized MGNPs (2% in 0.01M PBS, 100 µl) were added to bacterial samples (100 µl) and incubated at 37°C for 10 minutes.

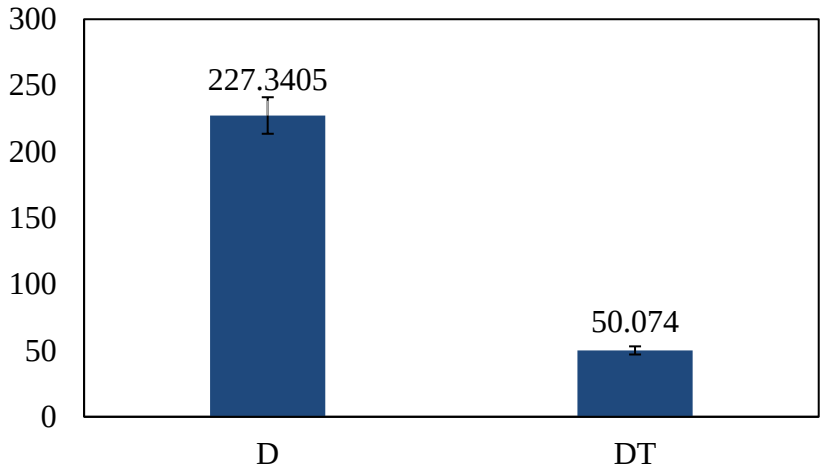
*TEM imaging.* The thin section samples were prepared as follows. A suspension of MGNP-treated bacterial cells or untreated bacterial cells (1 ml) was centrifuged at 2000 rpm for 5 minutes and the supernatant was removed. The pellet was then resuspended in a solution of glutaraldehyde in PBS (1%, 0.01M). The solution was centrifuged at 1000 rpm for 5 minutes and the supernatant was removed. Fixative was changed and the cells were left on ice for 30 minutes, avoiding any contact with the pellet. Suspension was washed (3 min x 3) with caco (0.1M). The pellet was then incubated in a solution of OsO4 in PBS (1%, 0.2M) at 4°C for 1 hour with one change. The excess OsO4 was washed with caco (0.1M). The solution was then en bloc stained with UA (2%) for 30 minutes. Afterwards, 2 dd$H_2O$ changes were done. The pellet was then dehydrated by incubating the pellet in 50%, 75%, and 90%, and 100% (1 ml, 2 times) ethanol at 4 °C for 7 minutes each. At room temperature, the solution was washed with 100% Acetone (7 min x 2). The embedding resin medium was prepared by mixing Acetone (250 ul) and Spurr's resin (250 µl) for 2 hours at room temperature. The pellet was then incubated (2 hrs x 2) with Spurr's resin (100%). The pellet with embedding resin was allowed to cure overnight at 70°C in a vacuum oven overnight.

*Fluorescence measurements.* Measurements were run using the following settings for the FITC tag: excitation: 488 nm, emission: 518 nm, and cutoff: 495 nm. The samples were run on a 96-well plate reader three times with the standard deviation as the designated error.

## Results and Discussion

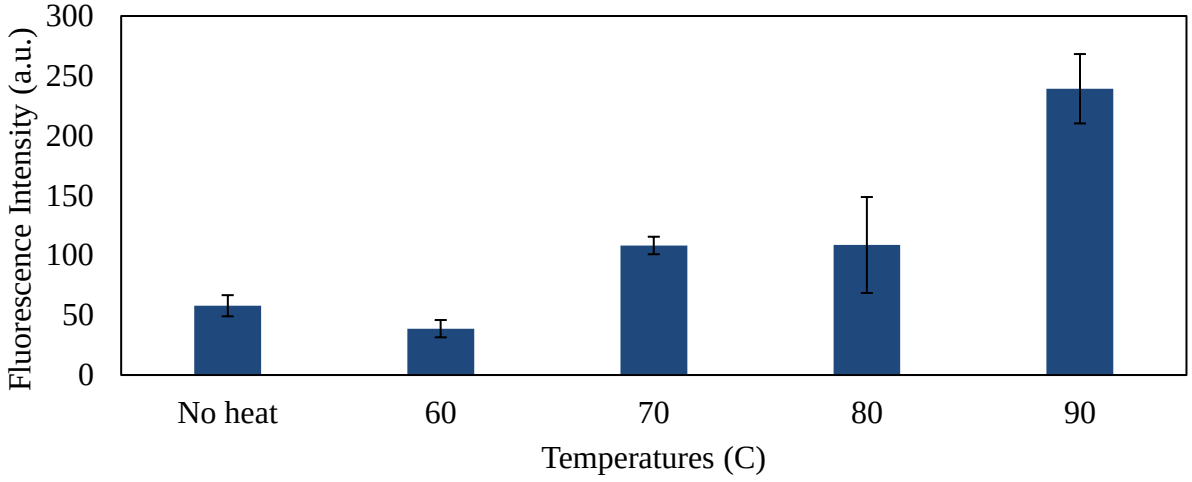
*Quenching efficiency.* An experiment to determine how effectively the gold nanoparticle can quench the detector fluorophores (DT), to determine background, was done. Specifically, the first experiment tested the detector's fluorophore in the presence of MGNPs, which should exhibit full fluorescence. The second experiment introduced the synthetic target, a strand required for effective hybridization to the MGNP surface. The results showed a 77.9% quenching efficiency, which is acceptable, but a 90% or higher efficiency is most desirable for a marketable biosensor. (**Figure 2**)

**Figure 2:** EC Probe Quenching Efficiency = 77.9%



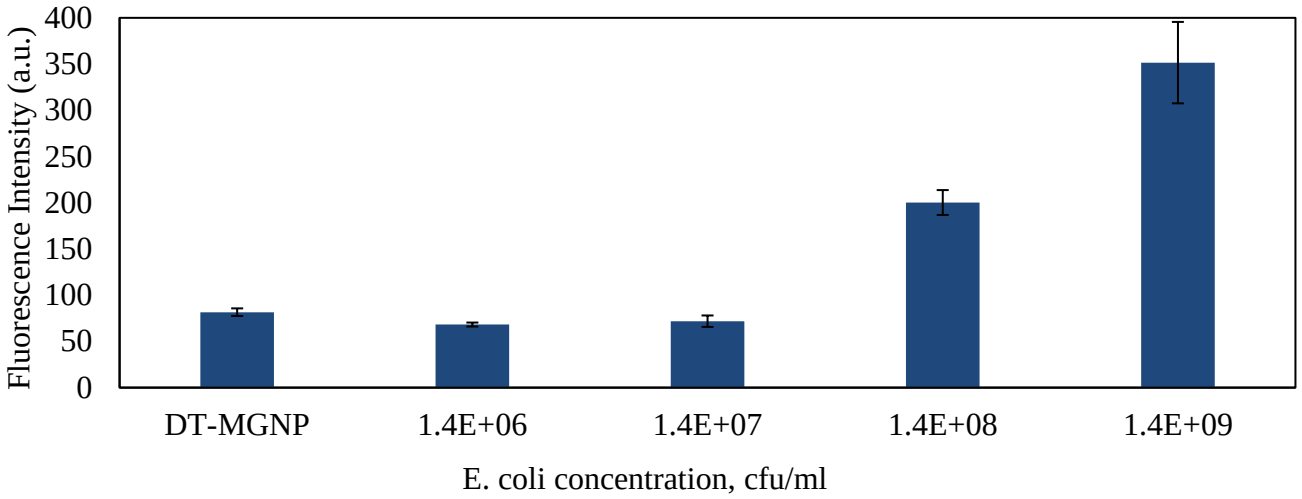

*Bacterial lysate preparation.* To determine the optimal conditions for thermal lysis, our positive control condition, temperatures ranging from 60°C to 90°C were tested. Specifically, a sample of *E. coli* (strain 137, clinical isolate) with $OD_{600}$= 0.5, or $10^8$ CFU/ml was used heated at each of these temperatures for 10 minutes. 90°C showed the highest increase in fluorescence intensity (**Figure 3**) when compared to the fluorescence of the detector alone (data not shown). The 90°C temperature was chosen and used for the rest of the experiments.

**Figure 3**: Thermally Lysed *E.coli* + DT-MGNP



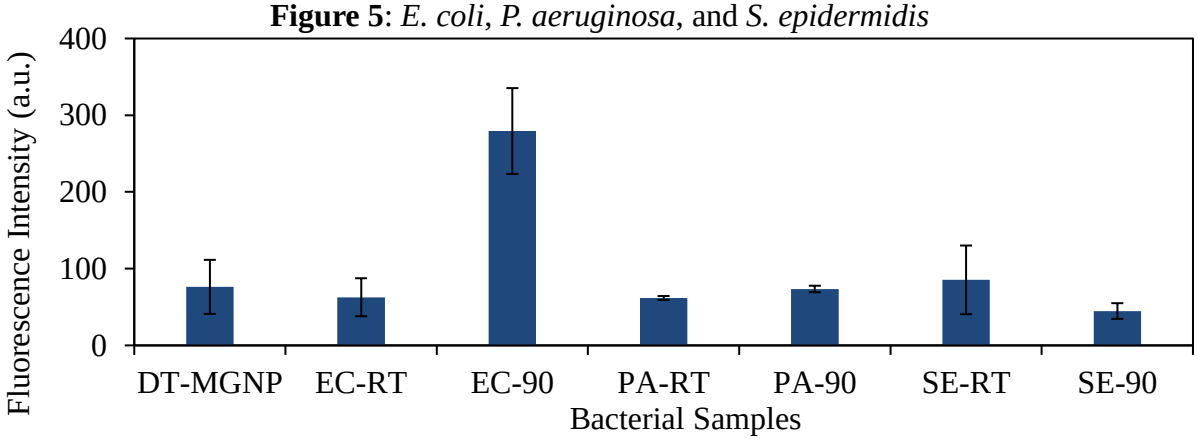
To further characterize the relationship between fluorescence and 16S rRNA release and hybridization, serial dilutions of the thermally lysed *E. coli* were performed and showed the fluorescence intensity increasing with increasing *E. coli* concentrations (**Figure 4**). Unfortunately, this assay does not seem to be sensitive, since the signal does not notably increase until the concentration is at $10^8$ CFU/ml. Notably, although heating bacterial cells does effectively release many of its components including nucleic acids, another reason for the positive results arises from the unfolding of the secondary structure of 16S rRNA, facilitating the hybridization process.

**Figure 4**: Lysed *E. coli* Serial Dilutions




*Probe specificity.* To determine how specific our dsDNA probes were to *E.coli* (EC), other bacteria including *P. aeruginosa* (PA) and *S. epidermidis* (SE) were tested. Bacterial samples at room temperature and at 90°C were used. These experiments showed that the *E. coli* lysate 16S rRNA restored fluorescence of the detector probe as expected from the previous experiment. However, the *E. coli* bacteria alone, along with all other bacterial types (lysed or unlysed) did not restore fluorescence. (**Figure 5**) This most likely means the 16S rRNA target did not hybridize to the detector probe, either because the bacteria did not internalize the MGNPs or the dsDNA could not effectively hybridize to the secondary structure of 16S rRNA.

**Figure 5**: *E. coli*, *P. aeruginosa*, and *S. epidermidis*



*Nanoparticle internalization*. To determine whether *E. coli* internalized the MGNPs, TEM images of the bacteria incubated with MGNP (10%, 0.01M PBS). This experiment was done as a proof-of-concept to determine if internalization was possible at all, which is why we chose a 10% MGNP concentration, as opposed to the normally used 2%. The images show what resembles nanoparticles in high electron density granules (black spheres), but further studies are needed to confirm the particles as nanoparticles. (**Figure 6**) Based on morphology and size, it is most likely they are nanoparticles. Additionally, changes in morphology of the bacteria from the process of TEM preparation, as seen in a (*E. coli* is rod-shaped), is normal.

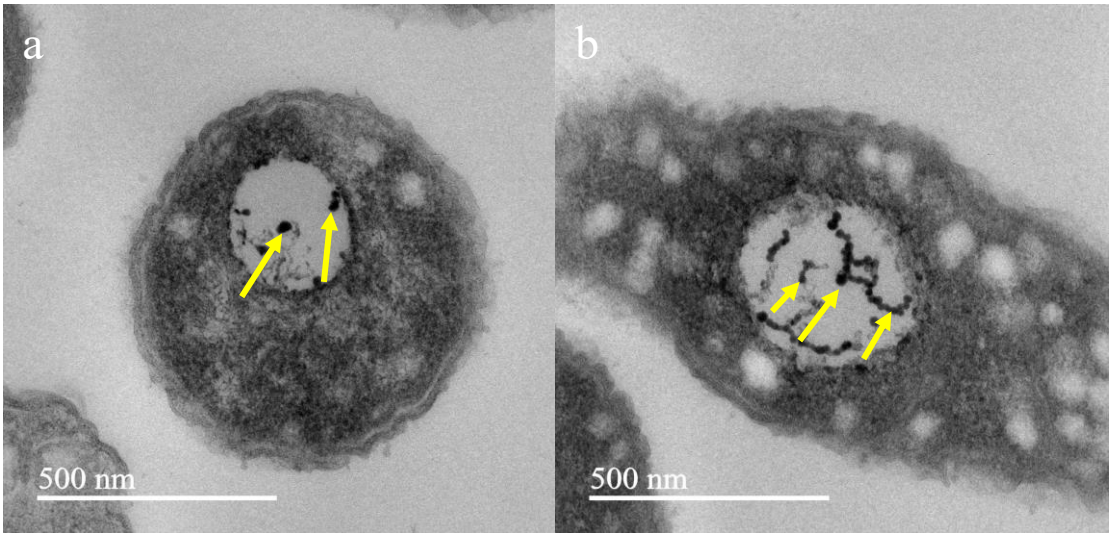



**Figure 6**: TEM Images of *E. coli* Incubated with MGNPs (a,b)

## Conclusion

Overall, the device requires testing a variety of detector and target probe sizes to optimize quenching efficiencies (currently at 77%, data not shown) as well as 16S rRNA and detector hybridization. Further TEM images are required to determine nanoparticle internalization, although it is most likely the case. If it is the case, the reasons behind why these particles are not restoring fluorescence of the detector probe should be further investigated.

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# *Microtubule dynamics in* Drosophila *models of neurodegeneration in search of a neuroprotective response*

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## Abstract

Microtubules function as both structural components and as the tracks for transport in neurons. Studies have shown that defects in microtubule organization lead to neurodegenerative disease. Microtubules have their own organizational polarity, which can be assayed by tagging end-binding protein 1, EB1, with GFP. The majority of EB1 comets travel towards the cell body. The polarity can be assayed to identify a change in microtubule organization. In a previous study conducted by Chen et al, there was an upregulation in microtubule dynamics in *Drosophila* that served as models for poly-Q neurodegenerative diseases. The authors identified an increase in dendrite stability, which is thought to be microtubule based. When the poly-Q gene was expressed, dendrites did not prune back after being subjected to a pulsed-UV laser. The goal of this study is to identify whether other candidate genes implicated in various neurodegenerative diseases cause an upregulation in microtubules and an increase in stability. This study is critical to understanding the role of microtubule dynamics in a novel neuroprotective pathway.

## Introduction

Neurons are a means of communication and drive many processes in the body. They are specialized cells that can send or receive signals from the brain. The three types of neurons are sensory, motor, and interneurons. The brain tells the body when to move, processes information, and receives information from both the body and the outside world. Without neurons the brain loses its method of communication with rest of the body, which has dire consequences.

In neurodegenerative disease the structure and function of neurons are progressively lost. These diseases include Alzheimer's, Parkinson's, ALS, and many others. Symptoms of these diseases may include, but are not limited to confusion, mental decline, muscle weakness, coordination problems, tremor, and involuntary movement[17-20]. Causes of disease and some key players have been identified [14, 16, 8], but there still remains many knowledge gaps to fill. Understanding the mechanism of disease may lead to improved treatments and patient outcomes.

The causes of neurodegenerative disease vary by disease, but many stem from copy number variation, and genetic mutations that can result in abnormal proteins. Spinocerebellar ataxias (SCA) and Huntington's disease are caused by trinucleotide expansion repeats. In a healthy individual, there are trinucleotide repeats, typically CAG repeats. Normally there are about 6 to 35 repeats in a person. In the disease state the trinucleotide repeat region is

expanded[14]. These trinucleotide expansion repeats may be due to defects in replication machinery, which slip when copying a repeat segment and then start over. The mechanism of expansion is not entirely clear, but studies support that expansion is due to this slippage during replication or defects in excision repair[12].

Other studies suggest that aberrant proteins may lead to neurodegenerative disease[16]. Prions are abnormal proteins that become infectious and can convert other proteins into the abnormal form. Alzheimer's, for example, is caused by the production of toxic alpha-beta (Aβ) peptide which accumulates and forms amyloid plaques. Aβ peptides are derived from an amyloid precursor protein (APP) that is cleaved by the enzymes BACE and γ-secretase. In addition to amyloid plaques, intracellular neurofibrillary tangles (iNFTs) are also present. INFTs are composed of tau protein which is a hyper-phosphorylated microtubule associated protein[14].

More recent studies have shown that defects in microtubule organization can lead to neurodegenerative disease[5]. Thus far, some key factors in the microtubule organization pathway have been identified. In the Rolls lab we continue to look for contributors of the microtubule organization pathway, and I used a microtubule assay in this experiment.

**Figure 1**: Microtubule organization is polymeric and

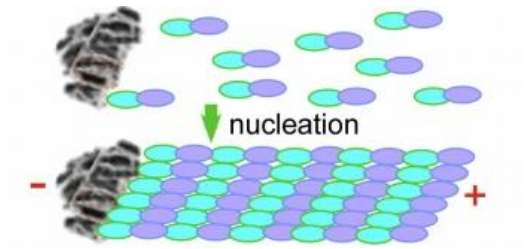
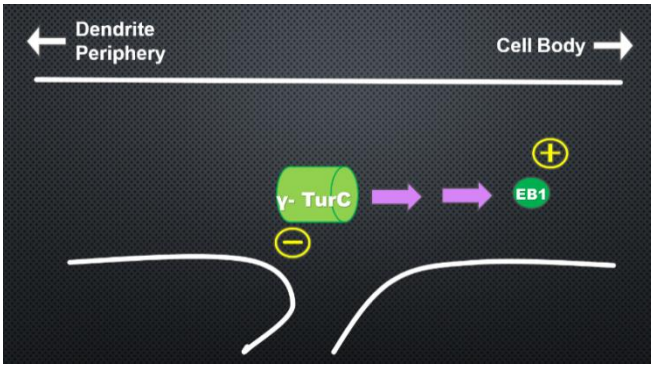



**Figure 2**: GFP tagged plus-ends travel through dendrite branch points




A previous study led by Li Chen in the Rolls Lab identified a microtubule response when neurons expressed poly-Q proteins that are associated with neurodegenerative disease. There was a statistically significant increase in microtubule dynamics. In addition to the microtubule response, dendrite stability increased. After a dendrotomy, the dendrites degenerate. In the study it was found that if they did an axotomy preceeding the dendrotomy, the dendrites would not prune back. It was hypothesized that a neuroprotective response was being activated due to the stress of the expressed transgenes[7].

The hypothesis is that the increased stability seen in the Li Chen study is due to the upregulation of microtubules. For our purposes, an increase in microtubule dynamics serves as an indication that there is a neuroprotective response being elicited in the dendrites. The question remains whether other triggers for neurodegeneration result in microtubule upregulation.

## Results

### *Microtubule dynamics in dendrites with disease associated transgenes*

The negative control had similar numbers of plus-end microtubules as other controls used in the lab previously. Since the plus-ends of microtubules are tagged with GFP, they can be counted when they pass the dendrite branch points. The total number of microtubules that passed at least one branch point were counted and divided by the length of the dendrite. This baseline is represented at 1 in **Figure 4**, and is labeled as Negative Control (Q27). The gene used in the Li Chen experiment was used in this experiment in order to obtain an idea of what the increase in microtubule dynamics looked like. The data collected from that repeated gene, Q78, served as a model of the microtubule response. Thus in **Figure 3** and **Figure 4** it is listed as Positive Control (Q78). The positive control did have a significant increase of 54.4%. The data was normalized to the negative control in microtubules per micron.

In an earlier study by Kleele et al., a microtubule response was found when mice overexpressed mutant Sod1[8]. Sod1 has been known to be associated with ALS. Sod1 is superoxide dismutase 1, which is an enzyme that works to eliminate toxins from the body. The enzyme plays a large role in eliminating superoxide radicals[2]. *Drosophila* males that expressed the human defective Sod gene1 were crossed with 221, Gal4, UAS EB1-GFP females to obtain the genotype, $Sod1/x\,;221, Gal4,\ UAS\ EB1-GFP/Sod1$. Microtubule comet tracking assays were taken for twenty-six animal organisms. The fold increase in microtubules per micron is 11% which is not statistically significant. Bonini et al. mention that *Drosophila* models with Sod1 may only serve as neurodegeneration models in the eye[11]. Other Sod1 forms will be tested including knockdowns of Sod1.

The defective gene labeled as MAPTau contains the human genes APP, BACE1, and MAPTau[1]. These three genes together are associated with Alzheimer's disease. As mentioned in the introduction APP is the amyloid precursor protein and BACE1 is a cleaving enzyme. MAPTau is a microtubule-associated protein that is hyperphosphorylated in Alzheimer's[3]. The microtubule change of 43.7% increase for MAPTau is not statistically significant when compared to Control Q27. However, it is trending upwards at a p-value of 0.08, and it may be statistically significant after more biological models are added.

Another control, yellow-white, was performed since it was crossed with the same tester line as MAPTau and Sod1. The tester line females used in these lines were 221, Gal4, UAS EB1-GFP. The average microtubules that passed branch points for the yellow-white larva was 0.445 MT/micron, which is higher than the average for MAPTau and Sod1. Due to the variation in this baseline data, the cross for yellow-white and data collection will be repeated.

**Figure 3**: Microtubule dynamics in *Drosophila* dendrites of overexpressed human disease proteins

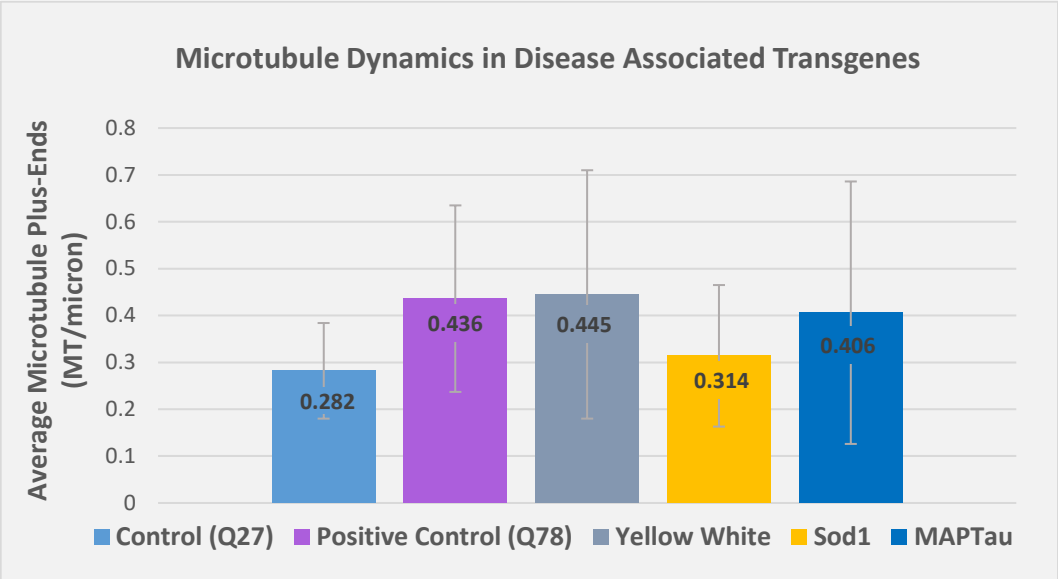
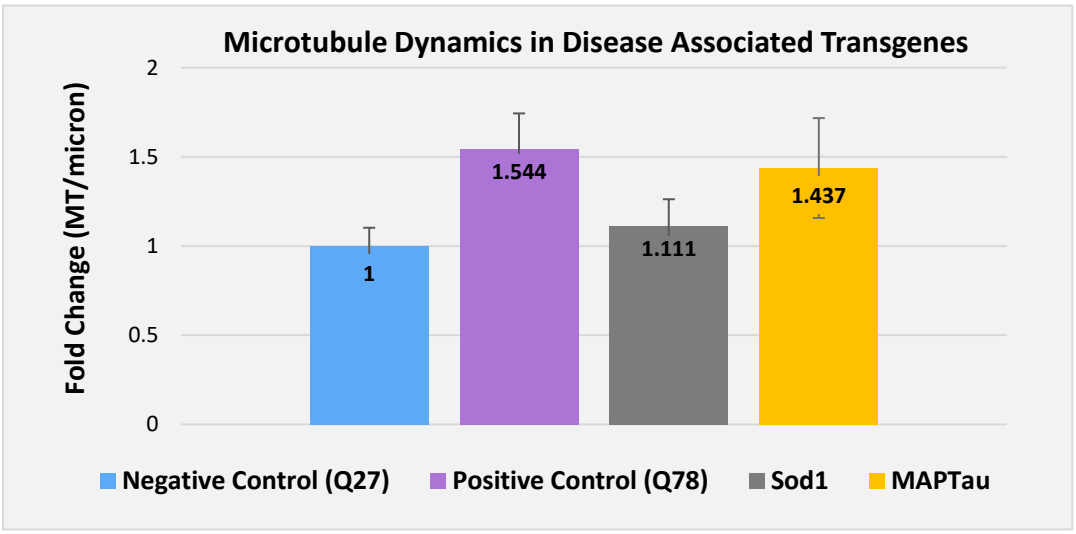



**Figure 4**: Percent change in microtubule dynamics for *Drosophila* with transgenes




***Microtubule dynamics in dendrites with gene knockdown***

There are several strategies to model neurodegeneration in flies: either by overexpressing human disease proteins or by knocking down *Drosophila* genes required for neuronal maintenance. The strategy used in this set of data is knockdown of genes. Dj-1alpha, also known as PARK7, is associated with Parkinson's disease. Dj-1 alpha is a positive regulator of androgen receptor-dependent transcription. It is also thought that it protects neurons against oxidative stress[3]. In this study dj-1 alpha had a statistically significant increase of 61.7% in microtubule dynamics (**Figure 6**). HtrA2 is also associated with Parkinson's disease. The HtrA2 gene

encodes a serine peptidase which is involved in apoptosis[2]. Thus, with the knockdown of HtrA2 there should be a decrease in the amount of apoptosis. In our study, when *Drosophila* expressed HtrA2 there was an increase of 78.3% in microtubule dynamics. Therefore, both the genes associated with Parkinson's disease elicit a microtubule response, which indicates a neuroprotective response (**Figure 5**).

**Figure 5**: Microtubule dynamics in *Drosophila* dendrites with gene knockdowns

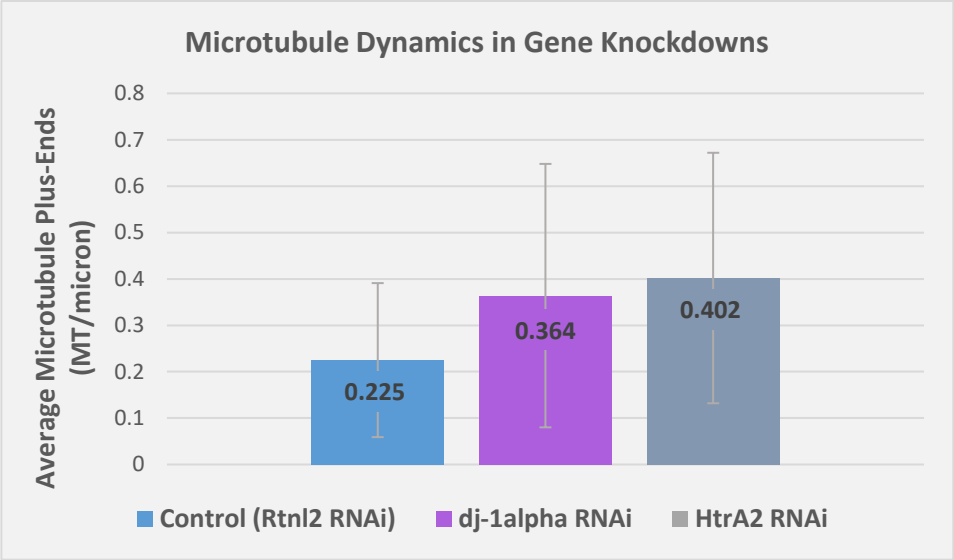
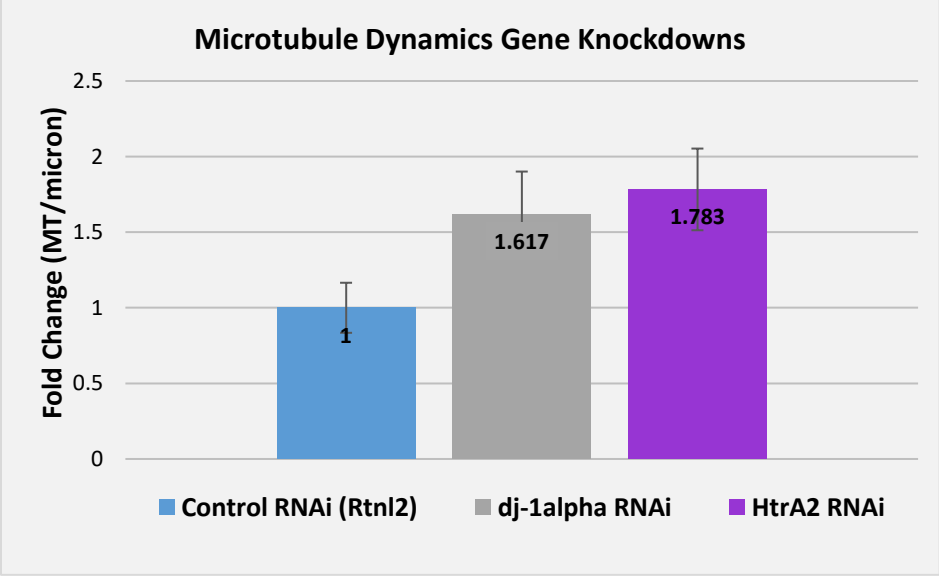



**Figure 6**: Percent change in microtubule dynamics for gene knockdowns



## Discussion

The original hypothesis was that the neuroprotective response is a general characteristic among other neurodegenerative disease associated genes. With the current data that continues to be the hypothesis, since the majority of the genes tested had a statistically significant or almost statistically significant increase in microtubule dynamics. Despite data collected, we cannot say that there is also a neuroprotective response associated with these genes yet. We used the increase in microtubule dynamics as the primary indicator of the neuroprotective response, however we must still look for an increase in dendrite stability, through a lack of degeneration. Our next step is to subject dendrites to a pulsed-UV laser and look for degeneration. There are other genes associated with neurodegenerative disease that are on our list to test. After the screenings are done we will begin our research into learning how the neuron identifies that there is stress or injury present. Our goal is also to discover the neuroprotection pathway in order to use it for future treatment. If this pathway can protect temporarily protect neurons from neurodegeneration, the pathway could be turned on in disease patients in order to slow down disease progression.

## Materials and Methods

### *Selection of cells for microtubule dynamics and injury*

In *Drosophila* neurons are classified by how complex the structure is. To study microtubule dynamics we looked at the simplest neuron type, class I. In a cluster of neurons, the cell with its dendritic branches pointing towards the dorsal end of the larva is class I neuron, or ddaE cell. DdaE cells are sensory neurons and are commonly referred to as the comb dendrite.

### **Drosophila** *stocks and crosses*

All *Drosophila* stocks were obtained through the Bloomington Stock Center. The tester line 221Gal4, UAS-EB1-GFP was used in order to express GFP in class I neurons and crossed with transgenic *Drosophila*. The transgenic *Drosophila* contained mutant forms of proteins which serve as models for various neurodegenerative diseases. *Drosophila* that had RNAi knockdown of proteins instead of mutant forms were crossed with the tester line Dicer 2; 221 Gal4, UAS EB1-GFP/TM6 in order to enhance the amount of knockdown. The Dicer2 female tester line was also crossed with Q27 and Q78 controls. The table below provides genes of the experimental lines and their descriptions provided by Bloomington. The table is organized by the disease that is modeled.

| Gene Abbreviation | Chromosome Location | Tester Line | Progeny Genotype |
|---|---|---|---|
| Q27 | 3 | Dicer2; UAS Gal4, 221, EB1-GFP/TM6 | $\frac{Dicer\ 2;}{+}; \frac{UAS\ Gal4, 221, EB1-GFP}{Q27}$ |
| Q78 | 2 or 3 | Dicer2; UAS Gal4, 221, EB1-GFP/TM6 | $\frac{Dicer\ 2;}{+}; \frac{UAS\ Gal4, 221, EB1-GFP}{Q78}$ |
| Sod1 | 2;3 | 221 Gal4, UAS EB1-GFP | $\frac{Sod1}{+}; \frac{221\ Gal\ 4, UAS\ EB1-GFP}{Sod1}$ |
| MAPTau | 3 | 221 Gal4, UAS EB1-GFP | $\frac{221\ Gal\ 4, UAS\ EB1-GFP}{APP, BACE1, MAPT}$ |
| Dj-1alpha RNAi | 2 | Dicer2; UAS Gal4, 221, EB1-GFP/TM6 | $\frac{Dicer\ 2;}{dj-1alph}; \frac{UAS\ Gal4, 221, EB1-GFP}{+}$ |
| HtrA2 RNAi | 2 | Dicer2; UAS Gal4, 221, EB1-GFP/TM6 | $\frac{Dicer\ 2;}{HtrA2}; \frac{UAS\ Gal4, 221, EB1-GFP}{+}$ |
| Rtnl2 RNAi | 2 | Dicer2; UAS Gal4, 221, EB1-GFP/TM6 | $\frac{Dicer\ 2;}{rtnl2}; \frac{UAS\ Gal4, 221, EB1-GFP}{+}$ |

*Q78 labeled ambiguously. Labeled as stock number 8150 (8141) which have the mutation on different chromosomes.

### *Larva reproduction and growth*

Stocks and crosses were kept at 25°C for optimal growth. Female virgins were selected from the tester line and crossed with males from the experimental line. The female *Drosophila* were given 24hrs to lay eggs and then the food cap was replaced. The larvae in the food cap were grown for three days so that they would reach the stage of third instar larvae. Changing the food cap daily ensures that all larvae within that cap are the same age.

### *Microtubule assay and quantification*

A wide field Zeiss microscope (LSM510, Carl Zeiss, Oberkochen, Germany) was used to take videos of microtubule branch points. In all videos at least three branch points were in focus to ensure consistency and accuracy. In order to quantify the data collected, the amount of microtubule comets that passed through a branch point were counted and the direction (plus-end-in or plus-end-out) were noted. The total number of microtubules are divided by the length of the dendrite branch analyzed in order to find the total microtubules per micron. The experimental average MT/micron was compared against MT/micron of the control using a t-test.

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3. MAPT microtubule associated protein tau [ *Homo sapiens* (human) ]. (July 31, 2016). Retrieved from http://www.ncbi.nlm.nih.gov/gene/4137
4. PARK7 Parkinsonism associated degyclase [*Homo sapiens* (human) ]. (2016, July 30, 2016).
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# *The Evolution of Slavery and Freedom from the 17th century to Emancipation*

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The problem of slavery and freedom was central to the foundation of the modern world. The Transatlantic Slave Trade, beginning in the 15th Century and continuing through the 19th century, created the "new world" slave societies in the Americas and led to the racialization of slavery. It played a major role in the rise of capitalism by providing the capital and labor required to fuel the vast market networks based on the commodification of human beings. The trade in human beings created a social order that deepened the ties between slavery and capitalism. The formation of the American colonies in the 17th century was part of this process, as African slavery became the basis of the emerging Southern slave economy. By the 18th century, with the rise of the Age of Revolution, slavery became a problem in the Western democratic countries. The problem of slavery and freedom presented an irreconcilable contradiction for American society, leading eventually to a civil war. The problem then became one that centered on the meaning of freedom and the question of how to justify inequality in a democratic society.

**The Transatlantic Slave Trade, Capitalism and the Racialization of Slavery**

The Transatlantic Slave Trade, dating from the 15th century to the beginning of the 19th century, created the African Diaspora in the Atlantic World with the capture, enslavement, and dispersal of African people from their homeland. The Transatlantic Slave Trade (TST) begins in the mid-15th century with the Portuguese capturing 240 Africans from West Africa—and taking them to Lagos, Portugal. Marcus Rediker described the transatlantic slave trade as ships that left from a European port with a cargo of manufactured goods to West Africa, where they traded for slaves, then headed to America where they sold slaves on plantations to produce commodities such as sugar, tobacco, or rice. The slave ship, according to Rediker, played a major role in the early stages of capitalism beginning in the late sixteenth century. Drawing from the early work of Eric Williams, in his seminal *Capitalism and Slavery (1944),* Rediker argues that the TST provided the capital that fueled the industrial revolution in England in the 18th The slave ship created a microcosm of capitalism, for Africans became human commodities sold on a market for profit, while insurance companies guaranteed the commodities, and accountants kept careful ledgers of profit and loss. The Transatlantic Slave Trade was founded on the degradation of human beings by turning them into commodities to be sold on a market like any other product. The ship was thus "central to a profound, interrelated set of economic changes essential to the rise of capitalism," he argues, such as the, "seizure of new lands, the expropriation of millions of people and their redeployment in growing market-oriented sectors of the economy; the mining of gold and silver, the cultivating of tobacco and sugar; the concomitant rise of long distance

commerce," and finally a "planned accumulation of wealth and capital beyond anything the world had ever witnessed."[1]

Slave traders and holders justified their enslavement of Africans by creating ideas of race that defined Africans as less than human and incapable of being civilized. They laid the foundation for racial hierarchy, racist ideas, and capitalism in the modern world, creating a false narrative to justify their barbarous treatment of Africans and Native Americans. The mercilessness and dehumanizing circumstances that defined the Middle Passage led to the enslaved being stripped of their names to become mere numbers in record logs. Slaves became privately owned property traded for profit. The enslaved were advertised in the best way possible to appeal to the buyer as merchants prepared their human commodities for sale. Prior to the sale, slaves were given more food to fatten them up; they were washed, shaved, and lathered in oils to give the illusion of strong, healthy slaves equipped for hardworking labor. The Middle Passage fed the upward social mobility of Europeans.

**Arrival in the Americas**

Africans and poor Europeans from England, Scotland, and Ireland arrived in the Americas in 1619 in Jamestown, Virginia, to reap benefits of gold the English expected to find; only later did the commodity of tobacco lead to slavery as major labor system to aid in the production of lucrative crops to build the wealth of the British Colonies. Britain rejected the Spanish colonizing practices that sought to dominate and impress into hard labor the native peoples. Tobacco's profitability fueled the development of slavery in the Chesapeake. In the seventeenth century, European indentured servants worked side by side with Africans and Native Americans to produce commodities for the world market. Thus, enslaved Africans, indentured Europeans, and Native Americans lived and worked together, having sexual relationships that often bore biracial children. Indentured Servants were contracted for seven years, and were entitled after the contract ended to a portion of land. They comprised the chief source of agricultural labor in Virginia and Maryland throughout most of the seventeenth century British Colonies. The high mortality of workers created no great desire for owning a man for a lifetime rather than a period of years, especially since a slave cost roughly twice as much as an indentured servant.[2] The onerous duties of indentured servitude frequently led to the death of many indentured servants. The declining population, combined with a necessity for a labor force, directed colonists to consider buying African slaves as the most efficient way to secure a labor force. The population of indentured servants diminished significantly due to the escape of white indentures from their short-term masters, but also because indentured servants did not endure the harsh living conditions and died.

The evolution of and the racialization of slave labor developed such that by the end of the 17th century, African slavery had become the major labor force. Laws in seventeenth century colonial Virginia revealed how slave-owners defined slavery—as well as how the law defined class relationships in society. These laws represented an early attempt by slave owners to mask over class conflict by enslaving Africans. For example, in 1630 Hugh Davis, a white man in the

[1] Rediker, Marcus. The Slave Ship: a Human History. Penguin, 2011, p. 43 .

[2] Morgan, Edmund S. American Slavery, American Freedom: the Ordeal of Colonial Virginia. History Book Club, 2005, p. 212

Virginia colonies, had an affair with a Black woman. The Virginia Assembly ordered that Hugh Davis was "to be soundly whipt before an assembly of Negroes & others for abusing himself to the dishonor of God and the shame of Christianity by defiling his body in lying with a Negro."[3] Thus early on, white was associated with purity and godliness, black with being uncivilized and heathen.

In 1662, a law established that the status of a child followed that of the mother, thus ensuring the perpetuation of slavery among Africans, and allowing slaveholders to rape their women slaves without fear of losing their property in children. Barbara Fields argues that this law was created to prevent the erosion of slave-owner's' property rights that would result if the offspring of free white women impregnated by slave men were entitled to freedom.[4] Virginia's system of indentured labor began to manifest some shortcomings that helped prepare the way for its replacement by black slavery.

The role of baptism played a fundamental role in the evolution of slavery in the British Colonies in the Seventeenth Century. Indentured servants eventually became free, thus creating a lower class that was not under the direct control of the planters.[5] Baptism and the Christian conversion it conferred had been an accepted route to freedom in the English Atlantic during the sixteenth and early seventeenth centuries.[6] Africans in Colonial America used this political comprehension as the impetus for their pursuit of freedom. Christianity was associated with freedom, and many slaves and indenture servants took advantage of this safety valve. This created a problem, for how would petty labor be exploited if servants became Christians? The Virginia assembly answered this loophole with a 1667 law establishing "the conferring of baptism doth not alter the condition of the person as to his bondage or freedom; that diverse masters, freed from this doubt, may more carefully endeavor the propagation of Christianity by permitting children, though slaves, or those of greater growth if capable to be admitted to that sacrament." The avowed object was to encourage masters in Christianizing their slaves by eliminating the danger of losing a slave through his conversion. But the effect, whether intended or not, was to remove the most powerful motive for a slave to wish for baptism.[7]

The only path to freedom, however, rested in the will of the master to grant freedom to his slaves. For example, a 1672 law made it legal to wound or kill enslaved Africans who resisted arrest, and if killed, provided compensation to the slave-owner. This indicated the relationship between slavery and the state. The reinforcement of power and custom created a society based on the exploitation of labor, capital, and greed. The laws of Virginia and Maryland, as well as those of the colonies to the south, increasingly gave masters the widest possible power over the slaves, and also, the prohibition of interracial marriage and the general restriction of slave status to nonwhites, codified slavery and enhanced the slave-owners' power

[3] Higginbotham, A Leon. In the Matter of Color: Race and the American Legal Process: the Colonial Period. Oxford University Press, 1979, p. 23.
[4] Slavery, Race and Ideology in the United States of America New Left Review, Vol. I, No. 181. (May/June 1990), pp. 107 by Barbara J. Fields
[5] Fredrickson, George M. White Supremacy: a Comparative Study in American and South African History. ACLS History E-Book Project, 2005, pp. 62.
[6] Goetz, Rebecca Anne. *Baptism of Early Virginia: How Christianity Created Race*. Johns Hopkins University Press, 2016, pp. 86.
[7] Morgan, American Slavery American Freedom, pp. 231

over their slaves.[8] These laws signified the early stages of defining class in America as it related to slavery and freedom.

Several problems emerged towards the late 17th century that led to the racialization of slavery—a rising younger class of slaveholders demanding land, problems with indentured servants, Native Americans defending their lands—and the role of African Slavery solidification in Virginia occurred in 1676 with Bacon's Rebellion, an armed rebellion against Virginia settlers led by Nathaniel Bacon. The fundamental root of the rebellion was Governor William Berkeley's refusal to retaliate against numerous Indian attacks on frontier settlements. It came about because of the struggle over access to land—resulting in the creation of landownership for white indentured servants and enslavement for Africans. This began the evolution towards a slave society based solely on Africans. The ruling planter class turned from white indentured servitude to African slavery because of their fear of disgruntled whites joining forces with enslaved Africans to their challenge dominance. Moreover, the slave-owning class did not want to elevate the white indentured servants: the objective was to make the poor, landless, white servants complimentary members of the power structure—to persuade them that having white skin was more important than their economic interests. By the early 1700s, racial slavery created a social order that intertwined every level of the New World.

**The Problem of Slavery in the Age of Enlightenment and Revolution**

The Age of Revolution illuminated the inherent contradiction of slavery and freedom as the American colonies fought for their independence, drawing from the Enlightenment ideas of natural rights and self-government. John Locke, in his essay "Concerning Human Understanding", argued that humans had natural inalienable rights that superceded man-made rights—that all humans, regardless of status, shared the natural rights of Life, Liberty and Property, and if the government failed to perform this basic duty, the people had the right to overthrow it. The Enlightenment thinkers saw human beings as basically good and rational and with the capability of changing their circumstances. Taken together, this major shift in the Western worldview privileged the idea of freedom over slavery, rendering slavery in need of defense. Yet, the Enlightenment produced contradictions of its own, as philosophers wrote racist books and created a pseudoscience to justify white supremacy rooted in slavery. Kendi, in *Stamped From the Beginning* argued, "Racist ideas clouded the discrimination, rationalized the racial disparities, and defined the enslaved, as opposed to the enslavers, as the problem people".[9] White indentured servants and enslaved Africans became familiar with Lockean principles, and sued for their freedom based on the concept of a "natural right to liberty". Thomas Jefferson, perhaps the leading 18th century American Enlightenment thinker, symbolized the fundamental contradictions personified in Enlightenment ideas. Jefferson wrote the most articulate defense of liberty in the renowned Declaration of Independence, stating all men were created equal. Paradoxically, he wrote this while a slave-owner. Jefferson illustrated, perhaps more than any

[8] Genovese, Eugene D. Roll, Jordan, Roll, The World the Slaves Made. Pantheon Books, 1974, pp. 31

[9] Kendi, Ibram X. *Stamped from the Beginning the Definitive History of Racist Ideas in America*. Nation Books, 2016, pp. 82.

other American, the problem of slavery and freedom, for he fought openly to defend an institution no longer defendable in the Western World.

Jefferson offered incongruous statements regarding slavery as he wrestled with the problem of slavery and freedom. For example, in a court case in 1769, Jefferson said that under the "laws of nature, all men are born free."[10] Jefferson asserted his political dissidence to British Colonialism in the Declaration of Independence saying, "We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness." Who did these "inherent" unalienable rights apply to? The American Colonists—tired of the oppressive legislation by the British Crown—went to war with Britain and won in 1783 independence. What did independence mean for African slaves in the former British Colonies? What did a new liberal bourgeois democratic society look like for Africans? How would the question of slavery be resolved? The American Revolution laid the foundation for a new government and US Constitution—but the question of slavery was revisited, an issue that remained central to the foundation of the new nation.

Jefferson, in his *Notes on the State of Virginia (1781),* introduced a bill to end slavery in Virginia whilst concurrently saying black people were inferior. Jefferson argued that blacks, whether originally a distinct race, or made distinct by time and circumstances, were inferior to European Americans in the endowments both of body and mind. "It is not against experience to suppose, that different species of the same genus, or varieties of the same species, may possess different qualifications."[11] Jefferson went further in his *Notes on the State of Virginia (1781)* saying, "black men preferred white women over their own, just as orangutans prefer black women over their own, they did not feel pain and that they required less sleep."[12] Toward the end of Jefferson's life he said, "we have the wolf by the ears, we cannot hold him and neither can we let him go." Jefferson asserted this belief during the time the boundaries of the new nation were growing through Westward Expansion, and economically, as the industrial North and slave-centered agricultural South were becoming financial vanguards of the American economy. Jefferson was struggling with contradictions in bourgeois democratic theory to possess slaves; however, he as well as other slaveholders still needed slaves for labor.

The Age of Revolution laid the foundation for the continuing contradiction and debate of the slavery question. This conflict presented itself with the creation of a bourgeois democratic society in Northern America. The Declaration of Independence ignited the debate over slavery by emphasizing the equality between all men and by guaranteeing the rights to life, liberty, and pursuit of happiness, substituted for property. The word "slavery" was never mentioned in the United States Constitution. It was clear, the men who wrote the Constitution sought by every elusion, and almost by subterfuge, to keep the acknowledgment of slavery out of the rudimentary form of government.[13] Independence translated into freedom from British colonialism to reap the benefits of African slavery and the newly acquiesced land for more labor and lucrative commodities. How would the question of slavery be answered?

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[10] Kendi, Stamped from the Beginning, 91

[11] Jefferson, Notes on the State of Virginia

[12] Jefferson, Notes on the State of Virginia

[13] B., Du Bois William E. Black Reconstruction: an Essay toward a History of the Part Which Black Folk Played in the Attempt to Reconstruct Democracy in America, 1860 - 1880. Russel & Russel, 1935, pp. 4

The issue of slavery was central to the Constitutional Convention in 1789. The issues of proportional representation and states' rights, both questions rooted in maintaining the slaveholders' powers, emerged to the forefront of debate. The founding fathers from the beginning struggled over how best to protect slavery while creating a democratic government. These debates and the solutions reflected the conflicting economic interest in the new republic. For example, In *Stamped from the Beginning*, Kendi noted "Massachusetts abolitionist and future vice president Elbridge Gerry insisted that Blacks were property and played the same role as cattle or horses did in the North. Why, he argued, might the South be able to count slaves and the North not be able to count its horses and oxen?"[14] The conflict resulted in the creation of the Three Fifths clause declaring the South to count slaves as three-fifths of a person strictly for representation in Congress and the Electoral College. This compromise was the most abhorrent, dehumanizing statute codified in the US Constitution. James Madison rejected monarchy of any kind and chose instead the creation of the Electoral College as a way to check the democratic nation and its relationship to slavery. This clause enabled the slaveholding South to wield disproportionate power in Congress even though they had a curtailed population size. A conservative, compromised document, the Constitution actually confirmed the dominant power of the slaveholders. The Constitution's infamous "three-fifths of a man" provision gave southern politicians control over federal politics for the next seventy years.[15] The three-fifths compromise legally institutionalized and resuscitated the dehumanization of the enslaved.

The compromises the Founding Fathers made in 1789 had a profound impact on the evolution of American democracy, as noted by the distinguished historian W.E.B. Dubois, who argued *in Black Reconstruction* that "the true significance of slavery in the United States to the whole social development of America lay in the ultimate relation of slaves to democracy. What were to be the limits of democratic control in the United States? If all labor, black as well as white, became free—were given education and the right to vote—what control could or should be to set to the power and action of these laborers?"[16] Dubois described how slavery underwrote the new democratic society, realizing what was at stake for the new nation if all people—regardless of race—were treated equal. How would a nation survive if all of its citizens had a voice in the social, political, and economic decisions in American society?

**Antebellum Slave Society**

American society after 1789 grew along the lines drawn in the Constitution. Northern society developed as one based on industry, while the South became one based on slave labor. However, the invention of the cotton gin in 1793 made cotton a global commodity and fueled the need for slave labor. In 1787, Congress agreed to abolish the international slave trade of Africans to the United States. Cotton made slave labor more essential, but the Northern economy, though one based on free labor and a market economy, was nonetheless deeply connected to southern slavery—banks, merchants, insurance, etc. As the North began to experience the advent of industrialization with the rise of textile industry, the northern factories made cloth out of the cotton harvested by slaves. Northern ships shipped cotton, and Northern insurance companies

[14] Kendi, Stamped from the Beginning, pp. 116
[15] Smith, Chip. The Cost of Privilege: Taking on the System of White Supremacy and Racism. Camino Press, 2007, pp. 36-37
[16] W.E.B Dubois, Black Reconstruction in America, 13

financed it. As a result, the North depended on the Southern slave society to produce cotton as it grew economically as an industrial society. Slavery provided the capital for an industrializing America.

The slave South faced several challenges as it entered the 19th Century. The Haitian Revolution, led by Toussaint Louverture, was the first and only successful slave revolution in the Western Hemisphere. This was a war between the Africans in Saint Domingue (current day Haiti) and the French Army. This revolution ended with Haiti being declared independent from France and the Louisiana Purchase, opening more space for the expansion of slavery. Over the next few decades, slaveholders marched their captives onto the new western lands, terrorizing them into planting new cotton and sugar fields, sending the crops to Northern and British factories, and powering the Industrial Revolution.[17] The independence of Haiti sparked major debates about whether black people were inferior, whether blacks could achieve freedom on their own, and more importantly, it sparked similar revolts among other black majority black colonies throughout the Western Hemisphere. This terrified slave owners who feared their own slaves might follow the Haitian path.

Southern slave society experienced several slave revolts in the first half of the 19th century, beginning in 1800 when Gabriel Prosser planned a large rebellion in Richmond, Virginia. Inspired by the Haitian Revolution, Gabriel Prosser planned to kill all slaveholders who blocked his revolt. However, the rebellion failed due to betrayal amongst members in the revolt. This led to stricter laws against both free and enslaved blacks and the hanging of the members involved in the planned attack. In 1822, Denmark Vesey, a slave in Charleston, South Carolina, planned a slave rebellion against the white slaveholders. Similar to Gabriel Rebellion it ended with the betrayal amongst the rebellious slaves. In 1831, Nat Turner planned a slave Rebellion in Southampton County, Virginia. This slave rebellion was on a continuum of planned slave rebellions in the United States inspired by the Haitian Revolution. This was one of the largest and deadliest slave uprisings in U.S History; however, it was dismantled after a few days. The revolts in the American South were unsuccessful for several reasons: lack of organization, lack of weapons, and betrayal amongst members. But more importantly, the federal government backed the slave-owning class, sending in federal troops when necessary. Nat Turner's Rebellion took place a year before the Virginia Legislature debated ending slavery in 1832. Turner's Rebellion caused greater fear amongst the Virginia Legislature, and the debate ended with no call for emancipation, but a decision to erase any resistance to slavery.

The other issue slave-owners faced was issue of state versus federal rights as revealed in the tariff issue and nullification crisis in South Carolina. This issue was caused by the introduction of protective tariffs for the raising of money of the United States. The South saw these protective tariffs damaging to their economy, because they had to pay higher prices on goods the South did not produce. In 1828, John Calhoun, Vice President of the United States at the time, wrote his *South Carolina Exposition* saying that tariffs were unconstitutional and he expressed his doctrine of nullification. The essence of the nullification crisis argued a state could refuse to recognize or enforce a federal law passed by the United States Congress. The Nullification crisis of 1833 ended with the reassembly of the South Carolina convention and the rescinded ordinance of nullification. The nullification crisis was the catalyst to the "states' rights" ideology as well as the on-going political struggles between the state and the federal government.

[17] Kendi, Stamped From the Beginning, pp. 133

Westward expansion over the antebellum South showed the continuous contradiction of slavery as the size of America grew. In 1820, a problem emerged when the state of Missouri requested for admission as a slave state. At the time, the United States had an equal divide between slave and free states. The admission of Missouri as a slave state would augment the sectional divide amongst the North and the South. Thus, Maine was admitted as a free state. The Missouri comprise of 1820 had a provision for the abolishment of slavery above the 36°30′N, except for Missouri. The compromise solved an immediate problem for slavery at time but the question of slavery would continue to be reassessed as the United States expanded to the west.

Eugene Genovese, in *Roll, Jordan Roll,* argued that the abolition of the international slave trade changed the dynamics of the slave South and forced a new relationship between the master and slave. Slaves in the antebellum South often tested the legitimacy of their master displaying the contradiction of total domination. Paternalism as defined by Genovese was an organic relationship between masters and that slaves based on dependency and reciprocity. The masters interpreted paternalism as self-deceptively wanting happiness for their slaves. The slaves resisted paternalism by fighting for their right to think and act as autonomous human beings.[18]. Slave-owners needed slave labor to survive, thus creating a kind of dependency they sought to mask over by forging the ideology of paternalism. In the slave-owners' view, their slaves were children who needed care. The slaveholders saw it as their duty to take care of their slaves; they interpreted this form of "benevolence" as a way of doing their good deed. However, slaves understood masters' dependency on them and used it to their advantage. Genovese also saw paternalism as the relations of super-ordination and subordination. Its strength as a prevailing ethos increased as the members of the community accepted—or felt compelled to accept—these relations as legitimate.[19] The antebellum Southern slave society was always in a process of negotiation along class relationships. But, how did the slave-owning class obtain the consent of slaves to their enslavement, or did they? This is not merely a process of complete vertical domination over slaves, but rather a function of what Italian political theorist Antonio Gramsci calls "hegemony". Gramsci argued that a ruling class reached maturity when it achieved the consent of its subjects to be governed. However, behind this consent lay state violence and coercion. The dominant slave-holding class achieved hegemony when it no longer needed brute force to govern. A key issue in achieving consent rested on the law. The law is the ultimate force that is used to shape the terrain and profess the ruling class' legitimacy. As an illustration, the Compromise of 1850 and Fugitive Slave Act drew slaveholders, non-slaveholders, and even abolitionists into the world of slavery. The Compromise of 1850 was compromise to settle the enduring dispute between the slave holding south and the Northern Free-Soilers regarding the problem of slavery. The provision also rewarded officers who caught runaway slaves with a bonus or promotion for their work—simultaneously punishing officials who did not arrest alleged runaway slaves. Coercion enabled the slave owning class to force subordinate classes to accept its legitimacy, whereas consent persuaded the master class to adhere to the ad hoc de facto laws. To the extent that the intellectuals fail to create hegemony, the ruling class falls back on the state's coercive apparatus, which disciplines those who do not consent.[20]

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[18] Genovese, Roll Jordan Roll, pp.148

[19] Genovese, Roll Jordan Roll, pp. 6

[20] Gramsci and the Theory of Hegemony, Journal of the History of Ideas, Vol. 36, No. 2, (April/May 1975), pp. 353 by Thomas R. Bates

The end of slave trade shaped the emerging antebellum slave society—that often tested the limits of hegemony, and slaves used their pre-political ideology to dismantle to fundamental contradiction of slavery. On balance, the revolts made a substantial contribution to the amelioration of the material conditions of slave life. The closing of the Trans-Atlantic trade, with its attendant rise in the price of labor, compelled the slaveholders to adopt measures designed to guarantee the productivity and reproduction of their labor force.[21] Paternalism in the American South laid the fundamental contradiction of slavery that slaves used as a tool for their own political and social mobility. The constant negotiation of the social terrain between the master and the slave led to a debilitating social slave system that constantly had to be defended. Throughout the antebellum period in the American South, slaves remade their cultural and political worlds through constant negotiations with their masters.

**Antebellum South, Paternalism, Revolution**

The ending of the international slave trade forced Southern slaveholders to rely on their slave society to reproduce themselves and also led to more residential slave-owners. This provision also required slaveholders to live on their plantations. In Eugene Genovese's *From Rebellion to Revolution*, he states paternalism implied considerable living space where slaves created stable families, developed a rich spiritual community, and attained a measure of physical comfort.[22] What did this mean for a Southern slave society that depended on the labor of slaves to elevate its class? The closing of the TST, the political crisis of ancient civilization, and the pressure of an ascendant Christianity had converged in the early centuries of the new era to shape a seigneurial world in which lords and serfs (not slaves) faced each other with reciprocal demands and expectations.[23]

The contradiction of slavery appeared in the laws and court cases as the antebellum South matured in the master-slave relationship. This is not merely a process of the master class failing to assert its vertical dominance over property, nor is it a product of the masters failing to care for their property —but rather what Steven Hahn argues is a function of slaves contesting the wills of their owners, forging complex ties to each other, etching out time and terrain that they could claim for themselves, turning privileges won into rights to be defended. Hahn argued blending the rituals of reciprocity into ostensible acts of deference and submission, the slaves transformed as well as resisted the Southern system of slavery.[24] In these laws and court decisions lay the fundamental contradiction of slavery. A slave could kill a white man in self-defense and escape conviction provided that his own life stood in clear and imminent danger. In a celebrated 1791 case in Virginia, Moses, a slave, had killed his overseer and escaped conviction. The court accepted the testimony that Moses had served honestly and faithfully and that he had killed only when the overseer tried to kill him.[25] What does this say about the evolution of slavery in the new nation? What does this say about the fragility of the inherent contradiction of slavery? A

[21] Genovese, Eugene D. From Rebellion to Revolution: Afro-American Slave Revolts in the Making of the Modern World. Louisiana State University Press, 1992, pp. 113
[22] Genovese, From Rebellion to Revolution, pp. 6
[23] Genovese, Roll Jordan Roll, pp. 4
[24] Hahn, Steven, A Nation under Our Feet Black Political Struggles in the Rural South from Slavery to the Great Migration. Harvard University Press, 2003, pp. 33
[25] Genovese, Roll, Jordan, Roll, pp. 34

century before that in Virginia under British colonialism, according to the Virginia Slave Codes, slaves were prohibited from lifting a hand against a white person even in self-defense. Thus, paternalism exposed itself within the previous law. This court case shows the humanization of slaves in the antebellum South, but as Genovese argued, it discredited the essential philosophical idea on which slavery rested, and simultaneously, bore witness to the slave's ability to register the claims of their humanity.[26]

**The World of the Slaveholders**

Slaveholders in antebellum South fashioned their own interpretation of the master-slave relationship. Paternalism for the slaveholders grew out of the necessity to maintain discipline and morally justify a system of exploitation.[27] Slave masters understood for this mature relationship to persist, there had to be some form of reciprocity between master and the slave. When the terrain of the Southern slave society was threatened, slave masters exhibited their dominance to show the slaves their self-deceptive benevolent tendencies. Slaveholders fired overseers who treated their slaves too humanely and overseers who treated slaves too severely. Genovese provided an example of how slaveholders sought to protect their slaves. The overseer faced limits who worked slaves beyond their strength, or that inflicted cruel or unnecessary punishment, or failed to see them well fed or kindly taken care of when sick. [28] The slaveholders recognized the necessity of protecting slaves from cruel punishment as a means for preventing resistance, if not rebellion. E. N. Elliot, president of Planters College in Mississippi, defined slavery as the duty and obligation of the slave to labor for the mutual benefit of both master and slave, under a warrant to the slave protection, and a comfortable subsistence under all circumstances. It is clear that the problem of slavery had changed since the first century of arrival. This illustrated not merely a process of slave masters showing their gratitude to slaves, nor is it a product of the masters failing to understand their role as the ruling class built on labor—but rather a function of the inherent contradiction of slavery. The master, as the head of the system, had a right to the obedience and labor of the slave, but the slave also has his mutual rights in the master: the right of protection, the right of counsel and guidance, the right of subsistence, the right of care and attention in sickness and old age.[29] The world of the slaveholders was a world of contradictions. The slaveholders recognition of the slaves' right to life, explicitly endorsed in the laws against murdering of slaves, both exposed the absurdity of the assertion of a doctrine of total surrender of will and registered their own inability to justify even to themselves the unlimited use of force. [30] The contradiction unremittingly appeared the more slaveholders became conscious of their reliance upon their slaves' labor.

**The World of the Slaves**

Slaves in antebellum South fashioned their own interpretation of the master-slave relationship. The Southern slave population began to reproduce itself naturally sometime around

[26] Genovese, Roll, Jordan, Roll, pp. 47
[27] Genovese, Roll Jordan Roll, pp. 4
[28] Genovese, Roll Jordan Roll, pp. 14
[29] Genovese, Roll Jordan Roll, pp. 76
[30] Genovese, Roll Jordan Roll, pp. 89

the middle of the eighteenth century, and a structure of kinship relations, expectations, and practices gradually took shape; this was bolstered by the closing of the African slave trade and the prevalence of cotton, tobacco, and grains that weighed lightly on the material conditions of slave laborers.[31] This enabled slaves to form their boundaries within the system of slavery and to reject the very essence of the social system. Slaveholders were always entitled to the revenue and harvest that slaves produced. But slaves managed to win time for themselves, set loose standards for various agricultural tasks, and avail themselves of opportunities opened by the rhythms governing various crop cultures. [32] Slaves understood the process of negotiation between masters and slaves, even when it came to petty production and provisioning. Steven Hahn, in his book *A Nation Under Our Fee*t, provided the quintessential example of the relationship when a slave master was trying to buy a few ducks from a slave. John Burnside, master of the Houmas Plantation in Ascension Parish, Louisiana, sought to purchase some ducks from his slave Louis, and pay for them the following day. "Very well, Louis," Burnside responded with the paternalist prerogative, "if you come tomorrow I'll pay you." "No master," Louis replied, deferentially but firmly, "me want the money now" [33] Louis understood the process of reciprocal obligations between within the master-slave relationship. The system of petty production, provision, and exchange permitted the slaves to enact various rituals of reciprocity that implicitly rejected the condition of enslavement and envisioned, if not insisted on, alternative possibilities. [34] The slaves in the antebellum South used their interpretation of this paternalistic relationship and fashioned their vision of the world. However, Steven Hahn argued, petty production, provisioning, and exchange did not, compose a sphere of autonomy under slavery or distinct set of social and economic relations buried within the slave regime. Insofar the reciprocal version developed through the antagonistic struggle between master and slave and became embedded as a central component of the regime itself.[35]

Slaves in the antebellum South used religion as an instrument to remove the notion of their dehumanization and their status as God quasi-ordained subordinate. The living history of the church has been primarily a history of submission to class stratification and the powers that be, but there has remained, despite all attempts at eradication, a legacy of resistance that could appeal to certain parts of the New Testament and especially to the parts of the old. For slave masters, this was not the anticipated disposition for the religious indoctrination of slaves. The slave masters sought to teach slaves to be docile and accept their subhuman status. However, the slaves took up the Christian message, blended it with their traditional religion, and forged a moral case for action on behalf of their own freedom.[36] White preachers taught slaves they did not have the right to judge their masters, and often fabricated the bible in a way in which God predestined them to serve their master. Moreover, slaves used their own religious practices to create their own interpretation of their spiritual freedom. They seem to have imagined a divine intervention that would end their collective oppression, punish their oppressors, and allow them to build a new order of freedom.[37] The religion practiced in the quarters galvanized slaves with a

[31] Hahn, A Nation Under Our Feet, pp. 17
[32] Hahn, A Nation Under Our Feet, pp. 22
[33] Hahn, A Nation Under Our Feet, pp. 29
[34] Hahn, A Nation Under Our Feet, pp. 30
[35] Hahn, A Nation Under Our Feet, pp. 32
[36] Genovese, From Rebellion to Revolution, pp. 103
[37] Hahn, A Nation Under Our Feet, pp. 47

sense of their own worth before God and man. Genovese noticed religion enabled slaves to prove that no man's will can become that of another unless he himself wills it—that the idea of slavery cannot be realized, no matter how badly the body is broke and the sprit tormented. [38] Slaves in the antebellum south—due to their interpretation of the paternalistic relationship—went through a social, cultural, pre-political and spiritual revolution in the pre-civil war period. The slaves also used the church as a meeting ground to discuss local events, resolve disputes amongst slaves, and dispense justice. They had three degrees of punishment [according] to magnitude of the crime.[39] They used the privileges they gained from the master-slave relationships and asserted them as rights to be fought for. Slaves used their political mobility through various kinship networks and organized amongst the slave masters and fashioned their own interpretation under the disguise of subservient.

**Conclusion**

In 1619, white indentured servants and African slaves arrived in the Americas, to accompany the enslaved Native Americans in the economic growth of the British Colonies. The creation of laws underwritten by racist ideas ensured a capitalistic society developed on free labor, coercion and vertical dominance. The slaveholders justified their enslavement of Africans by creating ideas of race that defined Africans as less than human and incapable of being civilized—which laid the foundation for racial hierarchy, racist ideas, race and capitalism in the modern world. The Age of Revolution created a contradiction for slaveholders with the making of a bourgeois democratic free society, built on the liberal ideologies of equality, life, liberty, and property. The construction of the US Constitution exacerbated African slavery and the rise of capitalism in the modern world. Slavery thus became a pressing issue in the American South, and the rest of the country, that could not be ignored. The end of the international slave trade in 1808 fostered a mature master-slave relationship. The ending of the slave trade led to a self-sustaining slave society where slaves had to reproduce in order to maintain labor supply. Southern paternalism reinforced racism as well as class exploitation, but it also allowed slaves to create their own interpretation and pre-political imagination in the antebellum South that assisted them in acquiring freedom. The abolishment of the international slave trade changed the dynamics and forced a relationship between the master and slave. Slaves in the antebellum South often tested the legitimacy of their master displaying the contraction of total domination. The masters interpreted paternalism as self-deceptively wanting happiness for their slaves. The slaves interpreted paternalism by fighting for their right to think and act as autonomous human beings. At the height of the tensions between the North and South over the question of slavery, slaves politically mobilized in making the civil war their rebellion. As Steven Hahn, in his book *A Nation Under Our Feet*, argued, they sensed emancipation and a new order of life might go along with it, and thus felt empowered to turn a rebellion of their own against the authority of the federal government into a rebellion of their own against the authority of their masters.[40] Newly freed blacks participating in the Union Army, in a fight against their former masters and the federal government—ending with the destruction of slavery—was a revolution. No other nation, in such a short time, rose from dehumanization to holding power. This paper, therefore, argues

[38] Genovese, Roll Jordan Roll, pp. 283
[39] Hahn, A Nation Under Our Feet, pp. 51
[40] Hahn, A Nation Under Our Feet, pp. 64

that the problem of slavery and freedom in the modern world, evolved over time due to persistent black resistance throughout the diaspora, class struggles between the bourgeoisie and ruling class, southern paternalism, and blacks joining the Union Army to fight against the Confederate Army.

# *Studying the phenotypic variability of neurodevelopmental disorders with Drosophila melanogaster*

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## Abstract

The recurrent 520-kb 16p12.1 microdeletion, a rare copy-number variant significantly associated with severe developmental delay has been shown to exhibit wide phenotypic variability. A two-hit model has been proposed as an explanation for this phenotypic heterogeneity in patients with the 16p12.1 microdeletion and potentially other variably expressive neurodevelopmental disorders. According to this model, the 16p12.1 microdeletion would render an individual vulnerable to the manifestation of neuropsychiatric disorders, and the co-occurrence of secondary variants will lead to the manifestation of a more severe phenotype. To further understand how secondary variants push the sensitized genetic background towards the threshold for neurodevelopmental disease, we studied pairwise phenotypes of 16p12.1 genes with secondary variants in fruit flies. *Drosophila melanogaster* is a well-studied model organism for human genetic diseases, with 75% of human disease genes having an ortholog in flies. We selected twelve genes found mutated in 26 families carrying the 16p12.1 microdeletion by whole-exome sequencing, which are also associated with developmental disease. Eye-specific pair-wise knockdown of 16p12.1 orthologs and secondary variants was achieved to systematically examine the two-hit combinations against one-hit controls and the phenotypes were quantitatively measured using Flynotyper. Analysis of these results indicates additive and epistatic effects from the combination of the 16p12.1 microdeletion with other neurodevelopmental disease associated genes.

## Introduction

A wide range of phenotypic severity characterizes many neurodevelopmental disorders, as observed with the 16p12.1 microdeletion resulting in the loss of 7 genes: *UQCRC2, PDZD9, C16ORF52, VWA3A, EEF2K, POLR3E, and CDR2*.[1] For example, children with the 16p12.1 microdeletion show significant phenotypic severity such as severe developmental delay, learning disabilities and craniofacial abnormalities.[1] However, parents carrying this same microdeletion show significantly less severe phenotypes including neuropsychiatric disease, learning disability and an increased risk for schizophrenia or depression.[1,2] The recently proposed two-hit model shows the presence of additional disease causing mutations in conjunction with 16p12.1 may explain some phenotypic variation, as the additional mutations surpass the tolerance threshold of

an individual.[1,2] Additionally, it has been shown that variation in genetic background of an individual has a significant impact on phenotypic severity resulting from a disease-causing mutation.[3] Therefore, we aimed to study the impact of variation in genetic background in conjunction with the 16p12.1 microdeletion in explaining phenotypic variability.

*Drosophila melanogaster* has been shown as an effective model organism for human disease, as it contains orthologs to 75% of human disease-associated genes.[4] Furthermore, the extensive knowledge of developmental processes and cell signaling of *Drosophila* provides an optimal environment for studying gene interactions within the context of a whole organism.[5,6] Likewise, through the use of tissue specific drivers, dispensable organs, such as the eye, can be utilized as experimental systems for genetic screening. Additionally, due to two-thirds of the *Drosophila* genome playing a vital role in eye development, phenotypic observations due to gene modifications can be translated to other tissues within the fly. The *Drosophila* eye also provides an ideal experimental system as it has a highly organized structure and thus defects in development result in readily observable phenotypes.[4,7] Computational methods can then be utilized to provide quantitative analysis of the resultant phenotypic severity.[4] Lastly, the *Drosophila* nervous system is highly similar to higher-level vertebrates enabling the impacts of orthologous genetic modifications of human neurodevelopmental disease-associated genes to be accurately translated to humans.[7]

High-throughput genome sequencing of 33 individuals carrying the 16p12.1 microdeletion was used to determine candidate genes potentially acting in concert with the microdeletion to result in phenotypic variation.[8] Functional genomic experiments using RNAi knockdowns in *Drosophila melanogaster* were then utilized for the fly orthologs of the 16p12.1 microdeletion conserved genes *UQCRC2, C16ORF52*, *POLR3E,* and *CDR2*. Additionally, the GAL4-UAS system was used to knockdown these gene orthologs in the eye to enable observation of gene interactions within a whole animal model. These knockdowns were then combined pairwise with knockdowns of 12 candidate genes (*SETD5, LAMC3, DMD*, *ARID1B, DST, NALCN, PDE11A, USP45, CAPN9, DNAH10, CACNA1A,* and *PYGM*) to systematically analyze and determine the level of gene interaction and subsequent phenotypic severity. Phenotypic severity of the fly eye was determined quantitatively using Flynotyper to provide a possible explanation for the phenotypic variation in individuals carrying the 16p12.1 microdeletion.[4] Analysis of these pairwise combinations of the 16p12.1 deletion as the first-hit and candidate gene as the second-hit indicated two-hit combinations were largely additive or suppressive. However, some combinations indicated significant enhancement of the two-hit phenotype compared to the first-hit and second-hit individually as seen with *C16ORFf52* in combination with *SETD5*.

## Methods

### Drosophila Stocks

Knockdowns for specific genes to produce the two-hits and one-hits were achieved through the UAS-GAL4 system and RNAi with w;GMR-GAL4 and UAS-RNAi transgenic lines. Within this study the following RNAi fly stocks were utilized from the Bloomington Drosophila Stock Center: UAS-*upset*$^{RNAi}$ (BDSC# 51447, 61266), UAS-*lanb2*$^{RNAi}$ (BDSC# 62002), UAS-*dys*$^{RNAi}$ (BDSC# 55641, 31553), UAS-*osa*$^{RNAi}$ (BDSC# 35447, 38285, 31266), UAS-*shot*$^{RNAi}$ (BDSC# 41858, 64041, 28336), UAS-*na*$^{RNAi}$ (BDSC# 26704), UAS-*pde6*$^{RNAi}$ (BDSC# 35743, 25828),

UAS-*usp16-45*$^{RNAi}$ (BDSC# 22338, 11326), UAS-*astc-r2*$^{RNAi}$ (BDSC# 36888, 25940), UAS-*calpa*$^{RNAi}$ (BDSC# 29455), UAS-*dhc98d*$^{RNAi}$ (BDSC# 23611), UAS-*cac*$^{RNAi}$ (BDSC# 965), UAS-*glyp*$^{RNAi}$ (BDSC# 10692), UAS-*dmyc*$^{RNAi}$ (BDSC# 9674, 9675, 25783, 43962, 64769). Fly stocks for GMR-Gal4-*cen*$^{RNAi}$ (VDRC# 33444), GMR-Gal4-*CG4169*$^{RNAi}$ (VDRC# 26404), GMR-Gal4-*sin*$^{RNAi}$ (VDRC# 51696), GMR-Gal4-*CG14182*$^{RNAi}$ (VDRC# 5370) and w;dcadGMR-Gal4/cyo were obtained from the Vienna Drosophila Resource Center.[9] All fly stocks were cultured under conventional conditions of cornmeal/sucrose/dextrose/yeast medium at 25°C. At least two RNAi lines were utilized per candidate gene when possible to improve confidence in interaction classification of the two-hit combinations.

Eye imaging using bright-field microscopy

1 to 4 day-old flies carrying the eye-specific driver GMR-Gal4 and a hairpin sequence complementary to the target gene under the expression of UAS (UAS-RNAi) were cultivated at 30°C were frozen at -80°C. Once immobilized the flies were mounted on Blu Tack (Bostik Inc, Wauwatosa, WI) for imaging with bright-field microscopy. These adult fly eyes were then imaged using a Semimotorized Olympus BX53 microscope with a 20x objective and 0.5x magnification C-mount camera (Olympus, Tokyo, Japan). CellSens Dimension software (Olympus Optical) was used to capture these images, which were then stacked with Zerene Stacker (Zerene Systems, Richland, WA).[4] Flynotyper software was used to quantitatively assign phenotypic scores for the first-hit, second-hit, and two-hit eye phenotypes.[4] Overall, phenotypic score correlates the ommatidial disorderliness and subsequently a more severe phenotype is represented by a higher phenotypic score.

Interaction Classification

Flynotyper generated phenotypic scores were plotted into GraphPrad Prism (GraphPad Software, Inc.) as min to max box and whiskers. Two-tailed Mann-Whitney statistical analysis was performed using MiniTab software (MiniTab, Inc.) with statistical significance as $p \leq 0.05$. Flynotyper results were obtained from an average of 10-15 fly eyes.

## Results

Targeted RNAi knockdown within the eye systematically produced flies with phenotypes for the first-hit, second-hit and two-hit combinations. These combinations comprised knockdown of the 16p12.1 orthologs as the first-hit (A) and knockdown of candidate genes (B) as the second-hit. The double knockdown comprised pairwise knockdown of both the 16p12.1 and candidate gene orthologs (A+B). Comparison of the phenotypic severities of the first-hit and second-hit to the two-hit phenotype revealed three general cases: addition, suppression and enhancement. Addition was characterized when the phenotypic score of the combination of both genes (A+B) was approximately the sum of the scores of the each of them individually (A and B) (Figure 1A). Suppression was distinguished when the phenotype of the double knockdown of A+B was milder (evidenced by a lower Flynotyper score) compared to the first-hit and second-hit individually (Figure 1B). Then, a two-hit phenotypic score that was notably higher than the sum of the one-hit and second-hit scores in multiple RNAi lines for the same gene indicated enhancement (Figure 1C). Again, two or more RNAi lines were used, if available, to produce the

two-hit phenotypes to improve confidence in determining the sensitivity of the 16p12.1 genes to variation in genetic background.

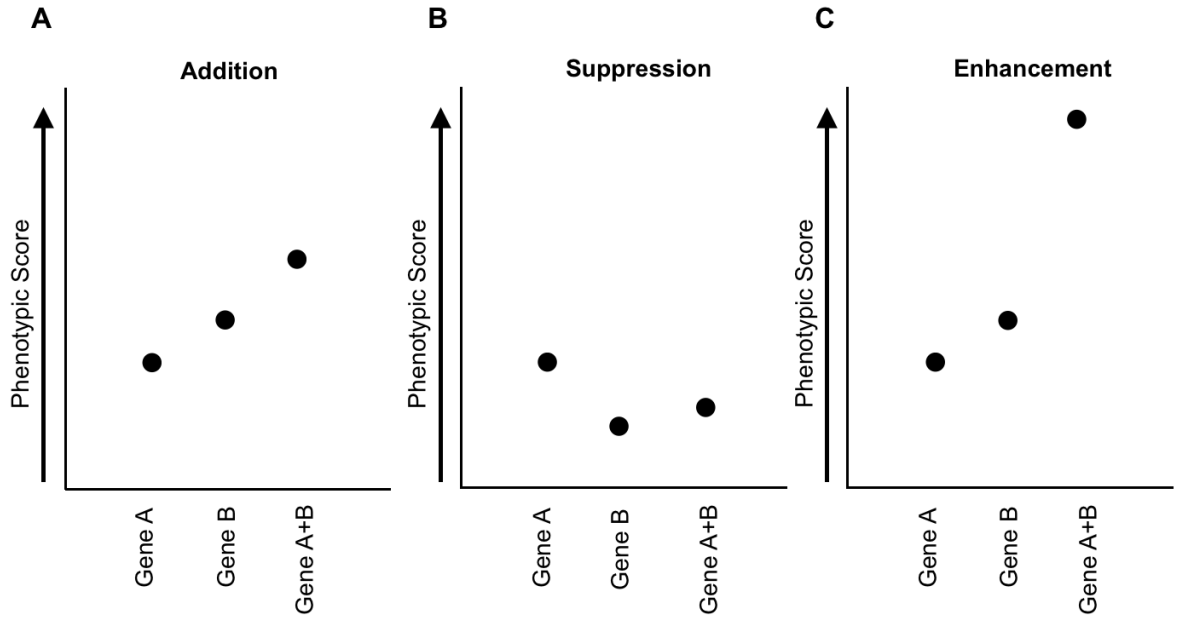


**Figure 1: Characterization of observed gene interactions.** Representation of characterization criteria used to identify observed interactions manifesting the double knockdown phenotypes as addition (A), suppression (B), or enhancement (C). Gene A is representative of the first-hit comprising 16p12.1 ortholog knockdown and gene B represents the candidate gene ortholog knockdown as the second-hit. Gene A+B represents the double knockdown phenotype resulting from simultaneous knockdown of gene A and gene B.

The majority of pairwise combinations between the 16p12.1 and candidate gene orthologs showed an additive or suppressive effect (Figure 2). Variation in the amount of addition and suppression was also observed within these combinations. Additionally, phenotypic scores for the two-hits were often approximately equal to the second-hit phenotypic score as a result of the second-hit conferring a severe phenotype. For example, *LAMC3* orthologous knockdown produced flies that had few to no ommatidia when it was the only hit to the genome. As a result, the combination of the mild phenotype from the 16p12.1 othologous knockdown was not able to further increase the ommatidial disorder. A strong indication of enhancement was observed with the double knockdown of *C16ORF52* and *SETD5* orthologs (Figure 3). Additionally, double knockdown of *POLR3E* and *USP45* shows some enhancement. However, because only data for one RNAi line for *USP45* was available additional testing is required to conclude this interaction.

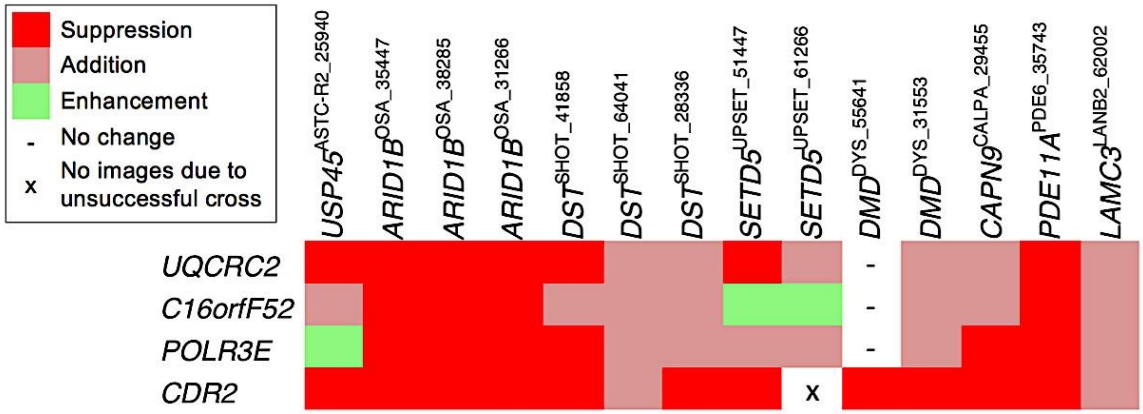


**Figure 2: Pairwise knockdown of 16p12.1 and candidate gene orthologs.** Combinations of pairwise knockdowns tested and characterization of their interactions. Enhancement of phenotype severity was only observed in the two-hit combinations for *C16orf52*/*SETD5* and *POLR3E*/*USP45*.

## Discussion

These results support the two-hit model that the 16p12.1 genes are sensitive to changes in the genetic background. Furthermore, the observation of suppression, addition and enhancement further support genetic background playing a crucial role in generating the phenotypic heterogeneity observed within individuals carrying the 16p12.1 microdeletion. Thus, the specific interactions between these genes remain to be examined to determine if genes are acting within similar pathways or in an epistatic manner. For example, *POLR3E* encodes RNA polymerase III subunit E (http://www.genecards.org/cgi-bin/carddisp.pl?gene=POLR3E) and is required in catalyzing transcription of DNA to RNA. Thus, it maintains an important role within gene expression. Furthermore, *USP45*, which encodes ubiquitin specific peptidase 45, is responsible for maintaining the activity of ERCC1-XPF DNA repair activity (http://www.genecards.org/cgi-bin/carddisp.pl?gene=USP45). Additionally, loss of ERCC1-XPF function has also been shown to have severe impacts on development (Al-Minawi et al. 2008). Thus, further characterization into the pathways of these proteins may provide insight into the manifestation of the more severe phenotypes observed in individuals carrying the 16p12.1 microdeletion. However, *C16ORF52* remains an uncharacterized gene. Nevertheless, an indication of enhancement with loss of *SETD5* provides an opportunity to further characterize the function of the *C16ORF52* gene. While *SETD5* also remains to be characterized, research indicates that it has sequence similarity to other characterized SET domain proteins such as *SETD7*, known to encode the histone-lysine methyltransferase SET7/9 (http://www.uniprot.org/uniprot/Q8WTS6; Marmorstein 2003). Thus, *C16ORF52* may be impacted in a primary or secondary way by changes in chromatin remodeling and subsequent gene regulation potentially related to loss of *SETD5* activity.

Furthermore, because these pairwise combinations have only been examined in respect to *Drosophila* eye development, impacts of these combinations should be examined further to ensure their accurate translation to nervous system development. Therefore, these observations will be integrated with gene expression data (RNA-seq) available from *Drosophila* brains with decreased expression of *UQCRC2*, *C16ORF52*, *POLR3E*, and CDR2.

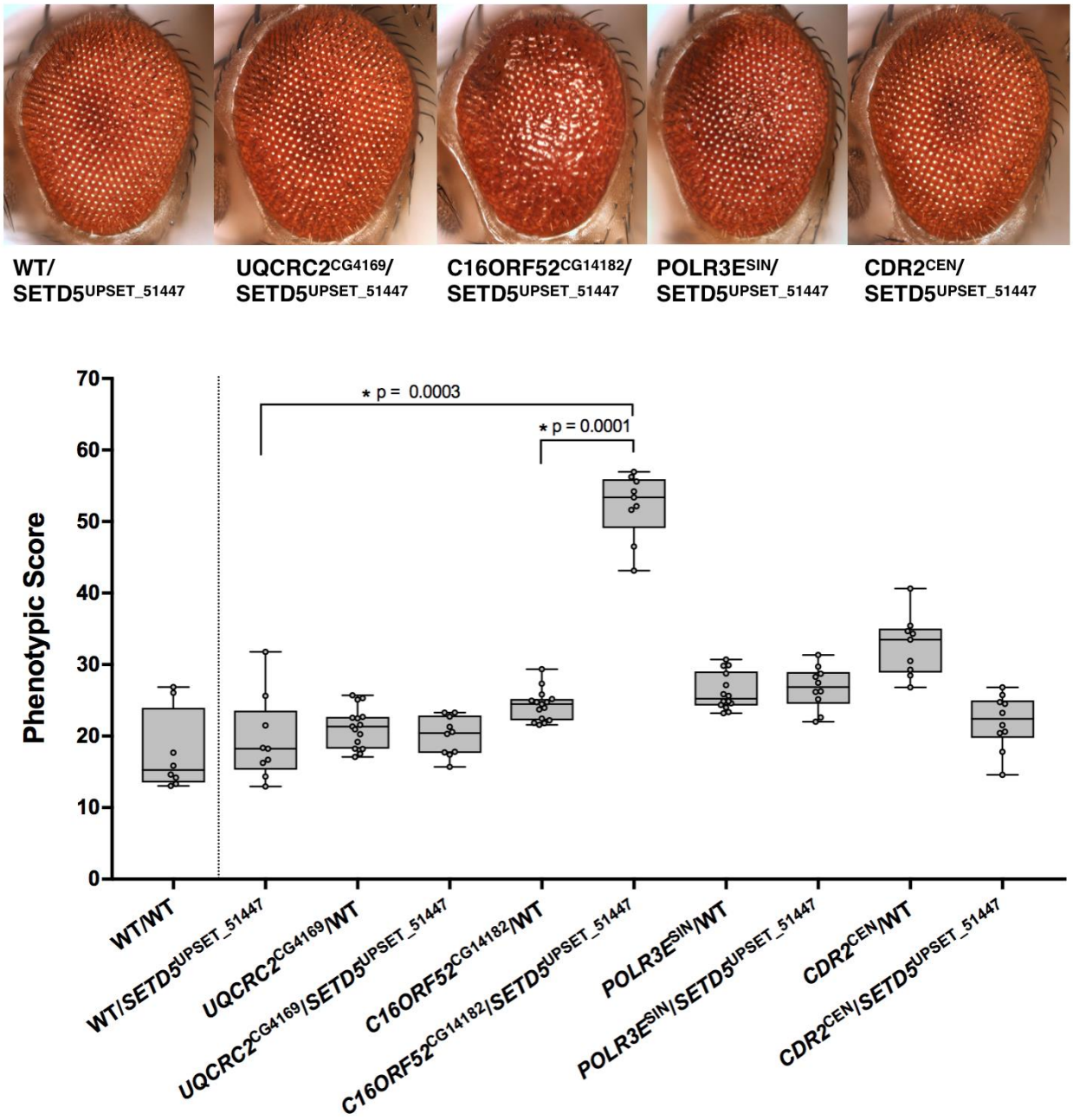


**Figure 3: *C16orf52*/*SETD5* enhancement of phenotypic severity.** Significant enhancement of phenotypic score is observed only for the ortholog of *C16orf52* in combination with *SETD5*. Two-tailed Mann-Whitney test confirmed a significant difference between the double knockdown and the first and second-hit phenotypes. This enhancement was also seen in the second RNAi line for *SETD5* (UPSET_61266: first-hit to two-hit, p=0.0000; second-hit to two-hit, p=0.0004). The results shown for *CDR2* may suggest a suppression effect with *SETD5*. However, results from a secondary RNAi line are necessary to conclude an interaction among these genes. The 16p12.1 orthologs *UQCRC2* and *POLR3E* did not show a significant difference of the eye phenotype compared to the one-hit.

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# *Staying Alive: Black Women's Resistance During Slavery*

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## Introduction

The history of slave resistance in the United States is a complicated topic of study, mostly because the definition of resistance is subjective. What one person views as an act of resistance may differ from another person's view. Since most slaves were not literate during the early stages of slavery scholarship, historians used documents from plantation owners; these documents were heavily biased and lacked the voices of those in bondage, making it difficult to understand a holistic perspective of slavery. With the publication of the Negro *Journal of Negro History*, we begin to hear from both sides and most importantly from the victims'. Stephanie Camp, an American feminist historian, wrote about black women's resistance in *Closer to Freedom: Enslaved Women and Everyday Resistance in the Plantation South*. Camp expanded our understanding of how female slaves resisted their captivity in the 1800s. The existence of slave resistance scholarship helped shift American scholarship on slavery from nostalgia and benevolence – the "Sambo thesis" – to the "accommodation versus resistance debate."[1] Slaves rebelled with theft, foot dragging, short-term flight and feigning illness. Uprisings were the most dramatic and violent way that slaves resisted enslavement. However, there were more insidious ways in which slaves rebelled on plantations. Slaves stole from owners, they damaged machinery, and worked slowly, which affected property and profit. Stephanie Camp argues that the paternalist model does give us a good theory of plantation management, but it does not offer a complete perspective on plantation and black life. Women rarely participated directly in rebellion and made up a small percentage of those who ran away to the North, which is the most studied forms of resistance. Historians need study to enslaved women's resistance in a creative way. Resistance is mainly seen as a "public phenomenon (visible, organized, and workplace oriented)", suggesting that resistance was not significant in private places, and this limits our understanding of women's lives in the past. For women in bondage, the body and home were sites of domination and resistance, because of hard labor in the fields and sexual exploitation in the home: "the body and home were key sites of suffering, but also a resource in women's survival"[2]. Resistance is difficult to define, especially in unusual circumstances such as slavery; however, it is the key to survival. This paper aims to use Camp's thesis as a framework to continue exploring women's resistance. I will be exploring the ways in which women resisted

[1] Closer to Freedom: Enslaved Women and Everyday Resistance in the Plantation South (University of North Carolina Press, 2004), 5.
[2] Ibid 4.

bondage though the creative and cultural mediums of sex, dance, and poetry. The first part of the paper will be a historiography of literature regarding slavery and the unique experiences of black women in bondage. The second part of the paper will analyze the difference forms of resistance, using a combination of primary and secondary sources.

## Historiography

Ulrich B. Phillips, the first major historian of Southern slavery, attracted attention and controversy. *American Negro Slavery*, published in 1918, was the first major systematic analysis of slavery in the South. He made observations regarding the workings of plantation and the overseers however he focused primarily on the masters. Philips claimed that "enslaved African Americans had been content with their place under the institution (Stevenson 698).[3]" He described that normal Southern slave as having an "eagerness for society, music and merriment, a fondness for display whether of person, dress, vocabulary or emotion, a not flagrant sensuality, a receptiveness toward any religion whose exercises were exhilarating, a proneness to superstition, a courteous acceptance of subordination, an avidity for praise, a readiness for loyalty of a feudal sort, and last but not least, a healthy human repugnance toward overwork" (Phillips 287).[4] Phillip's work was critiqued on the basis of its exclusive use of slave owners' documents, as well as for his sympathetic portrayal of plantation owners.

Sidney Drewry, a white Southern historian, published *The Southampton Insurrection*, which retells the events of the Nat Turner slave rebellion that occurred in Southampton County, Virginia, during August of 1831. Turner, the leader of the rebellion, marched alongside about 70 rebels to different plantations and killed an estimated 55-60 white Southerners, while freeing the slaves they encountered. Drewry depicted the rebels as fools who were tricked by "a wild, fanatical preacher." Drewry supported the view that slaves were loyal to their owners.[5] These interpretations and viewpoints of slavery were very dangerous, because they perpetuated myths of black inferiority, incompetence, and moral laxity.[6] Both Philips and Drewy were apologists for an inhumane, brutal and exploitative system and narrated that enslaved people were content with their circumstances; their work stripped the slaves of their humanity. These viewpoints were the opinion of white males, who were the ones that maintained and protected slavery under the law.

In the early 1900's Carter G. Woodson started the *Journal of Negro History* in order to collect scholarship regarding the history of African Americans. In 1935 John B. Cade published *Out of the Mouths of Ex-Slaves*, which contained autobiographical accounts of formerly enslaved African Americans who lived in Texas and Louisiana. Cade reviewed Phillip's literature, and stated that a major flaw of the *American Negro Slave* was "This failure to understand what the

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[3] Brenda E. Stevenson. "'Out of the Mouths of Ex-Slaves': Carter G. Woodson's *Journal of Negro History* 'Invents' the Study of Slavery.", 698.
[4] Ulrich B. Phillips, American Negro Slavery: A Survey of the Supply, Employment and Control of Negro Labor as Determined by the Plantation Regime (Baton Rouge, 1918), 287.
[5] Breen, Patrick H. The Land Shall Be Deluged in Blood: A New History of the Nat Turner Revolt. Oxford University Press, 2016, 3.
[6] Brenda E. Stevenson. "'Out of the Mouths of Ex-Slaves': Carter G. Woodson's *Journal of Negro History* 'Invents' the Study of Slavery." *The Journal of African American History*, vol. 100, no. 4, 2015, pp. 698–720. *JSTOR*, 700.

Negroes have thought and felt and done, in other words, the failure to fathom the Negro mind, constitute a defect of the work."[7] Cade interviewed ex-slaves who complained about the lack of food, clothing, and medical attention. They interviewees described "the constant separation of families, rape and sexual abuse, physical brutality, and overwork, a cruelty imposed not only by slaveholding men, but women as well"[8] . Enslaved people were neither happy-go-lucky nor loyal, and this narrative does not describe a benevolent institution; instead, it displays violent and oppressive circumstances. Cade undermined scholars like Drewry and Philips who believed that most slaveholders were kind, and most slaves were happy. Cade's careful work and methodology served as an inspiration to future scholars in the history of slavery. When Herbert Aptheker, an American Marxist and historian, reviewed Drewry's work several decades later, he argued that instead of viewing the rebels as "deluded wretches and monsters," they should be viewed as "human beings willing to resort to open struggle in order to get something precious to them--peace, prosperity, liberty, or in a word, a greater amount of happiness."[9] Aptheker argued that most slaves hated slavery and fought however they could to resist the oppressive institution.

Eugene Genovese**,** an American historian of slavery, coined the term "paternalism"**.** In *Roll Jordan Roll*: *The World the Slaves Made,* he defines paternalism as a negotiated space: it is the involuntary labor of the slaves as a legitimate return to their masters for protection and direction. Slaveholders saw themselves as benevolent paternalists rather than acquisitive capitalists; they believed they held the best interests of their slaves at heart. Slaves used this realization to make their situations better and build some security or safety. By accommodating these ideas, enslaved people controlled pace of work, received recognition for their marriages, and limited the power of slaveholders. [10] Breen states that Genovese believed "slaveholders understood themselves to be paternalistic people who were concerned with the well-being of their slaves", which is built upon Philip's work; however, it lacks the racism.[11] He argued that they did what they could to improve their lives or resist their enslavement, that a few slaves who had been involved in America's handful of slave revolts were unable to create "a revolutionary tradition", and that large scale political resistance was difficult.[12]

In *Closer to Freedom,* Camp outlined the temporal and spatial space of an enslaved person in the plantation south. She defined this as "Geographies of Containment", which are position or spaces within or space within antebellum Southern society that kept slaves inferior. These geographies of containment allowed "slaveholders power to define bonds people's proper

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[7] Review" of American Negro Slavery by Ulrich Bonnell Phillips, JNH 4, no. 1 (1919): 103

[8] Brenda E. Stevenson. "'Out of the Mouths of Ex-Slaves': Carter G. Woodson's *Journal of Negro History* 'Invents' the Study of Slavery." *The Journal of African American History*, vol. 100, no. 4, 2015, pp. 698–720. *JSTOR*, 699.

[9] Herbert Aptheker, *Nat Turner's Slave Rebellion: Together with the Full Text of the So-Called "Confessions" of Nat Turner Made in Prison in* 1831 (New York: Humanities Press, 1966), I, 5.

[10] Genovese, Eugene D. Roll, Jordan, Roll: The World the Slave Made. 1st ed., Pantheon Books, 1974, 146-147, 658).

[11] Breen, Patrick H. The Land Shall Be Deluged in Blood: A New History of the Nat Turner Revolt. Oxford University Press, 2016, 4.

[12] Genovese, Eugene D. Roll, Jordan, Roll: The World the Slave Made. 1st ed., Pantheon Books, 1974, 587-598).

location."[13] If the slaves stepped out of these spaces, they were punished, sometimes severely. Enslavement in the South culturally alienated black people because it reduced human beings to property. They could be sold at any moment; they were not financially compensated and were subjected to the will of another person and items like shackles, chains, passes, slave patrols, hounds, lashes, and auction blocks. In the nineteenth century lawmakers and slaveholders laid out restrictions of slave movement. Virginia was the first colony to pass laws that governed slaves' behavior. In 1680, "An Act for Preventing Negroes Insurrections" was passed. The law prohibited enslaved people from owning weapons, and leaving their place of work without a pass. The law stated: "It shall not be lawfull for any negroe or other slave to carry or arme himselfe with any club, staffe, gunn, sword or any other weapon of defence or offence, nor to goe or depart from of his masters ground without a certificate from his master, mistris or overseer, and such permission not to be granted but upon particular and necessary occasions."[14] Things like passes, tickets, curfews and roll call limited their mobility. Charles Ball called this "principles of restraint": slaves were not allowed to leave the plantation that they belonged to—not for a "single mile" or a "single hour"—and if they did not abide by these rules they were "taken up and flogged."[15] The plantation system was penal: when rules were broken they were punished, sometimes severely. Slave holders did not allow their slaves to leave the plantation without a pass. The passes explained to the reader the "spatial and temporal parameters" of the pass holder. The planters aimed to control those in bondage even in the nighttime. They were forbidden to leave the plantation in the evenings; some were not allowed to even leave their cabins. William Ethelbert Ervin wrote in 1846 "At nine o'clock every night the Horne must be blown which is the signal for each to retire to his or her house and there to remain until morning."[16] Overseers enforced these rules and made sure that everyone was present, and if not they were treated violently. This is because planters viewed themselves as paternalistic people who cared for the wellbeing of their slaves, they desired affection and loyalty from their slaves. This caused planters to control "nutrition, dress, hygiene, bodily function, pleasure, and family relations."[17] Due to the capitalistic nature of slavery, planters were incentivized to preserve and increase their investments, meaning rape was used as a means to produce capital. In 1807, The Act Prohibiting Importation of Slaves, a federal law, prohibited the importation of slaves from the coasts of Africa to the United States. [18] This law affected the institution because the supply was cut off, and slaveholders had to maintain slavery on their own. These laws strengthen the geographies of containment of enslaved people because slaveholders had to replenish the slave populations on their own.

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[13] Camp, Stephanie M. H. Closer to Freedom: Enslaved Women and Everyday Resistance in the Plantation South. Univ. of North Carolina Press, 2004, 17.
[14] Camp, Stephanie M. H. Closer to Freedom: Enslaved Women and Everyday Resistance in the Plantation South. Univ. of North Carolina Press, 2004, 18.
[15] Ibid, 13.
[16] Ibid, 24.
[17] Ibid, 18.
[18] United States Statutes at Large: Containing the Laws and Concurrent Resolutions ... and Reorganization Plan, Amendment to the Constitution, and Proclamations." *Avalon Project - Documents in Law, History and Diplomacy*, Yale Law School, avalon.law.yale.edu/19th_century /sl004.asp.

Geography of containment looked different for males and female slaves. Tasks that required travel were often reserved for men. When mail needed to be delivered, those tasks were allocated to men; they were also able to hire themselves out on their own time. At times, men could visit girlfriends and wives on neighboring plantations. These passes were valid from Saturday afternoon to Sunday evenings/Monday early mornings. However, it is important to note that this was a privilege that not everyone experienced. Men were not always allowed these luxuries because planters wanted "perfect order" from their slaves.[19] Men and women stopped working in the fields at sunset, however women had a second shift of labor, which was household work. They were obligated to work in the fields, and had to come home to more tasks that needed to be fulfilled. Bondmen also had tasks to be completed at night they hunted, fished, and contributed to the production of craftwork; together women and men worked to take care of their homes. The women's second shift of labor was greater: they would cook supper, clean the cabin, produce household goods like soap, candles, and wash and mend their families' clothing along with bed linens, bonnets and produced textiles for plantation use. Enslaved women were expected to exert the same amount of energy during their second shifts of labor: a Georgia woman who failed to complete her tasks was severely punished by her manager. She was stripped naked, tied to a post, instructed to wrap her arms around the post, and was beaten severely with 70 stripes. The shifts of work increased time-based control, which enslaved women had throughout the South and made it difficult for them to escape.[20]

Due to the plantation penal system, when women stepped out of these bounds they were physically punished; however, for women the violence inflicted upon them was sometimes infused with sexual overtones and hints of sadism. In the autobiography of Solomon Northup, he recalled a story about a woman who left the plantation to visit a friend. This woman was a mistress of the owner; he suspected that she had a lover on the other plantation and his sexual rage manifested into brutality. Patsy a slave on the plantation was stripped naked, laid down on her face completely naked and beaten severely. Solomon remarked that "Nowhere on that day on the face of the whole earth, I venture to say, was there such a demoniac exhibition witnessed as then ensued…She was terribly lacerated-I may say, without exaggeration, literally flayed."[21] "When women broke the rules, and moved out of bounds they risk and receive punishment that one more physically painful and heartbreaking someone sexually degrading."[22] Being punished was a traumatic experience, but adding sexual overtones makes it even more humiliating and brutal. These are examples of how the body was dominated by plantation owners, and how being victims of sexual violence manifested in a public manner.

Deborah, Gray-White's groundbreaking book, *Ar'nt I A Woman: Female Slaves in the Plantation South,* made black women visible in slavery scholarship; this book highlighted the burdens that black women were forced to carry, due to the brutal nature of slavery and sexual exploitation. From the very beginning, during the middle passage men and women were differentiated. On the middle passage women were not in the holds of slave ships: they were in the quarter desk. This made the women and girls easily accessible to the sexual desires of crew

[19] Camp, Stephanie M. H. Closer to Freedom: Enslaved Women and Everyday Resistance in the Plantation South. Univ. of North Carolina Press, 2004, 30.
[20] Camp, Stephanie M. H. Closer to Freedom: Enslaved Women and Everyday Resistance in the Plantation South. Univ. of North Carolina Press, 2004, 28, 31, 81-82.
[21] Ibid, 33.
[22] Ibid, 33.

members. This set the stage for exploitation; her sex life, marital status, workload, and diet was controlled by the slaveholder. Gray-White talks about the jezebel who "was of a person governed almost entirely by her libido."[23] The jezebel was the complete opposite of the Victorian white woman, meaning that she was not a pious person. This stereotype can be traced back to European views on African women from initial contact, and the belief that their polygamous relationships, tribal dances, and lack of clothing made them lustful and had abnormal sexual desire.[24]

Jennifer Morgan addresses the dangerous ideals regarding African women's bodies and sexuality in *Laboring Women.* By the time the English arrived in the West Indies, ideas and information about black and brown women had already formulated. European writers viewed black women as culturally inferior, and translated this into racial difference. Their bodies became entangled with savage behavior, and images of the women's bodies were viewed as barbaric. Morgan found that African women's "unwomanly behavior evoked an immutable distance between Europe and Africa on which the development of racial slavery depended."[25] The dehumanization of the African woman through her body and morality was tied to her race to justify the brutality of her bondage. Stripping African women of their humanity made it easy to overwork them, and use them as a means of reproduction. In June 1647, Richard Ligon travelled on the ship Achilles to settle as a planter in Barbados; he stopped in Cape Verde to trade, and it was there that he saw black women for the first time. In *True and Exact History of Barbadoes* he wrote that their breast "hang down below their Navels, so that when they stoop at their common work of weeding, they hang almost to the ground, that at a distance you would think they had six legs."[26] West African women's bodies were victims of the "colonizing venture" and because Europeans first contact with West Africa happened in a moment in which they were determined to make use of valuable resources; therefore, their bodies were less likely to be objects of lust or beauty.[27] They wrote regularly on the topic of African women's physiognomy and reproductive experiences. These viewpoints made African women indispensable because it "showed the gendered ways of putting African savagery to productive use." African women's bodies were turned into commodities from the very beginning and this justified the hard labor and set the stage for sexual exploitation.[28]

Elite slave-holding southerners were convinced that slave women were "lewd and lascivious" and that "they invited sexual overtures from white men", that any evidence of their resistance from sexual invitations was feigning. Due to these beliefs, public spectacles were made of black women, "the slave woman's body, however, commanded no such respect. Just as with reproduction, that which was private and personal became public and familiar."[29] During slave auctions women were exposed and examined for fertility, in moments when potential

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[23] White, Deborah Gray. Ar'nt I a Woman? Female Slaves in the Plantation South. Norton, 1987, 29.
[24] Ibid, 30.

[25] Morgan, Jennifer Lyle. Laboring Women: Reproduction and Gender in New World Slavery. University of Pennsylvania Press, 2004, 38.
[26] Ibid, 3.
[27] Ibid, 15.
[28] Ibid, 15.
[29] White, Deborah Gray. Ar'nt I a Woman? Female Slaves in the Plantation South. Norton, 1987, 32.

buyers were wary about the reproductive abilities of the enslaved woman, the person would be taken to a private room where she would have examined thoroughly by a physician, even though they probably were not able to assess fertility. Enslaved women were not clothed properly on plantations, but not because the planters did not want to clothe them properly: it was often because of the type of labor that was expected of the women. When they worked in the rice plantations/fields their dresses were "reefed up", this exposed their legs and thighs, in order to keep them out the dirt and mud. Those that worked in the home, had their skirts pulled up in order to wash floors.[30] "The very sight of semi-clad black women nurtured white male notions of their promiscuity."[31] Gray-White argues that "the conditions under which women were sold, and were punished also fostered an atmosphere conducive to such thoughts."[32] White men fostered environments in which black women could be held responsible for their abuse, which meant that they found excuses to engage in sexual contact with the women in bondage. These differences in geographies of containment shaped resistance opportunities.

## Resistance

According to Camp the enslaved women had three bodies. The first body was a site of domination: it was a body acted upon by slaveholders. Views on African and black women's bodies (previously cited in the historiography) rationalized enslavement and sexual violence against enslaved women. It caused slaveholders to strictly control the black body, in order to maintain the institution of slavery. The second body was the experience of the process of this control that slaveholders and planters had over people. "It was the body as a vehicle of feelings of terror, humiliation and pain." The second body was "associated with poverty, suffering and shame." The uncertainty of sale, sexual/nonsexual violence, disease and labor put to slaves were a source of "frequent anxiety and misery."[33] The third body, however, was a source of pleasure, pride, and self-expression. This was the body that disregarded curfew and pass laws, in order to escape to parties, where they could drink, eat, and dress up. This body was claimed, this body was theirs to enjoy: the third body was a site of pleasure and resistance.[34]

### Sex as Resistance

According to Gray-White, it is important to note that not all white-black relationships were exploitive, even though they began that way. An example of this is in the story of an enslaved woman named Cynthia, an acquaintance of William Willis Brown, who is narrating the story. When she was bought by a slave trader she was given two options: if she accepted his proposal, he would take her to St. Louis with him and establish her as his housekeeper on his farm, but if she rejected his offer he would sell her as a field hand on the worst plantation on the Mississippi River. She accepted this offer and became the slave trader's mistress and

[30] Ibid, 32.
[31] ibid, 33.
[32] ibid, 31.

[33] Camp, Stephanie M. H. Closer to Freedom: Enslaved Women and Everyday Resistance in the Plantation South. Univ. of North Carolina Press, 2004, 67.
[34] Ibid 68.

housekeeper. In other instances, women were more eager than Cynthia. Solomon Northup a kidnapped slave explained a story about a time when he was imprisoned in a slave pen. He was with a woman who "entertained an extravagantly high opinion of her own attractions." He said that she stated that she expected to be bought by a "wealthy gentleman of good taste." The thoughts of silks and stains and jewelry appealed to these women. And indeed, the travelers did see mulatto and quadroon slave mistresses with wealthy merchants strolling in the streets.[35] Some women were concubines to their white lovers and sometimes were able to obtain freedom for themselves and their children. These are instances when black women used their bodies as a medium of resistance. When they willingly engaged in sexual activities with slaveholders they sometimes were able to expect something in return. Unfortunately, when they participated in those activities the jezebel stereotype was strengthened, meaning that the promiscuity and sexual nature of black women was further affirmed in the minds of white slaveholders. However, using sex as a form of resistance is important, because traditionally resistance is seen a public and organized, but the body is a key source of women's survival. It was hard for women to organize or run away, it was humiliating for their private life to be put on display without their consent, and it was degrading for enslaved women's bodies to be used as machines for reproduction. Engaging in sexual resistance helped black women have control or autonomy in their situations. In some instances, they were able to use their bodies to gain favors, and in some cases **freedom**. They transformed their bodies, from a site of domination into a site of freedom for themselves.

## Dance as resistance

Dance helps to link African Americans to their African past, because it is very central to African culture. Key events of the life cycle are celebrated through dance such as fattening house dances, fertility dances, and rite-of-passage dances. "Dance serves as a mediating force between people and the world of the gods."[36] Dance is a part of the philosophy, customs, and sense of place, removing it from their lives would severely alter African culture. Most traditional dances have been connected to or are performed during religious ceremonies. Most of these events were open to the public, officials such as chiefs, elders, and priests were able to dance, and those who were not proficient had several months of instruction before taking the position. This meant that dance competency was extremely important in traditional West African society. With the beginning of the Trans-Atlantic slave trade came struggle between slave holders and captives. Being captured brought psychological and cultural transformation. European and American slave holder strived to destroy independent cultural expression, because they understood that having control over the slave ensured subordination. They sought to appropriate dance and use it as a form of domination. Slaves were able to retain elements of their culture in the new hostile environment.[37]

Slaveholders feared slave rebellions, especially when the need for labor intensified; in South Carolina the demand for slaves was amplified. Numerous slave insurrections caused the passing of laws to prevent rebellions. The Stono Rebellion occurred on September 9th, 1739, in the colony of South Carolina. It was the largest slave uprising in the British mainland colonies,

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[35] Ibid, 35.
[36] Hazzard-Gordon, Katrina. Jookin': The Rise of Social Dance Formations in African-American Culture. Temple Univ. Press, 1990, 3.
[37] Ibid, 5.

with 42-47 whites and 44 blacks killed. There were reports that slaves had weapons, and after killing a number of white people they marched with "drums, beating and colors flying." After 12 miles of marching they began to sing and dance, rejoicing. It was at this moment when the militia stationed themselves around them to prevent the success of the rebellion. In 1740, South Carolina legislation passed the Negro Act of 1740 that prevented slaves from visiting plantations, using drums, horns, or instruments to signal rebellion, from having gatherings of large numbers of people. Dancing affairs provided opportunities to exchange information and plan rebellions, especially when there were more slaves than white people. According to Hazzard-Gordon "The high pitch of emotions at these dances could serve as a pre-text for touching off a previously planned revolt."[38]

During the Middle Passage, traditional dancing was forbidden on the ships; however, there was dancing that occurred. After meals, the slaves were required to jump in their irons for exercise, as it was believed necessary for their health. "Dancing the slaves" was an activity on the slave ships, as evidenced by advertisements for musicians to be employed on slave ships. Crew members walked on the decks with whips and forced slaves to jump in their irons. A sailor recalled that he was hired to "dance" the men and others were employed to "dance" women. On ships without a musician, the music was provided by "a slave thumping on a broken drum, an upturned kettle, or an African banjo". When they danced, some slaves sang, and sang about their experiences. There was a captain who complained about the sorrow of the slaves, he remarked "The songs they sang of sorrow and sadness-simple ditties of their own wretched estate." Slaves choose to sing somber songs; it is not known whether or not the songs were traditional or new.[39] There were instances when the dancing was enjoyed by slaves: a board one ship, an officer recalled that "Our blacks were a good-natured lot and jumped to the lash so promptly that there was not much occasion for scoring their naked flanks. We had tambourines aboard, which some of the younger darkies fought for regularly, and every evening we enjoyed the novelty of African war songs and ring dances, fore and aft, with the satisfaction of knowing that these pleasant exercises were keeping our stock in good condition and, of course, enhancing our prospects of making a profitable voyage."[40]

Dancing also served to deconstruct the imposing presence of white people. Slaves were not able to openly criticize white people, so it had to be insidious. Dance was a tool for self-assertion, ridicule, and criticism. Slaves performed dances where white people were derided. Slaveholders did not understand these performances, and wrote them off as foolishness. A former slave recalled "It was generally on Sunday when there was little work . . . that the slaves both young and old would dress up in hand-me-down finery to do a high-kicking, prancing walk-around. They did a takeoff on the high manners of the white folks in the "big house", "but their masters, who gathered around to watch the fun missed the point."[41]

Slaves were able to hold secret dance parties: "deep in the woods away from slaveholders' eyes they held secret parties where they danced, performed music, drank alcohol, and courted."[42] These parties were spaces that were not in complete control of the slave holders.

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[38] Ibid, 34.
[39] Ibid, 8.
[40] Ibid, 9.
41 Ibid, 46.
42 Camp, Stephanie M. H. Closer to Freedom: Enslaved Women and Everyday Resistance in the Plantation South. Univ. of North Carolina Press, 2004, 60.

It is important to note that slave masters tried to limit occurrences of these parties. Charlie Crump recounted that "we ain't 'llowed ter go nowhar at night". They were not allowed to participate in these illegal parties; however, they found ways to do it. One planter complained about that nighttime activities of the slaves stating that "night is their day". They would risk punishment; however, all black people would "gang up an 'have fun." The patroller did not know that there "wus a number of little paths what run through de woods dat nobody ain't watched case dey ain't knowed dat de paths wus dar."[43]

In order to prepare for the parties, they obtained the goods they needed by stealing from their slave masters, which they justified by explaining that the goods "belongs to massa, and so do we and we only use one part of his property to benefit another." They hid themselves in "valleys, swamps, and other by-places" in order to cook in secret. They prepared food into the early hours of the morning, and they destroyed anything that left a trace. At the start of the party around 10pm a fiddler, began "some favorite tune" and people danced until midnight when it was time to eat. The food was delicious and "well cooked". Most of the time, slaves only received one meal during the day; however, at the party there was plenty of food for everyone.[44]

Musicians performed for their friends and neighbors, playing fiddles, banjos and tambourines. They also improvised melody-making instruments from reeds and handsaws, and made percussions from spoons, bones, pans, and buckets in order to play "Turkey in the Straw" and popular dance tunes. When there were no musicians present, they sang and danced to the lyrics. According to Dosia Harris "one went somepin lak dis:"

> Oh! Miss Liza, Miss Liza Jane?
> Axed Miss Liza to marry me
> Guess what she said?
> She wouldn't marry me,
> If de last Nigger was dead.[45]

Dance tunes also contained political meaning; an example is a song about a rejected lover, and the person who was the object of affection was titled "Miss". Miss is a sign of respect that white people denied enslaved people. These songs were sung that plantation events under the supervision of the slaveholders. However, not all songs could be sung in the presence of the slaveholders. Mollie Williams, a bondwoman from Mississippi, sung a song that was about resistance the lyrics read:

> Run tell Coleman,
> Run tell everybody
> Dat de niggers is arisin'![46]

Competition arose at these parties, which encouraged camaraderie among participants. In order to win a dance competition, one had to "execute dance moves while maintaining an

[43] Ibid, 69.
[44] Ibid, 70.
[45] Ibid, 74.
[46] Ibid, 75.

outward demeanor of "control and coolness."[47] Nancy Williams competed with Jennie (another slave) to see who could perform the dance the best. In order to make the challenge harder they danced with a glass of water of their head. The person who won was the one who maintained "her cool" and made the dance look simple. These dances gave women the ability to show their strength. This gave women the opportunity proves their physical power. Dance competitions sometimes provided women with some relief from black gender hierarches.[48]

These are the ways in which dance became a medium of resistance for enslaved black woman. Dance helped reaffirm control over their body, on the Middle Passage slaveholders strived to use the body and dance as a form of domination. "Dancing the slaves" was used to ensure the quality of the product that would be sold when they finally reached their destination. They were able to resist this by singing war and somber songs, alongside performing ring dances on ships where they aimed to erase their culture. On the plantations, they used dance gatherings to plan insurrections, have secret dance parties, and to mock slaveholders. Being able to have fun and enjoy their bodies is a reclamation of their body and humanity.

## Poetry as resistance

Analyzing poetry as resistance is difficult due to the fact that most enslaved black people were not literate, but as documented through this paper black women found ways around this. Phillis Wheatley was born in Senegal/Gambia around 1753, and was brought to Boston, Massachusetts, on a slave ship in 1761 and purchased by John Wheatley. The Wheatleys taught Phillis how to read and write; she received lessons in theology, English, Latin, and Greek. Wheatley was a world-renowned poet: her first volume of poetry was called *Poems on Various Subjects, Religious and Moral*, published in 1773. She gained recognition and fame after she was published, in order to validate her authorship, the volume included preface where 17 Boston men vouched that she was the author of those poems.[49]

**On Being Brought from Africa to America 1768**

'Twas mercy brought me from my *Pagan* land,
Taught my benighted soul to understand
That there's a God, that there's a *Saviour* too:
Once I redemption neither sought nor knew.
Some view our sable race with scornful eye,
"Their colour is a diabolic die."
Remember, *Christians*, *Negros*, black as *Cain*,
May be refin'd, and join th' angelic train.

[47] Hazzard-Gordon, Katrina. Jookin': The Rise of Social Dance Formations in African-American Culture. Temple Univ. Press, 1990, 20.

[48] Camp, Stephanie M. H. Closer to Freedom: Enslaved Women and Everyday Resistance in the Plantation South. Univ. of North Carolina Press, 2004, 76.

[49] Neale, Sondra O. "Phillis Wheatley." Poetry Foundation, Poetry Foundation, www.poetryfoundation.org/poets/phillis-wheatley.

The speaker begins the poem by declaring that her presence in America was an act of mercy by God, because she was brought out of a Pagan land, which is Africa. This displays that she appreciates virtues of a Christian country. The speaker has learned about God and is saved, and has gained redemption that they hadn't thought about. This can be inferred through the use of the words "benighted", defined as 'taken over by moral and intellectual darkness, ignorance', and "redemption" defined as "being saved from sin and evil." The next four lines of the poem are an exploration of the knowledge the speaker has gained as a result of Christianity. In line 5, the mood/tone of the poem shifts. The speaker makes the claim that black people are viewed and treated no better than animals--a sable, which is a small animal with black hair. In the next line, she quotes "Their colour is a diabolic die", talking about the hypocrisy of this phrase. White Christians calling black Christians "a diabolic dye" is implying that black people are black because they are evil. In line 7 the speaker is reminding God-fearing Christians that all people are created equal in God's eyes, and are capable of joining the angelic train.

It is safe to say that white men attempted to dominate Wheatley's poetry, especially considering that she needed the affirmation of white men in order to even be published. However, Wheatley found ways to assert her humanity within her poetry. This is because in her poem she states black people are not evil, and that **her** God would never turn anyone away because of skin color. She is not praising slavery; rather she is praising them for being brought to Christianity, and is calling out those Christians who use religion to discriminate, enslave, and disenfranchise black people. At this time period, black people were not human in the eyes of white colonists. The act of writing poetry could only be the act of a human. In order to write poetry one had to experience emotions, her publication was a testimony to emotions and pain that they supposedly did not have as outlined in Jennifer Morgan's *Laboring Women*. It is also important to note that she is writing this poem in traditional European format, which one could assume once again is complacency, but as Camp states, black women's resistance should not always be seen as a public phenomenon. Although the poem is a public thing, the format can be seen as the cloak to deride/critique or deconstruct the white presence, in the same way it was used for dance. Phillis Wheatley's literacy was a privilege that not many women and black people had at this time period. However, given the opportunity there were probably a lot of poems within black women that were not allowed to fully manifest due to black women being illiterate.

## Conclusion

Black people in the United States have always found a way to create agency for themselves: one just has to understand how to look for it. In slavery scholarship, white men erased the voices of black people, and rewrote the history of a brutal and exploitative system in an apologist manner. When Carter G. Woodson published the Journal of Negro History, in order to compile slavery scholarship, the voices of the formerly enslaved were rightly uplifted. It was not until the 1980's, however, that we are able to get scholarship that narrated the unique experiences of enslaved black women. Deborah Gray-White's Ar'nt I A Woman? built her work upon the idea that black women not only had to deal with being black, but also being a woman, and how gender differentiated their experiences in bondage. Followed by Jennifer Morgan's Laboring Women whose extensive research displayed the dangerous ideals regarding the bodies of African women and their sexuality, the commodification of their bodies, and how it became the justification for their enslavement and sexual exploitation. Followed by Stephanie Camp who outlined the ways

in which black people were enslaved, the geographies of containment in the penal plantation systems that forced people to stay within those bounds, or else face punishments. Black women were contained in different ways than men, which shaped resistance opportunities; this is where Camp stresses that resistance needed to be analyzed in another context. Because the body and home were key sites of suffering and domination, our understanding of resistance can be more broad and inclusive. Black women utilized their third body, to experience pleasure, pride and self-expression. They reclaimed their bodies and humanity and this is a form of resistance. Black women used sex as resistance to gain favors, and in some cases freedom. Women were also able to use dance as resistance: as outlined in Katrina Hazzard-Gordon's work dance was a medium or a conduit for reconnection to African culture, after the Stono Rebellion the rebels danced and sang and rejoiced. In the Middle Passage, dance was turned into a tool of domination; however, there were instances in where they were able to sing songs from their culture and perform war dances. On the plantations, they used dancing to ridicule whites and to deconstruct their imposing presence insidiously, under the guise of fun. They held secret dances parties in the woods where they would drink, eat, dance, sing and dress up. Competitions arose at that these parties, and provided a woman the opportunity to display their strength, control and dancing abilities. Finally, poetry was used as an act of resistance, Phyllis Wheatley's poetry asserted her humanity, displayed her emotions, that she supposedly did not have because according to white men black women did not feel pain, and used European format to express her views on slavery and Christianity, and to deconstruct their imposing presence. These acts arguably kept black women alive, and more importantly provided some type of joy in a lifetime full of pain, misfortune and uncertainty.

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# *Interactive Effects of Nematode and Bot fly Parasitism on the Survival of White-footed (Peromyscus leucopus) Mice*

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## Abstract

The white-footed mouse, *Peromyscus leucopus* (Rafinesque), is the most abundant rodent in Northern America. These mice are frequently studied in laboratory and field settings due to their tendency to harbor many zoonotic pathogens. There is interest in factors that influence the survival of these mice; parasitism is one such factor that is known to impact their survival (Burns, Goodwin and Ostfled, 2005). An ecto-parasite known as *Cuterebra fontinella,* or bot flies, has curiously been shown to cause a significant increase in survival. We set out to determine if bot flies alter mouse survival in Pennsylvania, and further, to investigate if this effect is mediated, in any way, by the removal of gastrointestinal parasites, which have also been shown to influence mouse survival in Pennsylvania. We monitored bot fly infection rates and mouse survival in 12 populations. Half (6) of these populations were provided with anthelmintic treatments which cleared nematode infections. This study uses generalized linear models to determine if botfly infections alter mouse survival and if this impact is mediated in any way by nematode removal.

**Key words:** *Peromyscus leucopus*, white-footed mice, bot fly, nematodes

## Introduction

*Peromyscus leucopus* (the white footed mouse) is a rodent native to North America (Rafinesque). These rodents are known to be reservoirs for several tick-borne and zoonotic pathogens, such as arboviruses (Hardy, 1994) and *Borrelia burgdorferi* (Burgdorferi), to name a few (Vandergrift and Hudson, 2009). The most studied is Sin Nombre Hanta virus, which was identified as the etiological agent of the 1993 human outbreaks in the four corners region of the United States (Childs et al). This pathogen is transmitted to humans by inhalation of aerosolized urine and feces of these rodents who often invade houses garages and sheds. They also play a major role in the life cycle of *Borrelia burdorferi*, the spirochete responsible for Lyme disease (Burgdorferi). Because *P. leucopus* are important reservoirs of zoonotic agents, much subsequent attention has been paid to their population dynamics and their parasite communities (Wolf 1996,

Jones Ostfeld, Falls, Fryxell). This led to the discovery of arboviruses (Hardy, 1994) and lymphocytic choriomeningitis virus (Ralph, 1999) and several bacterial pathogens such as *Borrelia burgdorferi* (Burgdorferi), *Anaplasma phagocytophilum* (Magnarelli et al., 2006) and *Francisella tularensis* (Eisen et al., 2008). Although transmission of these zoonotic diseases is rare, understanding the factors that facilitate spillover to humans is critically important.

It is well known that the population dynamics of *P. leucopus* are unstable; the mice population can shift to be as much as 16 times more abundant than their typical population level (Wolff). The occurrence of these population shifts are important to monitor; a shift in the population could cause an increase in human exposure to zoonotic diseases, such as Lyme disease, due to an increase in rodent-human contact (Ostfeld et al, 1996). The survival of *P. leucopus* is an essential topic to study because the potential for population instability among *P. leucopus* and other small mammals could ultimately lead to higher accounts of zoonotic diseases. Parasitism and food availability are factors that may potentially influence the survival of *P. leucopus*.

Furthermore, a 1996 study on the population fluctuations of sympatric mast-eating rodents, such as *P. leucopus, P. maniculatus* (deer mice), and *Tamias striatus* (eastern chipmunks), examined their relationship between food availability; it specifically focused on how the production of acorn mast influences population fluctuations (Wolff, 1996). This study utilized a 14-year dataset to establish a correlation between that the population dynamics of small rodents and acorn production (Wolff, 1996). The results of this study showed a positive relationship between acorn production and rodent density the following year ($r^2$=0.79). Additionally, the results showed that a large production of acorns in the fall also increased the survivorship of rodents (Wolff, 1993).

Numerous studies have examined the effect of gastrointestinal and ecto-parasites on the population dynamics of *P. leucopus*. However, most studies have sought to evaluate what role gastrointestinal parasites play in the instability of small mammal populations and have also closely observed the effect of parasitic infections in *P. leucopus* through manipulative studies where mice were given an anthelmintic or non-anthelmintic treatment. As discussed by Vandegrift et al. (2008) Parasitism, more specifically in regards to the *P. leucopus* species, is suspected to impact midsummer breeding hiatus. Studies have been conducted to determine if parasites, food availability, or a combination of the two, plays a role in breeding patterns of *P. leucopus*. Evidence from Vandegrift et al. (2008) suggest removal of parasites through anthelmintic treatments resulted in a reversal of the midsummer breeding hiatus, whereas increased habitat quality did not alter the vital rates of mice. Through these studies, seven distinct gastrointestinal parasites have been known to infect *P. leucopus*.

A 2009 study conducted by Vandegrift and Hudson looked at the role of these seven gastrointestinal parasites, *Pterygodermatities* (Ricklefs), *Syphacia peromysci* (Harkema), *P. Peromysci* (Lichtenfels), *Mastophorus muris* (Gmelin), *Capillaria Americana* (Read), *Heligmosomoides vangefriti* (Durette-Desset and Kinsella) and *Brachylaima peromysci* (Reynolds), to evaluate how they affect *P. leucopus*. This study examined the impact gastrointestinal parasites have on the population dynamics of these mice. The results of this study suggest that gastrointestinal parasites may play a role in the dynamics of these mice because infection is associated with reduced breeding and has little effect upon mouse survival (Anderson and May 1978). The result was tested more formally in 2008 by Vandegrift and Hudson, where they examined how anthelmintic treatment affected the reproductive output of *P. leucopus* (Vandegrift et. al. 2008). By manipulating the GI parasite burden. The results showed

that both sexes were positively affected by the anthelmintic treatment and an increase in body condition, growth rate and survival was observed (Vandegrift et. al.). This causation suggests that gastrointestinal nematodes have an impact on *P. leucopus* by reducing their reproductive output (Vandegrift et. al.). In addition to gastrointestinal parasites, *P. leucopus* are also susceptible to ecto-parasites such as fleas, ticks and *Cuterebra fontinella* (bot flies) and these too may have an impact on the survival of these mice.

A bot fly is an obligate parasite, meaning it requires a host to complete its life cycle. They are common in eastern deciduous forests and this species relies on mice to complete its life cycle (Cramer and Cameron, 2006). The bot fly life cycle begins with bot fly eggs being laid in the host habitat. Egg hatching occurs as a response to an increase in temperature, which also indicates a nearby viable host (Catts, 1982). The bot fly larva then enters the host through the nostril, mouth or an open wound and begins migrating to the inguinal region, or groin, of the host (Cramer and Cameron, 2006). Once the larva implants itself in the inguinal region of the host, the development lasts for typically one month (Cramer and Cameron, 2006). Studies conducted on bot flies display counterintuitive results: this warble fly tends to increase mouse survival, unlike the results observed in the studies focusing on the effect of gastrointestinal parasites.

A 2005 study focused on how bot flies affect the population dynamics of P. *leucopus* and revealed that mice who were infected with bot flies were living longer than those who were not infected (Burns, Goodwin and Ostfeld, 2005). This study discovered that the effects of bot fly parasitism on an individual-level, such as persistence and reproduction, can extend into population-level parameters. The data collected from this study was consistent with previous studies that have been done in the field and laboratory setting (Burns, Goodwin and Ostfeld, 2005). The data suggested that bot fly parasitism may enhance the survival of infected mice due to the fact that mice with a bot fly parasitism experience constricted movement, hence causing these mice to remain on the trapping grid longer or avoid predation (Burns, Goodwin and Ostfeld, 2005).

However, many researchers suspect that bot fly parasitism imposes a reproductive cost on individual *P. leucopus* and thus their population growth, yet the cost exhibited by these mice has been difficult to document (Cramer and Cameron, 2006). For example, although the reproductive organs of infected *P. leucopus* had less mass, upon examination, it appeared that infected males and infected females exhibited similar reproductive functioning to their uninfected controls (Cramer and Cameron, 2006).

Additionally, some studies have analyzed the movements of *P. leucopus* in regards to bot fly parasitism and sought to examine the effect bot flies have on the movements of individual mice. The study found that the movements of uninfected males and females differ and are closely related to the size of their specific home range (Cramer and Cameron, 2009). More specifically, similar laboratory studies found that bot fly infected animals were less active and spent less time doing specific locomotor activities (Smith, 1978). These laboratory studies have allowed researchers to consider how reduced movement of *P. leucopus* and *P. maniculatus* as a result of bot fly infections may affect these mice in their natural habitats. However, field studies discovered that bot fly infestations did not have an apparent effect on the movement of male and female *P. leucopus*. These conflicting results counter the assumed knowledge that bot flies inflict some sort of cost on their hosts (Cramer and Cameron, 2009). The difficulty of documenting the cost of bot fly parasitism on hosts has led several researchers to conclude that a bot fly-host interaction may not be parasitism at all (Cramer and Cameron, 2006).

The purpose of our study was to test if gastrointestinal parasite removal would alter prevalence and or intensity of bot flies infecting mice. It also was set up to examine whether bot flies reduce survival and if there are any interactive effects of botflies and nematodes. To evaluate these questions, we analyzed the data collected from these 6 treated and 6 control populations between 2011 and 2013.

## Materials and Methods

*Experimental design and trapping habitat*

The field grids containing the live capture traps used to capture the mice in this study were set in the Appalachian Highlands of central Pennsylvania. Traps were checked triweekly beginning in spring and ending during the fall. Sunflower seeds were used to bait the traps; each trap was set in the evening just before dark and checked again the following day. The traps were checked routinely and maintained often, any damaged traps were replaced.

*Anthelmintic treatment and vital rate estimates*

There were 12 total trapping grids used in this study: 6 control grids and 6 experimental grids. The experimental grids were treated with an anthelmintic treatment called Levamisole Hydrochloride, which was administered to the mice by the food placed in the traps. Data was collected on 9,190 mice. Baseline demographics and density levels were obtained by trapping each site twice before anthelmintic treatments were administered. Once captured the mice were processed on site; data on body length, body mass, sex, body condition (noting any wounds or scars), and breeding status were collected and recorded. The male mice were determined to be in breeding condition if their testes had descended, whereas females were examined to determine if they were lactating, pregnant or had a perforate vagina. Animals captured in more than one trapping session were considered residents. Mice were identified using Trovan (EIDAP, Sherwood Park, Alberta, Canada) which are transponder tags that are inserted subcutaneously into the scruff of the neck of the mice during processing.

*Dissections*

The gastrointestinal tract of incidental mortalities was dissected. Dissections occurred in order to collect data on the internal parasites present in each mouse. Mice were pinned to a dissection tray and sprayed with 70% ethyl alcohol to lyse any lingering viruses. The body cavity was cut open with scissors; the gut (stomach to the anus) was placed in the water bath to prevent the gut from drying out. The gut was cut into approximately 5 cm pieces; the tract was open longitudinally and carefully examined under a dissecting microscope and any gastrointestinal parasites present were recorded, removed, collected and preserved. Each collected worm was identified and counted to measure the density and prevalence of nematode infection.

*Statistical analysis*

Binomial generalized linear models (GLMs) were used to determine what factors influence botfly prevalence and intensity. Using stepwise backward selection, the best predictors of each response were chosen and variables with $P < 0.05$ were retained. To illustrate the survival of *P. leucopus* infected and uninfected with bot flies, 4 graphs were generated based on the statistical results obtained.

## Results

For this experiment, we set out to identify if there is any interaction between gastrointestinal nematodes and bot fly infections that may increase survival of *P. leucopus*. The number of individually sampled resident mice was 9,190 and for each mouse, we recorded data including breeding status, reproduction, and the absence or presence of nematodes and bot flies. Survival was measured as days known alive. The Levamisole Hydrochloride anthelmintic treatment was successful at reducing the nematode infections of mice on the experimental grid (Fig. 1). This confirms that our manipulation of nematodes was successful and means we can address further questions regarding the potential interactions with botflies.

We wanted to measure the survival of mice infected with nematodes before looking at whether or not the interaction between bot fly and nematode parasitism has an effect on the survival of *P. leucopus.* There was no significant difference between the survival of female mice

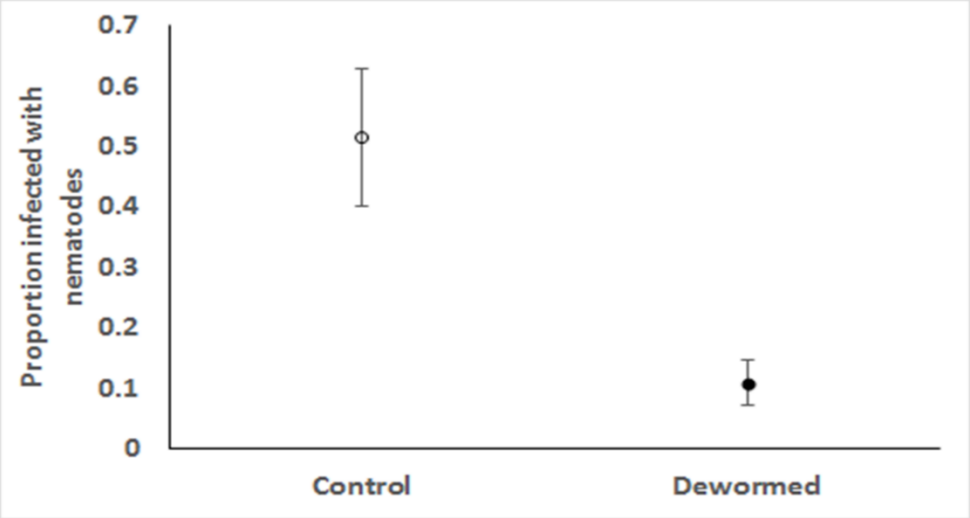


**Figure 1. Proportion of Mice Infected with Nematodes for the Control and Dewormed**

on the control grids and dewormed grids ($P>0.05$). The mice on the control grid lived on average 97.2 days whereas dewormed female mice lived 98.2 days. In contrast, there was a significant difference between the survival of male mice infected or uninfected with nematodes ($P<0.05$). Male mice on the control grid lived 93.8 days while dewormed male mice lived on average 102.7 days (Fig. 2).

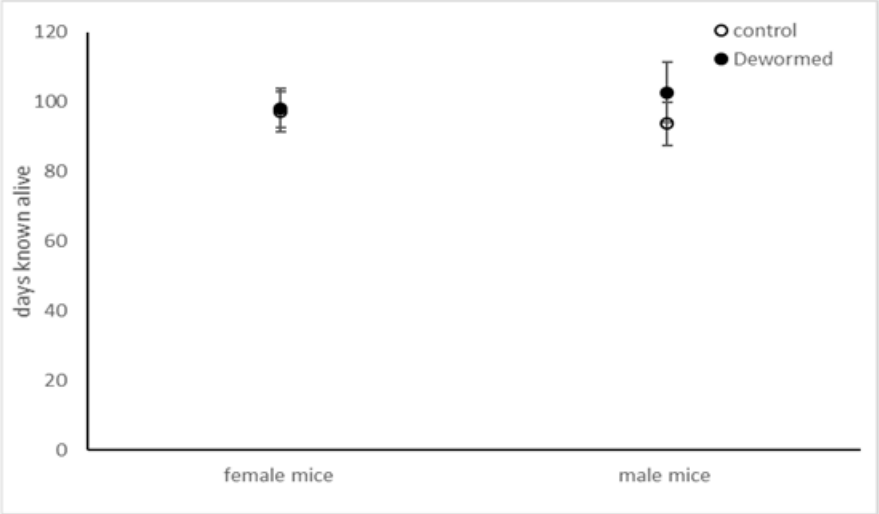


**Figure 2. Surival of Female and Male Mice Infected With Nematodes**

Figure 3 depicts the average survival of mice on dewormed and control populations as well as whether or not the mice were infected with botflies. Although there was no difference in days known alive between mice with and without botfly infections, among those with botfly infections, those mice that were also dewormed survived longer than those from the control populations. There was no difference in average survival for dewormed mice (47.4 days) and the control's (54.4 days) survival. However, mice on the control grids without botflies survived 54.4

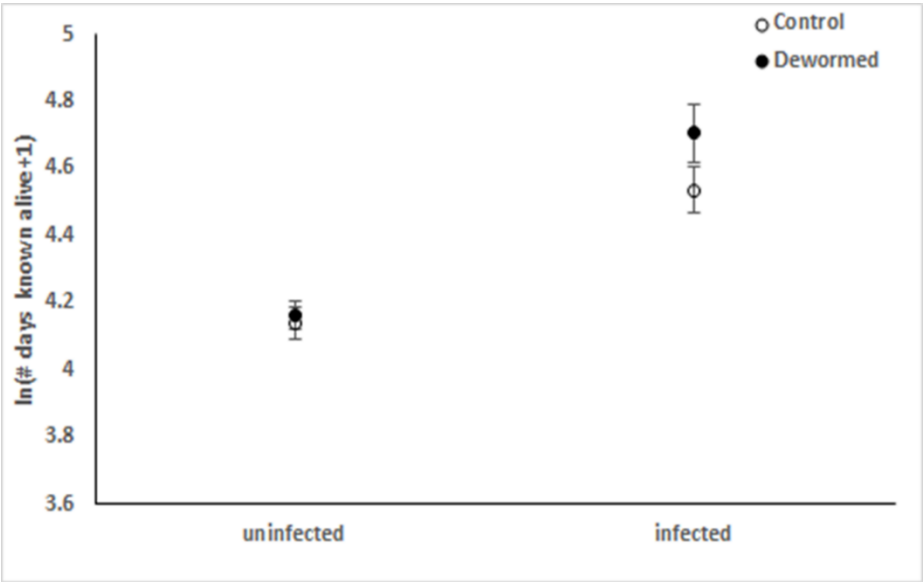


**Figure 3. Survival of Male and Female Mice Infected and Uninfected with Bot Flies**

The x-axis illustrates bot fly uninfected mice and bot fly infected mice for the control and dewormed groups.

days on average whereas mice with botflies on the control grid survived 95.5 days, which displays an increase in survival (Fig.3). Of those mice that were infected with botflies, dewormed mice survived significantly longer at 143.3 days relative to 47.4 days survived by

dewormed mice uninfected with bot flies (Fig.3). It is also clear from this figure that botfly infections greatly increase the lifespan of these mice.

In Vandegrift, Raffel, and Hudson (2008), deworming was reported to influence survival in male *P. leucopus,* but not in females. Here, sex remained a significant variable in the model for predicting days known alive and so we analyzed the sexes independently. The results of their 2005 experiment research were confirmed here with dewormed males surviving about 30.8 days longer than untreated males, (Fig. 4) There was no difference between dewormed (87.6 days) and control populations (88.6 days) in the survival of male bot fly infected mice.

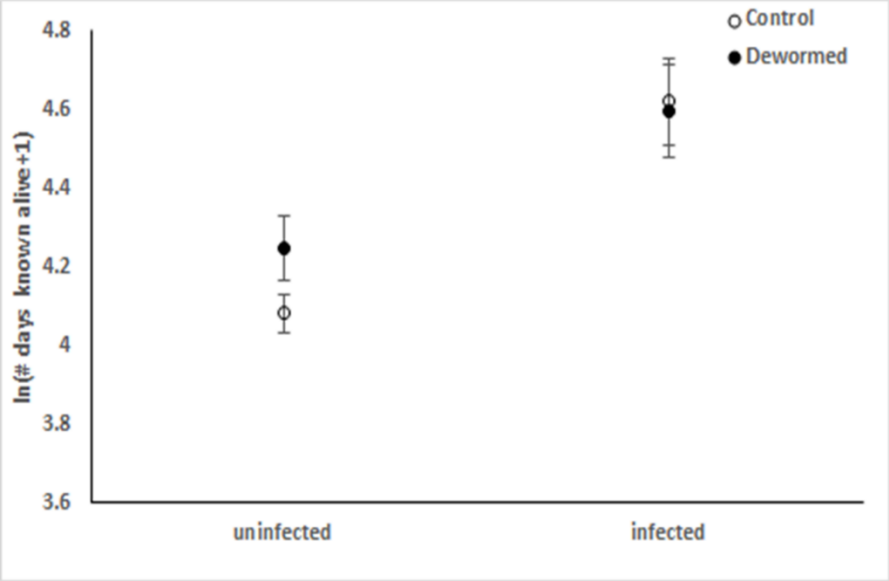


**Figure 4. Survival of Male Mice Infected and Uninfected with Bot Flies**

The x-axis illustrates bot fly uninfected mice and bot fly infected mice for the control and dewormed groups.

In light of these interesting sex effects, we decided to determine if our interaction between worm removal and botfly infection may have influenced the survival of one sex or another. Here, we found that survival of male mice was only increased by deworming when they were not infected by botflies. Survival did not differ when the males became infected with botflies. However, the pattern observed is the opposite in female mice. Dewormed females without botflies did not survive longer than control (wormy) female mice. Dewormed females that had botflies survived significantly longer (51 days) when compared to bot infected but wormy females from the control population. (Fig. 5).

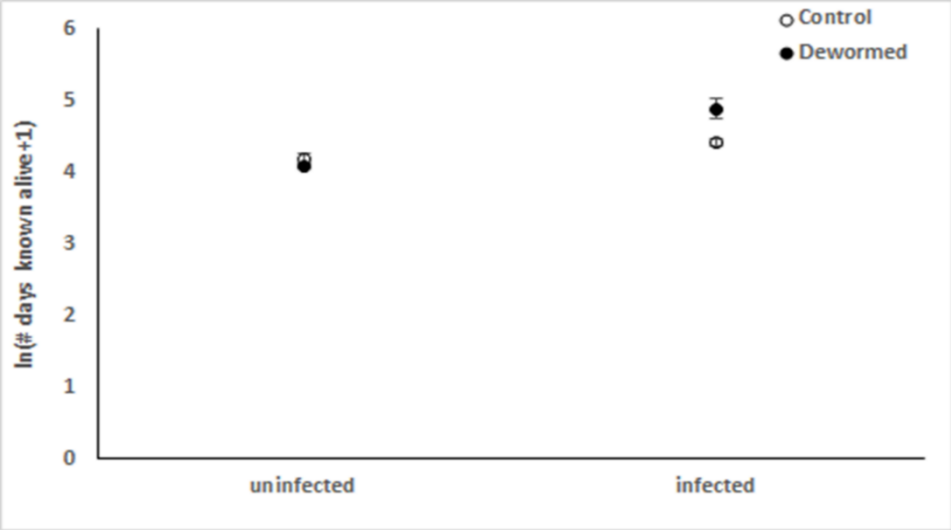


**Figure 5. Survival of Female Mice Infected or Uninfected with Bot Flies**

The x-axis illustrates bot fly uninfected mice and bot fly infected mice for the control and dewormed groups.

## Discussion

An ideal experimental design would involve manipulation of both worms and botflies whereby we would be able to specifically remove only botflies from mice. Currently, a medicine of this type does not exist. Ivermectin and has been utilized in trials of this type, but it is not parasite specific, which makes it impossible to examine only the impact of botflies as this broad spectrum treatment would also alter flea, tick, mite and worm prevalence. Another improvement to this ideal factorial design would be to have populations that are infected with additional worms and additional botflies; we can push the pendulum in both directions and potentially gain more information about the tensions that shape the observed dynamics. Although these are strong, well supported population-level results, further experimentation (as described above) is warranted and would be beneficial to our understanding of the forces that drive the instabilities in the dynamics of *P. leucopus*. As discussed these instabilities likely impact the exposure of humans to the vast array of known and unknown zoonotic pathogens these mice can harbor. Therefore, there is an opportunity to increase public health in the human population by disseminating messages warning of high density mouse years and how to safely handle and dispose of mice caught within the home.

Burn's study focused on the role bot fly parasitism played in the reproductive output of *P. leucopus*. The findings of this study suggested that mice infected with bot flies were surviving longer. Burns and Ostfeld suspect that these trends may be the result of a life-history trade off. Coupling these findings with the earlier findings from Vandegrift and Hudson, which showed nematodes impact mice survival, we set out to test if there were interactive effects between worms and bot flies which might further influence *P. leucopus* survival.

An apparent difference between the survival of dewormed and non-dewormed bot fly infected *P. leucopus* was observed. These findings however were not substantial for male bot fly

infected mice and were isolated to female bot fly infected mice. Dewormed bot fly infected male mice only lived 118.4 known days alive in comparison to 127.9 known days alive for bot fly infected mice on the control grid, which is about an 8% increase in survival. Furthermore, dewormed bot fly infected female mice averaged 162.0 known days alive, whereas non-dewormed bot fly infected female mice survived on the control grid for 110.9 days known alive. Dewormed bot fly infected mice displayed a 46% increase in survival than non-dewormed bot fly infected mice. This difference indicates an interaction between nematode removal and bot fly parasitism on the survival of female *P. leucopus*.

Although these findings suggest that survival of *P. leucopus* may be affected by the interactions of bot flies and nematodes, more research needs to be conducted to further explore these findings. In order to strengthen this study and obtain concrete results a manipulative experiment of bot flies would be ideal. While this experiment did manipulate nematodes, by treating groups of mice with anthelmintic treatment, this study does not fully explore the interaction between bot flies and nematodes because the mice were not experimentally infected with bot flies.

Given these limitations an ideal and more successful future study would consist of both experimentally manipulating bot flies and nematodes. To do so *P. leucopus* would need to be dewormed using an anthelmintic treatment and infected with bot flies. Additionally, an effective study would contain a factorial design with 3 grids where mice were only dewormed, 3 grids where mice were only infected with bot flies, 3 grids where mice were both dewormed and infected with bot flies and lastly 3 control grids.

## Acknowledgements

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# *Parasite community dynamics in dewormed and worm-infected Peromyscus leucopus populations*

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*Abstract*

*Peromyscus leucopus*, white-footed mice, are reservoirs and hosts for numerous human diseases, including hanta virus, arboviruses, and bacterial pathogens, which are transmitted via zoonotic spillover. In order to control spillover, it is important to study and predict population dynamics within natural mice populations. An important aspect of mouse survival and therefore disease transmission is the mouse's role as a host for parasites. Mice are often co-infected with various types and intensities of parasites, each of which interacts with the host. We experimentally removed nematodes from the tested mouse population to view the effect on the number and intensity of other parasites, as well as the effect on the overall body condition and fecundity of the mice. This information will provide a greater understanding of the relationship between parasitism and population dynamics, and ultimately help prevent and control future zoonotic diseases.

## Introduction

Within the past 30 years, 87 new species of human pathogen have emerged at an alarming rate of about 3 introduced every year (Woolhouse 2009). However, the scientific community has completely failed to predict the pathogen type, time, or place of these emergences. Moreover, pathogens rarely exist in isolation; many host organisms are simultaneously co-infected with multiple pathogen species. Pathogen interactions can increase or decrease transmission, virulence, and emergence rates, while also altering host and pathogen populations via effects on host fitness and population dynamics (Seabloom et al. 2015).

Nonetheless, current research emphasizes a one-host one-pathogen paradigm instead of the more common co-infection of multi-host pathogens (Yakob et al. 2013).

This research project focuses on parasite interactions in a widespread peri-domestic rodent, the White-Footed Mouse (*Peromyscus leucopus*) (Rafinesque 1818). We chose this species because the history of pathogen emergence tells us the most common pathogen type to emerge are viruses and about 60% of these viruses are zoonotic (jumping from animal to man) (Woolhouse 2009). Among animal groups, rodents serve as reservoirs to most of these new pathogens. For example, it is a reservoir host and vector for many zoonotic pathogens, such as hanta virus (Childs et al., 1991), arboviruses (Hardy 1994), and various bacterial pathogens, including its large role in Lyme disease (Donahue, et al. 1987). In addition, *P. leucopus* is the most abundant rodent in the densely populated northeast of the United States. Therefore, *P. leucopus* is a compelling choice to investigate co-infections and gain a better understanding of how this specific pathogen community may aid in the prediction or prevention of the next emerging infectious disease.

Much of the research on the drivers of population instability in *P. leucopus* populations has focused upon bottom-up factors like the mast of Oak trees (*Quercus spp.)*. Indeed, acorns play a major role in mouse population growth via increasing breeding and survival (Ostfeld, Jones & Wolff 1996; Wolff 1996). This has led some authors to speculate that they can predict the number of human Lyme disease cases based upon the amount of acorns present in the environment two years prior (Ostfeld, Jones & Wolff 1996). However, the factors driving the decline phase in *P. leucopus* remain unknown. Gastrointestinal parasites can destabilize host population dynamics (Anderson and May 1978). For example, nematodes drive the cyclic populations of Red grouse (*Lagopus scoticus*) in Northern England and Scotland (Hudson et al. 1999). *Pterygodermatites peromysci* is the dominant nematode parasite in the gastrointestinal tract of *P. leucopus* and in a 2005 deworming experiment, it was shown that *P. peromysci* diminished *P. leucopus* body condition and breeding in the summer months (Vandegrift et al. 2008). In another helminth manipulation experiment on *P. leucopus*, the reduction of nematodes increased the prevalence of other gastrointestinal parasites, including protozoans and cestodes (Pedersen and Antonovics 2013).

These results provide insight into parasite interactions and confirm that parasite-host dynamics require more than a single-host single-parasite experiment, because parasites may interact agonistically or antagonistically within a mouse's gut. It also provides an opportunity for further investigation -- because these two parasite removal studies utilized different deworming drugs. In the former, Levamisole hydrochloride (BOC Sciences) treatment removed only nematodes, while in the latter,Ivermectin (Merck & Co, Inc.) eliminated nematodes as well as other ectoparasites like ticks, fleas, botflies, and mites. Given these interesting results, we sought to determine if levamisole dewormer may have indirectly influenced the ectoparasites community of *P. leucopus* in our prior research effort.

## Methods

*Experimental design, trapping*

In order to accomplish this, mice were trapped on 12 experimental grids in open hard-wood forest in central Pennsylvania USA. To insure independence, experimental grids were at least 250 m apart and each grid contained twelve-8 x 8 grids of multi-capture live traps, with

traps 10m apart. Traps were checked two consecutive days per week, every three weeks, from April to December.

*Anthelmintic treatment, small mammal processing, dissections*

Each grid was trapped twice before anthelmintic treatment in order to establish baseline demographic and density levels. Of the twelve grids, six grids were chosen at random and all of the mice caught on these six grids were given Levamisole Hydrochloride, an anthelmintic, upon each capture. The mice caught on the remaining six grids were provided with an equal amount of sterile water without wormer and were used as a control. Mouse sex, body length, tail length, body mass, body condition, and reproductive condition were recorded upon each capture. Body condition was determined from the residuals of a cubic spline fit of mass versus body length. Reproductive condition was determined by the presence of descended testes in males or whether the female was lactating, pregnant, or had a perforate vagina. The number of ticks and botflies were counted and the absence or presence of fleas were measured.

Mice were tagged and identified by Trovan transponder tags that were inserted into the scruff of the neck upon first capture. Animals that were captured repeatedly were considered residents of the area. Deceased mice were dissected to quantify gastrointestinal parasite infection burden. The gut (from above the stomach to the anus) was removed and cut. The tract was examined under a microscope and all gastrointestinal worms were removed, collected, and preserved. Worms were identified to species and counted to determine the prevalence and intensity of infection for each. This experiment was conducted with the approval of the Pennsylvania State Animal Care Committee (IACUC #16061, "Transmission Dynamics of Directly Transmitted Diseases in Wildlife Reservoir Hosts").

*Statistical analyses*

Generalized linear models (GLMs) were utilized to analyze response variables, and the best predictors of the response variables were determined via backward stepwise selection, keeping variables with $p < 0.05$. When the response variable was presence or absence of an infection, data were analyzed with binomial GLMs. For some analyses, mice were separated into groups based on mass, with juveniles being less than 16g, sub adults being 16-20g, and adults being 20g.

## Results

The number of individual *P. leucopus* captured was 9,189. Recapture of these individuals represented over 24,000 captures in the 99,840 trap nights from 2011-2013. Based on the Jolly-Seber population size estimates, there was no influence of parasite treatment on the population density of mice both before and after the anthelmintic treatment (all $P > 0.05$).

*The effect of treatment on parasites*

To determine pretreatment differences in the response variables between treatment and control grids, we tested for the effects of parasites on the density, mass, and body condition of the mice. We also tested for the effects of parasites on the proportion of the population breeding before anthelmintic treatment. There were no significant initial differences between experimental and control grids for any of the response variables (all $P > 0.05$).

Following anthelmintic treatment, there was a significant difference between the prevalence of nematodes in the control and treatment populations. The treatment population had a significantly less prevalence of nematodes than did the control population (Fig. 1). There were no significant differences (all $P < 0.05$) in fleas, mites, mobile mites, bot flies, ticks on neck, or ticks on head, between control and experimental grids (Fig 2).

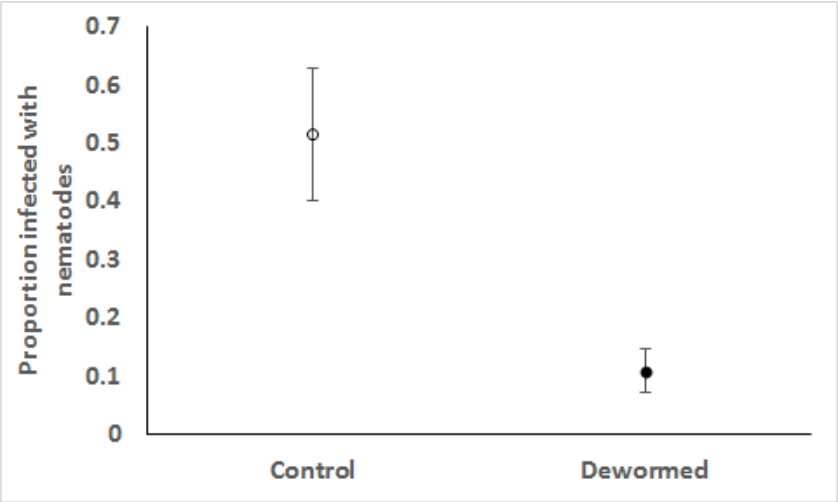


Fig 1: Proportion of mice infected with nematodes in the control vs. dewormed mouse populations.

## Discussion

Although our results were not statistically significant, there are reasons to suspect it could have altered the community. In the 2013 de-worming experiment (Pederson and Antonovics 2013), the mice that had been de-wormed had a higher prevalence of protists and cestodes, or tapeworms. However, there were large differences between experiments in terms of space, duration and replication. Their experiment was in Mountain Lake, Virginia, USA, and was only conducted for one summer, while the experiment in Pennsylvania, USA, lasted over three years. They also only used 6 mouse populations, 3 control and 3 treatment, while our experiment used 12 mouse populations, 6 control and 6 treatment. The final and likely the most critical difference was that they used Ivermectin, which kills ectoparasites as well as nematodes, while we used Levamisole, which only kills nematodes.

Based on their results that de-wormed mice had more cestodes, or tapeworms, it is very likely the Ivermectin killed the ecto-parasites, including fleas, on the mice. When the mice groom themselves, they likely ingest these dead and dying fleas, and fleas are often intermediate hosts for tapeworms (i.e. dog and cat tapeworms, *Dipylidium caninum*). Further, the dewormed mice are better able to consume the fleas because the fleas are dying or dead. This could allow for extra time to groom off more fleas than other mice and therefore ingest more fleas than other mice. This may permit a higher likelihood of tapeworm infection; however, if the experiment ran longer, this increase in tapeworms would eventually fade because the flea population would be extinguished. Since we used Levamisole, no ectoparasites were killed, as shown by the similar prevalence and intensity of fleas, mites, mobile mites, and ticks on both the control and de-

wormed populations. Therefore, our treated mice evaded grooming and did not have an increase in cestode prevalence.

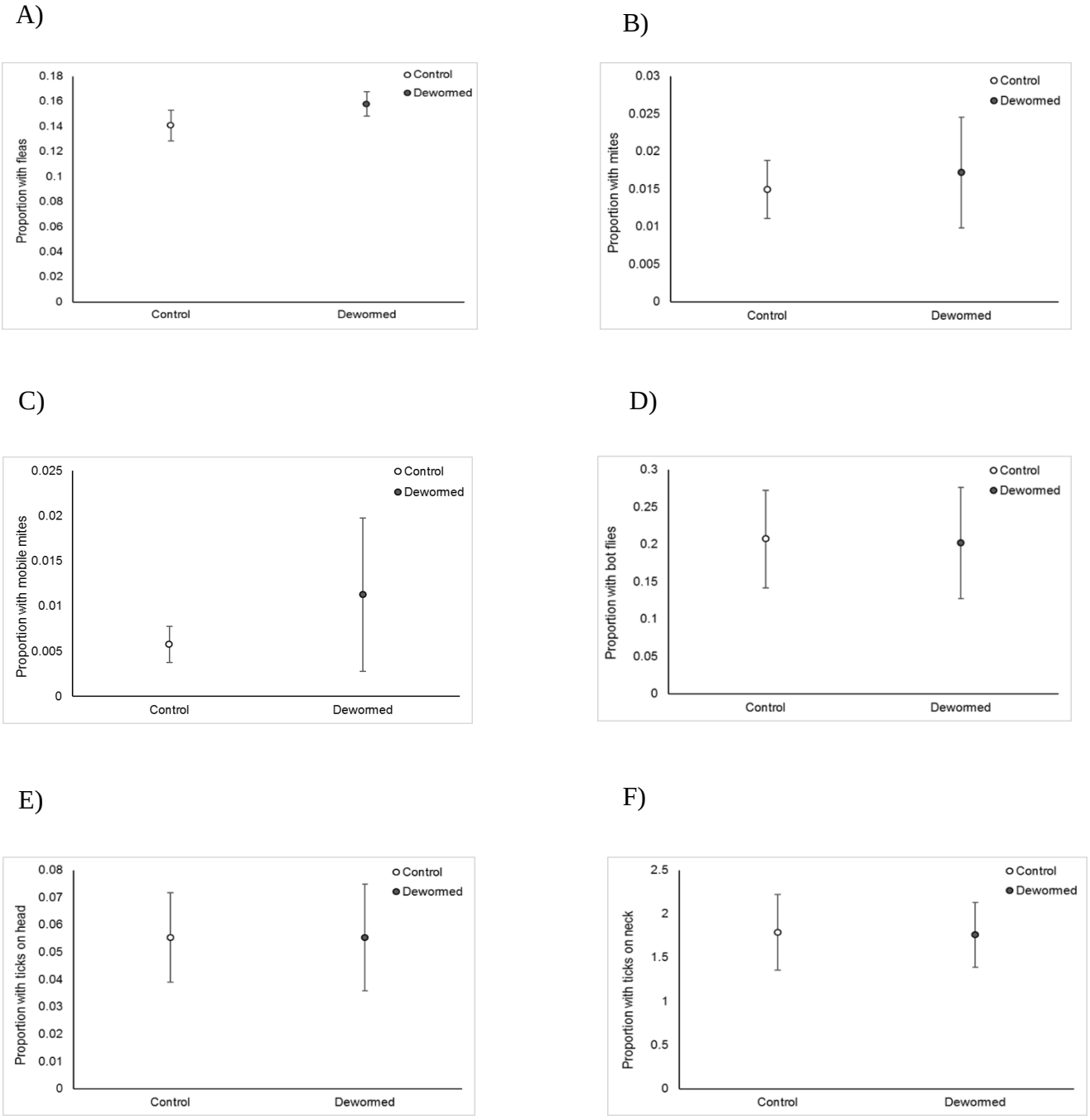


Fig 2: Proportion of mice with (A) fleas, (B) mites, (C) mobile mites, (D) bot flies, (E) ticks on head, and (F) ticks on neck in control vs. dewormed mice for all, female, and male animals in sites 2 and 3. Site 1, which has 3 grids, was not included due to the lack of yearly repetition from 2012-2014. Error bars indicated +/- SE of the grid means (n = 9 grids).

In the future it would be interesting to test the effects of different anthelmintic treatments on the prevalence and intensity of parasites within the same mouse population. It would be interesting to measure the effects of the various treatments on the mice survival, fecundity, and population dynamics. Another critical development that would aid the study of parasite community ecology would be the development of parasite-specific drugs. The nematode parasite community of the *P. leucopus* gastrointestinal tract has 7 members in Pennsylvania and we are completely unable to disentangle the impacts of each species, because we are unable to treat to remove individual species. This type of treatment likely has ramifications for selection of these species as well as those that are parasitic of the companion animals (dogs and cats) for which we have been altering parasite community dynamics for centuries. Only after some of the aforementioned issues are resolved will we be able to address these parasite community dynamics in a controlled and replicated way.

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# *The Association between Maternal Social Information Processing and Children's Inhibitory Control and School Readiness*

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*Abstract*

Difficulties present in self-regulatory capacities in children can adversely affect a child's school readiness. It has been hypothesized that maternal social information processing (SIP) capacities influence children's self-regulatory capacities. This study examined whether maternal social cognitive and neurocognitive capacities are associated with children's self-regulatory capacities and school readiness. 42 mother-dyads were recruited from low-income areas. The children's ages ranged from 4 to 5 years old. The social information processing theory (SIP) of parenting risk was used to measure maternal social-cognitive and neurocognitive capacities across three domains. These domains included maternal attributions, unrealistic expectations and executive functioning. Children's behavioral inhibition was assessed. Mother's and teacher's ratings of externalized behavior and teachers ratings of school readiness were also collected. Two of the three domains of SIP, unrealistic expectations and executive functioning, showed significant associations with both children's behavioral inhibition and mother's ratings of externalized behaviors. Although direct links between SIP and teacher ratings of school readiness were not found, higher levels of externalized behaviors were found to be associated with poorer school readiness. Thus, there was some support for SIP to be linked to school readiness. Implications for preventive interventions are discussed and further exploration of parental SIP and school readiness are warranted.

## Introduction

Factors present during early childhood can be predictive of many adult outcomes. Whether it is emotional, social or physical development all of these factors have a direct effect on the development of children (Encyclopedia of early childhood development, 2011). Young children typically are part of a small microsystem which is primarily composed of their parents and school. This study will examine whether maternal social cognitive and neurocognitive capacities are correlated to children's self-regulatory capacities and school readiness.

**Self-Regulation in Children**

Self-regulation is a complex culmination of capacities that allow children to respond appropriately to their environment (Bronson, 2000). These specific capacities allow children to regulate their behavior and act in accord to social standards (Kochanska, Coy & Murray, 2001). These capacities include being able to begin and stop activities based on the situational demands, control verbal and motor acts in social and educational settings, and delay gratification (Kopp, 1982).

Children begin to build the foundation of their self-regulation capacities in the first five years of their life (Blair, 2002). Late infancy through preschool age is considered the critical time period for the emergence of self-regulatory capacities (Kochanska, Coy & Murray, 2001). Within the first two years of life children are capable of control, which entails initiating, maintaining and stopping behaviors and following caregivers' requests (Kopp, 1982). By the age of 2 children have acquired the skill of self-control which allows them to regulate and delay behavior on request, but also when there is an absence of external monitors (Kopp, 1982). By age 3, children should be able to self-regulate, or in other words, have the flexibility in their control processes where they can meet the demands of varying situations. Although the development of a certain level of self-regulation occurs naturally, it is still governed by involvement with the environment.

Maternal discipline style is a factor that is commonly linked to the presence of self-regulation difficulties in children (Kochanska, Coy & Murray, 2001). Difficulties in self-regulatory capacities are typically expressed as externalized behavior problems. Externalized behavior is defined as problem behaviors directed toward the external environment that can be identified through rule-breaking, disruptive behaviors and negative interpersonal interactions (January et al., 2017). Evidence of the early expression of externalized behaviors is important because it is indicative of future antisocial behaviors such as substance use and conduct problems, which have major life consequences (January et al, 2017). The presence of rule breaking at home and school, poor emotional regulation, and ineffective discipline by parents have been labeled as early indicators of criminality (Wrightsman, Greene, Nietzel & Fortune, 2001). These early indicators show the impact that the presence of externalized behaviors and the role parents play have on children's future outcomes. In children the presence of these behaviors does not only impact future outcomes such as criminality, but has been linked to current and future academic problems (January et al, 2017). Research has suggested that the early display of externalized behaviors has been linked to poorer academic performance.

**Self –Regulation and School Readiness**

Deficits in the ability to self-regulate have been associated with poor school readiness. Self-regulatory skills are not only associated with the academic component of school readiness, but also the behavioral component (Razza & Raymond, 2013). One specific self-regulation capacity that will be the primary focus of this study is behavioral inhibition. Externalized behavior will also be a primary component of this study, but is being used to conceptualize the lack of self-regulatory capacities or behavioral inhibition.

Another self-regulatory capacity of interest in this study is delay of gratification. Delay of gratification entails a child's ability and willingness to either control their impulses to act immediately or to do as instructed, which is to wait for the desirable award (Mischel, Shoda, & Rodriguez, 1989). In other words, this measure examines a child's ability to express inhibitory control when directed to do so. For example, a well-known delay-of-gratification task is the

Marshmallow Test (Bembenutty & Karabenick, 2004). This task asks kids to not eat the singular marshmallow while the researcher steps out the room. The children are told if they are able to wait, when the researcher returns they will give them two marshmallows. The time it takes for the child to either wait or eat the marshmallow is measured as delay of gratification. In 2013, Razza and Raymond (2013) found that delay of gratification was positively associated with academic skills and negatively associated with externalizing behaviors. In other words, children who displayed more externalizing behaviors had lower scores for delay of gratification, meaning they were less able to delay gratification. Research has shown that the ability to delay gratification served as a protective factor against behavioral problems and it also promoted academic performance (Razza & Raymond, 2013). Presently, past research has shown that there is an association between school readiness and delay of gratification. This study will build upon previous research that has examined associations between child self-regulatory capacities and school readiness. In addition, given the well-established role of parenting in influencing the development of children's self-regulatory capacities, this study will also assess the impact of maternal social-cognitive and neurocognitive capacities.

**Maternal Social Information Processing**

The Social Information Processing (SIP) model of parenting risk uses cognitive mechanisms to understand how parents respond emotionally and behaviorally to their environment (Azar, Stevenson, & Johnson, 2012). The SIP model is utilized as the foundation to the present study (Azar, Stevenson, & Johnson, 2012). These are the three elements of the model: schemas, executive functioning and biased appraisals (see figure 1 below).

A schema is a person's knowledge structure that can be thought of as a filter for one's intake of information from the surrounding world (Azar, McGuier, Miller, Hernandez-Mekonnen, & Johnson, 2017). The SIP model attempts to capture a parent's schema by focusing on, their expectations of their child. Whether these expectations are realistic or developmentally inappropriate is reflective of the quality of the parent's schema (Azar et al, 2017). Parents who tend to have developmentally inappropriate or rigid expectations may be at risk for various problematic parenting behaviors such as neglect and physical abuse.

Executive functioning consists of higher-level cognitive processes. These processes include problem-solving, planning, and working memory. In 2015, Bridgett and colleagues concluded after reviewing numerous studies on executive functioning that self-regulation is intergenerationally transmitted from parent to child (Bridgett et al., 2015). This link was found between ineffective parenting such as harsh discipline, but also was correlated with executive functioning. Mothers with lower overall executive functioning responded more harshly to a child's conduct problems (Bridgett al, 2015). While reviewing one particular component of executive functioning, it was concluded that mothers with lower working memory had a tendency to react negatively when faced with challenging behaviors from their child (Bridgett et al, 2015). Also, mothers who have poor spatial working memory tended to be less sensitive in terms of responsiveness to their infants.

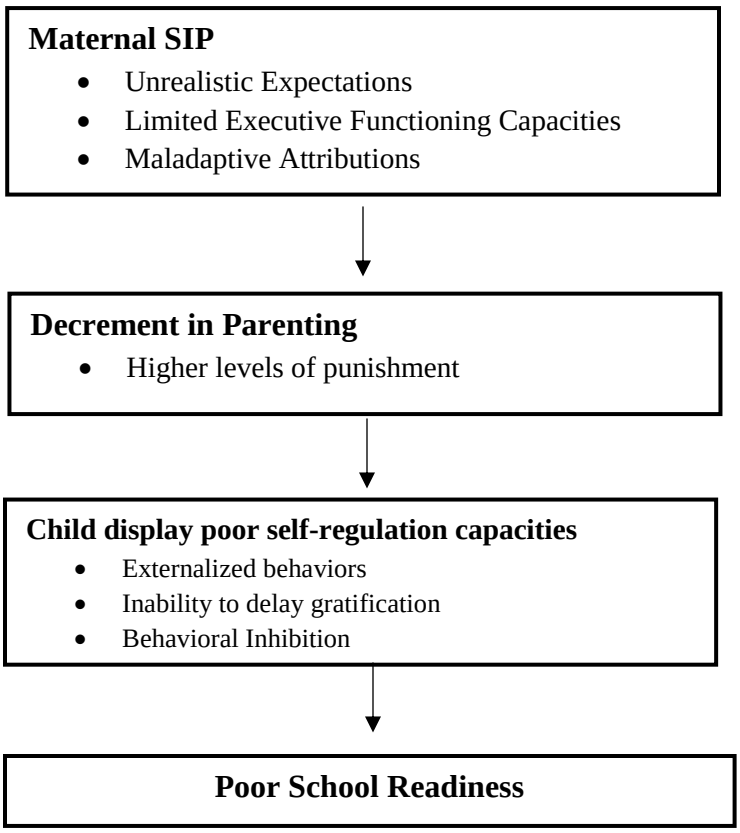


*Figure 1. A theorized pathway attempting to illustrate the correlation between maternal SIP and children's ability to self-regulate and their school readiness.*

The last component of the SIP model is attributions. Attributions can be thought of as a person's interpretation of others' behavior (Azar et al, 2017). Hostile attribution bias is a bias for interpreting ambiguous situations as hostile or threatening. Parents who exhibit this bias tend to have more aggressive responses to child behaviors, including increased use of harsh discipline (Slep & O'leary, 1998). Harsher parenting styles tend to be correlated with children who have poor self-regulation. Hostile attributions prevent the measured parenting required to help children develop self-regulation. Poor self-regulation is an element of the presence of many externalizing behaviors such as aggression, rule breaking, and defiance. The presence of these behaviors does not only increase the risk of developing antisocial behaviors in children, but also is correlated to poorer school outcomes.

**Current Study**

The present study is premised on the idea that maternal cognitive processes will affect children's self-regulatory capacities. Using this SIP approach to understanding these cognitive process postulates that children will be effected in terms of ability to display behavioral inhibition and their level of externalized behaviors. This study examined the following hypotheses:

Hypothesis 1: Maternal SIP difficulties will be associated with children's externalizing behaviors

Hypothesis 2: Maternal SIP difficulties will be associated with difficulties in children's behavioral inhibition

Hypothesis 3: Maternal SIP difficulties will be associated with poor school readiness

Hypothesis 4: Difficulties in Children's behavioral inhibition will be associated with externalized behaviors

Hypothesis 5: Children's behavior inhibition difficulties will be associated with poor school readiness

## Methods

### Participants

Participants in the study were low-socioeconomic (SES) mothers that were recruited in Philadelphia, PA, as part of a larger federally funded study that examined SIP and child neglect (NICHD #5R01HD53713). These mothers had children ranging from 4 to 5 years old. Participants were recruited from child protective services, parenting services contract agencies, and community settings such as Head Starts and daycares.

### Demographics

Forty-two mother-child dyads participated in this study. Of the 42 children who participated in the study, the average age was 4.96 years old (*SD*=.58) with 47.6% being male and 52.4% being female. Of the 42 mothers in the study the average age was 30.00 years old (*SD*= 5.40). The sample was primarily African-American mothers (69.0%) and children (69.0%). Of the mothers in the study 59.5% reported not being employed and 40.5% reported being employed. Of the mothers reported being employed, 47% reported working a part-time job, and 52.9% reported working a full-time job. On average the 42 mothers participating in this study had an education level of 11.26 years (*SD*=1.51). Of the mothers participating, 28.6% had substantiated child protection services (CPS) records for maternal perpetration of child neglect. Of the mothers with a CPS record, 17.1% were reported as only being a perpetrator of neglect and 11.4 % of mothers were reported for being a perpetrator of neglect and other forms of maltreatment.

### Procedure

Data collection was completed over the course of 3 home visits that were scheduled a week apart. During these visits consent forms were solicited and assessments began. Mothers gave consent for their children and themselves and also for their children's teachers to participate in the study. Mothers also gave consent for a record search of Department of Social Service records for evidence of maltreatment. Assessments and measures were given in a fixed order, standardizing the delivery process of the measures. The mothers were paid $150 for participating in the study. Forms were sent to the children's teachers/daycare providers to complete.

## Measures

**Parent Opinion Questionnaire (POQ).** The POQ was used to measure unrealistic expectations mothers may have for their children's capacities (Azar et al, 1984). The scale was designed to capture these expectations at varying developmental stages (Twentyman, Plotkin, & Dodge, 1981). These stages ranged from infancy to 16 years old. The measure consists of 80 agree-disagree statements. These statement range from, "In most cases, a 6 years old can get up, was, dress, and go to school unassisted" to "A 15 year old should be expected to help 'patch up' his or her parents' martial problems" (Twentyman, Plotkin, & Dodge, 1981). This scale has adequate test-retest reliability over a two week period (r=.85) and good internal consistency [r= .83 with 100 CPS cases (Azar, 1988); r = .87 with 296 normal mothers (Hamilton & Orme, 1986)

**Wisconsin Card Sorting Test (WCST)** The WCST is a neuropsychological test of executive functioning (Heaton, 1981). The number of preservative errors will be used to indicate executive functioning problems. Preservative errors are calculated by indicating the number of times the participant continued to use a rule that was no longer correct or applicable to their new task. This is indicative of greater executive functioning problems. To reduce positive skew in these data, scores were log-transformed prior to analyses.

**Child Vignettes (CV)** To measure mothers' attributions for their children's behavior, the CV was used. This scale measures the degree to which parents attribute negative intentions to their child's misbehavior. It also measures the degree to which they would punish the child for these behaviors. Mothers were read 18 vignettes which described aversive child behavior (Plotkin, 1983). They were then asked to imagine if this child was their own. They then rated on a scale from 1 to 9 how much that child engaged in that behavior to annoy them (Negative attributions ratings). They were then asked, using the same scale, to which degree they would punish the child (Punishment ratings). Lastly, they were asked to rate using the same scale, to what degree did they feel the child's behavior was due to something the parent did (Blame ratings). The purpose of the last rating was to capture possible self-blame which is typically found in neglectful parents rather than negative intent attributions which is most commonly found in abusive parents. This scales has been used in prior research and has an adequate internal consistency (alpha= .94).

**Gift Wrapping Task** The gift wrapping task is a child's measure used to assess the child's ability to delay gratification or express inhibitory control (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996). The children were sat facing away from the researcher and were told that they were getting a gift and were instructed not to peek. The researcher then wraps the present for 60 seconds purposefully doing so in a loud manner. The children's peeking behaviors are then assessed and coded. Peeking behavior is coded on a 1 to 5 scale (5= child turns around and does not turn back, 4= child turns around and turns back, 3= child looks over shoulder enough to see, 2= child turns head to side, but not over 90°, 1= child does not try to peek). Latency to peek over shoulder and latency to turn around and peek were also recorded for analysis. The peeking behavior rating scale had an adequate interrater reliability (alpha=.958). The latency scales both had good interrater reliability with latency to turn around being, alpha= .81 and latency to peek over shoulder being, alpha=.807.

**Walk-a-Line Slowly (Balance Beam)** The Walk-a-Line slowly task is primarily used to asses a child's behavioral inhibitory control (Kochanska et al, 1996). The children were asked to walk along a 6-foot straight line as if it were a balance beam. The researcher measured the amount of time it took for the child to walk the line. This was considered the child's baseline. The child was then asked to repeat the task two more times but was instructed to walk as slowly as they can. The researcher recorded the time for each subsequent attempt. To quantify the inhibitory control the difference of the child's fastest time and slowest time will be used. Previous research has been able to link scores on this task to measure of executive functioning such as the Dimensional Change Card Sort, but also other inhibitory control measures such as the peg-tapping task (Bierman, Nix, Greenberg, Blair & Domitrovich, 2008).

**Child Behavior Checklist (CBCL)** The CBCL was used to assess emotional and behavioral problems as a measure of externalizing behaviors. The 100-item questionnaires were given to parents and teachers gauging questions around emotionally reactivity, anxious and depressive symptoms, somatic complaints, sleep problems, attention problems, aggressive behaviors, and if the child was withdrawn (Achenbach, 2000). Only the attention and aggression subscales were used by this study. Each question on this scale uses a 3 point Likert scale as the responses. With 0 meaning not true, 1= sometimes true/somewhat true, and 2= very true/often true. Higher scores on this scale mean greater problems. Scaled internal consistency within the CBCL is $\alpha$= 0.94(total problem scale), $\alpha$=0.87(internalizing scale), and $\alpha$=0.89(externalizing scale) (Kristensen, Henriksen, & Bilenberg, 2010). CBCL items are rated by mothers and teachers (Teacher Child Behavior Checklist, TCBCL).

**Child Behavior Questionnaire (CBQ)**

The Child Behavior Questionnaire is a 32-item questionnaire were rated by teachers as a measure of a child's school readiness. CBQ is comprised of five subscales rating children's aggressive/oppositional behavior, prosocial behavior, emotional regulation, social competence, and internalizing/withdrawn behaviors. The response options were given on a 6-point Likert scale ranging from 1 being almost never to 6 being almost always. The aggressive/oppositional behavior scale was composed from items from the Teacher Observation of Classroom Adaption-Revised (Werthamer-Larsson, Kellam, & Wheeler, 1991). The prosocial behavior, emotion regulation and social competence scales were adapted from the Social Competence Scale (Conduct Problems Prevention Research Group, 1990).

## Results

**Descriptive Statistics on Study Variables and Comparisons to Prior Work**

As noted in Table 1, most measures in the study were completed. The exceptions were one mother that refused to complete the Wisconsin Card Sort and three children that did not attend daycare or kindergarten and no teacher data was available. Two other children's teachers did not submit forms when this report was completed.

When compared to prior research, the mean and standard deviation of the data collected on maternal unrealistic expectations show close resemblance to non-neglectful moms in the Azar et al. (2017) study. In regards to negative attributions, the mean is similar to neglectful mothers (Azar et al, 2017). Scores on the gift delay task resemble scores from previous studies utilizing this paradigm with similar populations (e.g., Merz et al., 2016). Data collected on similarly aged

children that completed the balance beam task were not replicated in the data set. For the balance-beam task, the mean obtained in this sample was higher than the data collected by Bierman and colleagues (2008). In a study that looked at children who were in a borderline or clinical range for externalizing behavior, our children's means fell considerably lower than Roskam and colleagues (2016) when they conducted their descriptive analysis of their participants CBCL data, meaning the children in the present data set displayed less externalized behavior than the children in the Roskam and colleagues (2016) study.

*Table 1. Descriptive Statistics*

| Variables | Number of Participants | Mean | Standard Deviation |
|---|---|---|---|
| **SIP Factors** | | | |
| Unrealistic Expectations (POQ Total) | 42 | 7.73 | 4.15 |
| Executive Functioning (WCST errors) | 41 | 13.66 | 11.24 |
| Negative Attributions (CV Annoy) | 42 | 52.14 | 20.8 |
| **Behavioral ratings** | | | |
| Maternal Rating Attention Problems (CBCL) | 42 | 4.71 | 2.18 |
| Maternal Rating Aggressive Behavior (CBCL) | 42 | 16.19 | 6.92 |
| Teacher Rating Aggressive Behavior (TCBCL) | 37 | 9.46 | 11.17 |
| **Teacher Rating Attention Problems (TCBCL)** | 37 | 4.54 | 4.69 |
| **Behavioral Inhibition** | | | |
| Balance Beam (Seconds) | 42 | 6.88 | 1.15 |
| Gift Delay Peeking Rating | 42 | 2.67 | 1.52 |
| Latency to Peek Over Shoulder | 42 | 35.86 | 25.79 |
| **School Readiness (CBQ)** | | | |
| Emotional Regulation | 37 | 4.21 | 3.09 |
| Prosocial Behavior | 37 | 4.59 | 3.19 |
| Social Competence | 37 | 4.43 | 2.41 |
| Aggressive/Oppositional Behavior | 37 | 2.24 | 1.18 |

**Associations between Maternal Social and Neurocognitive Capacities and Children's Externalizing Behavior**

The first hypothesis, that SIP problems will be associated with externalizing behaviors, was tested using Pearson correlations as seen in Table 2. For the first domain of SIP, unrealistic expectations, there was a significant negative correlation between maternal unrealistic expectations and teachers' perception of aggressive behaviors which was contrary to the hypothesis. Children whose mothers tended to have more unrealistic expectations had teachers who rated the children as having significantly lower levels of aggressive behaviors. There were no significant associations between maternal ratings of externalized behaviors and maternal unrealistic expectations.

As predicted, the second domain of SIP, maternal executive functioning, was significantly positively correlated with mothers' perceptions of attention problems and aggressive behavior. Specially, mothers with more preservative errors on the Wisconsin Card Sort (WCST) (poorer executive functioning) perceived higher levels of both aggressive behaviors and attention problems in their children. This is consistent with the theorized model that maternal SIP difficulties is associated with the presence of children's externalizing behavior. There were no significant finds for the association between teacher ratings and maternal executive functioning.

The last domain of SIP, negative attributions, did not yield any significant associations with either mothers' or teacher ratings' of externalized behaviors.

*Table 2. Correlations between Maternal SIP capacities and Children's Externalizing Behavior*

| Variables | Maternal Rating Attention Problems[1] (CBCL) | Maternal Rating Aggressive Behavior[1] (CBCL) | Teacher Rating Attention Problems [1] (TCBCL) | Teacher Rating Aggressive Behavior [1] (TCBCL) |
|---|---|---|---|---|
| **Unrealistic Expectations (POQ Total)** | .029 | -.181 | -.185 | -.291* |
| **Executive Functioning[1] (WCST errors)** | .391** | .391** | .103 | .003 |
| **Negative Attributions (CV Annoy)** | .039 | .098 | -.245 | -.219 |

[1]*Different participant size, refer to Table 1*
*+p<.10 level *p<.05 level **p < .01*

**Associations between Maternal Social and Neurocognitive Capacities and Children's Behavioral inhibition**

The second hypothesis, that maternal SIP will be associated with difficulties in children's behavioral inhibition, was also tested using Pearson correlations. There was a significant negative correlation between maternal unrealistic expectations and child's latency to peek. As predicted, children whose mothers exhibited more unrealistic expectations displayed less behavioral inhibition and peeked over their shoulder sooner.

For the second domain of SIP, maternal executive functioning, there was a significant negative correlation with child's latency to peek over shoulder and turn around (Table 2). That

is, mothers who were less cognitively flexible (more executive functioning difficulties) had children who had shorter latency to peek/turn around on the delay task, thus exhibiting poorer behavioral inhibition. The last domain of SIP, negative attribution, did not yield significant associations with any of the behavioral inhibition measures.

The balance beam measure did not yield significant associations with any of the SIP domains. That is, SIP was not linked to behavioral inhibition as measured by the balance beam measure, which measures a child's ability to behaviorally inhibit gross motor movements.

*Table 3.Correlations between Maternal SIP capacities and Children's Behavioral Inhibition Measures*

| Variables | Balance Beam (Seconds) | Gift Delay Peeking Rating | Latency to Peek Over Shoulder | Latency to Turn Around and Peek |
|---|---|---|---|---|
| **Unrealistic Expectations (POQ Total)** | -.082 | .121 | -.270* | .132 |
| **Executive Functioning[1] (WCST errors)** | -.055 | .232 | -.274* | .-.394** |
| **Negative Attributions (CV Annoy)** | -.193 | .008 | -.142 | .236 |

*[1]Different participant size, refer to Table 1*
*+p<.10 level *p<.05 level **p < .01*

## Associations between Maternal Social and Neurocognitive Capacities and School Readiness

The third hypothesis was that maternal SIP difficulties would be associated with poor school readiness was tested using Pearson correlation. Contrary to the hypothesis maternal SIP difficulties did not yield significant results with teacher ratings of children's school readiness except for a trend on children's emotional regulation in the opposite direction to the prediction. In other words, there was a marginally significant trend that mothers who tended to have more negative attributions had children who were rated by teachers as more emotionally regulated.

*Table 4. Correlations between Maternal SIP capacities and Teacher Rating of Children's School Readiness*

| Variables | Emotional Regulation[1] | Prosocial Behavior[1] | Social Competence[1] | Aggressive/Oppositional Behavior [1] |
|---|---|---|---|---|
| **Unrealistic Expectations (POQ Total)** | .211 | .171 | .204 | -.161 |
| **Executive Functioning[1] (WCST errors)** | .059 | -.047 | .008 | .173 |
| **Negative Attributions (CV Annoy)** | .223+ | .136 | .192 | -.188 |

*[1]Different participant size, refer to Table 1*
*+p<.10 level *p<.05 level **p < .01*

**Associations between Children's Behavioral Inhibition and Externalized Behavior**

The fourth hypothesis, that children's behavioral inhibition difficulties will be associated with externalized behaviors, was tested using Pearson correlations. There was a positive correlation between the gift-delay rating and the ratings of attention problems from teachers. Children who displayed more behavioral inhibition difficulties on the gift delay task had teachers who reported more attention problems as the hypothesis predicted. There was also a significant negative correlation between latency time to turn around/peek and teacher ratings of attention problems. Children who displayed less behavioral inhibition and peeked earlier had teachers who rated them having more attention problems, as the hypothesis predicted. Mother ratings of externalized behaviors did not yield significant results, nor did teacher ratings of aggression.

*Table 5. Correlations between Children's Behavioral Inhibition and Externalized Behavior*

| Variables | Maternal Rating Attention Problems[1] (CBCL) | Maternal Rating Aggressive Behavior[1] (CBCL) | Teacher Rating Aggressive Behavior[1] (TCBCL) | Teacher Rating Attention Problems[1] (TCBCL) |
|---|---|---|---|---|
| **Balance Beam (Seconds)** | -.043 | -.145 | -.180 | -.112 |
| **Gift Delay Peeking Rating** | .205 | .050 | .131 | .358* |
| **Latency to Peek Over Shoulder** | -.140 | -.017 | .006 | -.142 |
| **Latency to Turn Around and Peek** | -.222 | -.237 | -.044 | -.333* |

[1]*Different participant size, refer to Table 1*
*+p<.10 level *p<.05 level **p < .01*

**Associations between Children's Behavioral Inhibition and School Readiness**

The fifth hypothesis that is children's behavioral inhibition difficulties will be associated with poor school readiness were tested using Pearson correlations. No significant correlations were found.

*Table 6. Correlations between Children's Behavioral Inhibition and Teacher Rating of Children's School Readiness*

| Variables | Emotional Regulation[1] | Prosocial Behavior[1] | Social Competence[1] | Aggressive/Oppositional Behavior [1] |
|---|---|---|---|---|
| **Balance Beam (Seconds)** | .001 | .136 | .072 | -.008 |
| **Gift Delay Peeking Rating** | -.059 | -.119 | -.094 | .145 |
| **Latency to Peek Over Shoulder** | -.113 | .005 | -.059 | .017 |
| **Latency to Turn Around and Peek** | .015 | -.020 | -.004 | -.086 |

[1]*Different participant size, refer to Table 1*
*+p<.10 level *p<.05 level **p < .01*

**Associations between Children's Externalized Behavior and School Readiness (Clarifying Analysis)**

To understand the lack of findings for the analyses involving the school readiness measure, the assumed link between ratings of behavior problems and school readiness was tested using Pearson correlations.

There was a statistically significant positive correlation between maternal ratings of attention problems and aggressive/oppositional behaviors. As the hypothesis predicted, mothers who reported having children with more attention problems had children whose teachers rated them as having more aggressive and oppositional behavior. There was a marginally significant trend between maternal ratings of children's aggressive behavior and teachers' ratings of children's aggressive/oppositional behavior, indicative of poor school readiness.

There was a statistically significant negative correlation between teachers' ratings of children's aggressive behavior and teachers' rating of emotional regulation, prosocial behavior, and social competence. Meaning, children whose teachers rated them as exhibiting higher aggressive behavior were also rated lower on the all three of the school-readiness subscales. There was a positive correlation between teacher ratings of aggressive behavior in the children and the aggressive/oppositional behavior subscale of the school-readiness measure.

There was a statistically significant negative correlation between teachers' rating of the children's attention problems and teachers' rating of emotional regulation, prosocial behavior and social competence. Meaning, children whose teachers rated them as exhibiting higher attention problems were also rated lower on all three of the school readiness subscales, indicative of poor school readiness. There was a positive correlation between teacher ratings of attention problems in the children and the aggressive/oppositional behavior subscale of the school readiness measure (poor school readiness).

*Table 7. Correlations Between Children's Externalized Behavior and Children's School Readiness*

| Variables | Emotional Regulation[1] | Prosocial Behavior[1] | Social Competence[1] | Aggressive/Oppositional Behavior [1] |
|---|---|---|---|---|
| **Maternal Rating Attention Problems[1] (CBCL)** | -.175 | -.109 | -.151 | .348* |
| **Maternal Rating Aggressive Behavior[1] (CBCL)** | -.075 | -.170 | -.129 | .226+ |
| **Teacher Rating Aggressive Behavior[1] (TCBCL)** | -.552** | -.668** | -.648** | .691** |
| **Teacher Rating Attention Problems[1] (TCBCL)** | -.738** | -.722** | -.777** | .908** |

[1]*Different participant size, refer to Table 1*
*+p<.10 level *p<.05 level **p < .01*

## Discussion

The majority of research examining the SIP model of parenting risk has focused on the role of maternal cognition in parenting. The present study sought to extend this research by

examining associations between maternal social and neurocognitive abilities and children's behavioral inhibition and school readiness as measured by maternal and teacher ratings of behaviors problems and teachers' ratings of school readiness. Specifically, the model hypothesized that deficits in maternal SIP would lead to poor child behavioral inhibition, poor school readiness, and the presence of externalized behaviors in children.

The first hypothesis tested was whether SIP difficulties were associated with higher levels of externalized behaviors in children. Only mother's executive functioning was found to link to the level of children's externalizing behaviors, as predicted, but only when the child's behavior was rated by the mother, not teachers. Inconsistency between the mother rating and teacher ratings of externalized behavior may be due to the fact that mothers and teachers do not observe children in the same environment. Children may not act the same way at home that they do at school or the structure at home and school may be different, which may give children more or less opportunity to express these behaviors. Teachers' class size and other classroom contextual factors (e.g., frequency of child misbehavior) may also affect their rating of the children that participated in the study (Berg-Nielsen, Solheim, Belsky, & Wichstrom, 2012). In larger classrooms, child misbehavior may go unnoticed, or if this child has peers who tend to have more externalized behaviors, their expression of externalized behaviors may seem minimal to the teacher and not properly reported. Contrary to the hypothesis maternal unrealistic expectations was negatively correlated with teacher ratings of children's aggressive behavior. It is not clear why this relationship did not support the hypothesized model, but one can speculate that parents' higher expectations for their child may lead the child to exhibited behavior more similar to adults. This behavior can transfer to the school setting where the teacher may perceive the child as having less of these aggressive behaviors because of socialization and the responsibilities the child has taken on at home. It is important to note that the means of mothers' unrealistic expectations in this study more closely resembled mothers who lacked SIP difficulties, which may be another explanation for this relationship. These mothers may not have social and neuro-cognitive impairments as hypothesized, such that these unrealistic expectations may be used more cautiously and deliberately and be beneficial to the child. The lack of findings in this domain of SIP suggests that there may be a specific threshold for the effects of unrealistic expectations. A number of unrealistic expectations below this threshold may be beneficial to the child, while above this threshold it may produce adverse outcomes for the child. In regard to negative attributions, findings did not replicate previous work. Although maternal attributions have been linked to parenting risk (Azar et al., 2017), maternal negative attributions were not found to link to children's self-regulatory capacities.

The second hypothesis tested was whether maternal SIP difficulties were associated with difficulties in behavioral inhibition in children. As predicted, children with mothers who tended to have more unrealistic expectations and poorer executive functioning exhibited poorer behavioral inhibition. Mothers who tend to have better executive functioning are believed to have better cognitive flexibility, which may involve some modeling of maternal behavioral inhibition, but also teaching and modeling different ways to display behavioral inhibition.

There was inconsistency in SIP findings between the child behavioral inhibition measures. As predicted, the gift delay measure showed significant links to SIP and only trends were found for the balance beam measurement of behavioral inhibition. The lack of consistency across the two measures may be attributed to variation in the type of behavioral inhibition each measure assessed. The gift delay measure assesses children's ability to delay gratification but also children's compliance, while the balance beam primarily focuses on children's ability to

behaviorally inhibit gross motor movements. As this study's focus is on preschoolers there may be developmental aspect involved in the lack of maturation to be able to inhibit these gross motor movements while compliance is typically more heavily influenced by socialization rather than biology.

The third hypothesis tested was whether maternal SIP difficulties were positively associated with poor school readiness as measured by social competencies. No support was found for this hypothesis directly with the CBQ data. Surprisingly, the reverse was found for one SIP domain. There was a positive trend between maternal negative attribution's and teachers' ratings of children's emotional regulation, meaning the more negative attributions a mother had, the higher the children were rated on emotion regulation capacities by their teachers. The SIP model was developed around parents who maltreated their children, including those who neglected and abused their children. Child neglect and abuse has been associated with poor school performance. With the children on highly structured schedules in daycare and schools it may be more difficult for teachers to identify this emotional dysregulation. Children tend to perform their best when they are on a set and predictable schedule.

The fourth hypothesis tested was whether children's behavioral inhibition difficulties were associated with the presence of externalized behaviors. As hypothesized, poor behavioral inhibition was correlated with the level of externalized behavior based on teachers' ratings of attention problems.

The fifth hypothesis was that children's behavioral inhibition difficulties will be associated with poor school readiness. Results from this study failed to support this hypothesis when teachers' ratings of school readiness were examined. To understand the lack of findings for the analyses involving the school readiness measure, the assumed link between ratings of behavior problems and school readiness was tested. Teacher ratings of attention problems and aggressive behaviors in the children were significantly associated with all the school readiness subscales (emotional regulation, prosocial behavior, social competence, and aggressive/oppositional behavior). Maternal ratings of the children's aggressive behavior and attention problems were associated with the school readiness domain of aggressive oppositional behavior. These promising results may indicate that the presence of externalized behaviors is a better indicator of school readiness than children's behavioral inhibition and maternal SIP. In previous research, the CBQ has been used a measure of school readiness, but also as a measure of temperament. Typically, a CBQ is not the only measure used to predict a child's school readiness but it is usually coupled with other academic measures (i.e. Test of Preschool Early Literacy). The lack of academic measures in this project may be the reason for the lack of findings.

This study supported the idea that difficulties in specific domains of maternal SIP are associated with children's externalized behaviors and poor behavioral inhibition. It also supported the idea that children's poor behavioral inhibition is associated with externalized behaviors. This study did not find the posited association between difficulties in maternal SIP and poor school readiness and children's poor behavioral inhibition and poor school readiness. There was an association between children's externalizing behaviors and poor school readiness. There was a lack of findings regarding maternal negative attributions and all the children's outcomes. Previous research has shown the impact negative maternal attribution has on parenting (Azar et al., 2016 & Azar et al., 2017). Wang, Deater-Deckard, & Bell (2013) found that household chaos moderates the relationship between maternal attributions and parenting behavior. Doing further analysis on the chaos of the homes of the mothers that participated in the

study may provide more insight on the lack of findings between maternal attributions and the child outcomes researched in this project. This can be explored in the larger project, of which this sample was a part, as home chaos was measured.

Although the study was not able to support all of the predicted hypotheses, findings nevertheless have implications for schools. This study looks at both mother and child, allowing prevention and intervention workers to create a programs that involve just the child, mother, or the mother-child dyad. Specifically, this project can give insight to evidence-based practices focused on changing behavior problems that use a systemic or ecological model. That is, practices that work with parents and not just children in schools. A systemic model argues for environmental factors that may contribute to a child's adverse outcomes and this project provides insight on the effects maternal social cognitive and neurocognitive capacities have on their child's behavioral inhibition and school readiness. Intervention programs such as ParentCorps (that is, including the parent, child and teacher) build upon many of the hypotheses that were supported in this study. This program has elements of Parent Child Interaction Therapy (Niec, Eyberg, & Chase, 2012), or instruction involving using positive reinforcement to encourage compliance and social-behavioral compliance. This type of intervention program has had research support that suggest it reduces children's externalized behaviors and an increase in their academic performance by children (Brotman et al., 2013).

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# *Fifty Shades of Race: The Influence of Racial Identity on Racial Categorization*

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*Abstract*

Categorization, including but not limited to social categorization, is a natural and automatic process for human beings. The aim of this study is to investigate whether racial identity plays a role in how racially ambiguous faces are categorized by Black and White individuals. Participants are African Americans and European Americans affiliated with the Pennsylvania State University, as students, staff, or faculty. Participants were given a forced choice task where they had to racially categorize visual stimuli, which were morphed faces of a phonotypical averaged White and a phonotypical averaged Black face, as Black or White and then racial identity was measured by the Race Specific Collective Self-Esteem Scale (CSE) and the Multigroup Ethnicity Identity measure (MEIM). Results found that race, gender, and member self-esteem or private self-esteem was significant predictors for breakpoint scores (or the amount of a Black face morphed into a White face to consider the face Black).

## Introduction

It is common for humans to navigate the world through the use of categories, whether natural categories (e.g., plants or animals) or artifact categories (e.g., tools and food). Other types of categorization, such as social categorization, are not as concrete. Social categorization is a process that involves perception and cognition to sort individuals in their surrounding environment (Krueger, 2001). Research suggests that the process of social categorization occurs automatically (Devine, 1989), which is beneficial to humans because it allows individuals to use group based information and apply it to make inductive inferences (Gelman & Davidson, 2013). For example, individuals will use knowledge gained from prior experiences with a group of people and apply it to other group members (Nisbett, Krantz, Jepson, & Kunda, 1983). Social

categories help individuals organize their understanding of human characteristics and the relationship systems that human social life consists of (Fiske & Neuberg, 2013).

However, automatic social categorization has drawbacks. The tendency to categorize runs the risk of leading to prejudice and stereotyping, two related concepts that affect how we treat individuals. The term "prejudice" refers to negative affect when interacting with members of an out-group, while the term stereotype refers to the mental portrayal of beliefs or behaviors of members of an out-group (Liberman, Woodward, & Kinzler, 2017). Research has shown that the presence of traits that are perceived to belong to African Americans (e.g., skin tone, thick lips, wide nose) activates stereotypes affiliated with the group, which can happen with or without racial categorization (Blair, Judd, Sadler, & Jenkins, 2002). Stereotyping even occurs within a racial group. A study conducted by Blair, Judd, and Chapleau (2004), showed that Black and White inmates were given harsher sentences for the same crime if they appeared to have more Afrocentric features, regardless of their actual race. Thus, how people categorize in-group and out-group, and/or the traits that are affiliated with in-group or out-group members, may have important consequences for an individual's wellbeing. The purpose of our study is to investigate one possible mechanism behind racial categorization.

**Origins of Racial Categorization**

Racial categorization is a specific form of social categorization that will be the focus of the current paper. Race is a social construct used to categorize and identify people who share common ancestry, culture, historical affiliation, or physical features. The discussion of race in our society is typically avoided. In fact, children as young as ten years old learn to avoid acknowledging racial differences (Apfelbaum, Pauker, Ambady, & Sommers, 2008). The discomfort of discussing race is a sensitive topic due, in part, to the origins of race as a construct. The construct of race dates back to European colonization. When Europeans first encountered Africans, early English voyagers called Africans "Black" in reference to their skin tones (Jordan, 1974). The term Black became prominent because it was the polar opposite of how Europeans thought of themselves. During the time Black Africans were "discovered," the English beauty standard consisted of fair and white skin. The ideology behind the enslavement of Black Africans was that White people were more civilized and therefore superior to Black people. Thus, the many contrasts between Black and White served as justification for slavery. Although the rationale behind the enslavement of African Americans is not as widespread today, and despite the fact that there are multiple races in existence, racial categorization distinguishing between Black and White race remains salient in today's society,

Racial categorization is not a process limited to adults. The ability to distinguish different races is not innate, but there is some evidence that infants as young as three months are beginning to distinguish between their own race's faces and the faces of individuals of other races. Using the visual preference paradigm, which tracks eye movements to see which image they preferred, Kelly et al. (2005) displayed that three-month-old infants exhibited a significant preference for looking at faces from their own racial group over faces from other racial groups. At six months of age infants begin to develop the other race effect (ORE), which is a phenomenon whereby individuals are more prone to make recognition mistakes when faces are from a different racial group rather than from their own. By nine months old, the other race effect can be fully demonstrated (Kelly et al., 2007). Infants' preference for same-race faces can be described by the multidimensional face space model (Valentine, 1991). This model states that a face is encrypted as a vector according to how much it diverges from the prototypical norm. At

birth there is no clear prototype; the prototype can have a broad range or be unstated. The prototype is formed through experience and interactions with faces in an infant's environment (Nelson, 2001). In other words, facial input experienced early in life, in regards to race and species, serves as the foundation for face-processing abilities.

**Mechanisms Behind Racial Categorization**

There are many different ways people place other individuals into categories. Appearance serves as a salient cue when determining the race of an individual. In a study conducted by Brown, Dane, and Durham (1998), participants ranked skin color as the most important determining factor for race. Skin color was followed by hair, eyes, nose, mouth, cheeks, eyebrows, forehead, and ears. Examples of physical features specific to African Americans that are commonly a determining factor for racial identity include wide noses, thick lips, and dark skin (Blair et al., 2002). When determining racial categories, children's decision is based almost exclusively on skin tone with physiognomic features barely being considered. Adults can determine race without skin tone cues because adults consider facial features in addition to skin tone when deciding racial categories (Dunham, Stepanova, Dotsch, & Todorov, 2014).

Another mechanism that impacts racial categorization is the previously mentioned other race effect, also known as the cross-race effect or own-race advantage. The other race effect was first exhibited initially in a study conducted by Malpass and Roy (1969). During this study, participants were flashed 10 faces of their own race and 10 faces of another race for one second each. Participants were then shown 80 pictures and asked to recall which 20 they had seen before. Results of this study showed that memory for the faces they had already seen was more accurate when the face was from their own racial group. The initial explanation for individual's superior ability identifying members of their racial group is due to daily encounters. People tend to have more interactions with members of their in-group which, in turn, leads to the ability to identify them more effectively than people who belong to their out-group (Nelson, 2001). A later study conducted by MacLin and Malpass (2003) used identical faces and changes in hair styles to fit a racial marker. Once the hair styles were changed, despite the faces remaining the same, the racial categorization was changed. Findings of this study suggest that the memory associated with other race effect occurs due to placing the faces in a social category rather than exposure (MacLin & Malpass, 2003).

Another factor that could possibly play a role in racial categorization is group identification. Castano, Yzerbyt, Bourguignon, and Seron (2002) conducted a study in Italy which investigated how identifying as a member of a group impacts the categorization of others as in-group or out-group members. This study was completed using 36 undergraduate females who were all born and resided in northern Italy. Castano et al. measured the strength of the participants' identity and had them categorize morphed picture of northern and southern Italians. Results of this study showed that people who identified highly with northern Italy were more strict when categorizing people as a member of their in-group (i.e., they tended to classify faces as in-group when they had fewer southern Italian features morphed in). Both low identifiers and high identifiers were biased to reject faces as members of their in-group, which displays the over-exclusion effect. In other words, regardless of how they identified, participants were more prone to classify faces as members of the out-group. However, highly identified Northern Italians were more likely to categorize faces as out-group than those who were less strongly identified. This study showed that there is some relationship between identity and the process of racial identification. Similar to Castano et al. (2002), this study looks at how identity influences

categorization of other individuals, but rather than focusing on categorization within one racial background, it looks at two completely different racial backgrounds. Group identification has also been shown to influence the extent to which race influences the ability to remember faces (Hehman, Mania, & Gaertner, 2009) and emotion decoding (Stevenson, Soto, & Adams, 2012).

### The Present Study

The goal of the present study was to investigate whether racial identity impacts how African Americans and European Americans categorize racially ambiguous faces. In this experiment we used a between participant design. The independent variable was strength of racial identity (weak or strong) and race of the participant, while the dependent variable was an index of when participants classified morphed Black/White faces as Black. There is an extensive amount of research that looks at racial categorization; however, not many studies have investigated the link between racial identity and categorization. This study involved a forced-choice racial categorization task and then measured racial identity through two questionnaires, the Multigroup Ethnicity Identity Measure (MEIM) and a race-specific version of the Collective Self-Esteem Scale (CSE). We expect to find that Black participants with a strong racial identity will be more exclusive than Black participants with weak racial identities when completing our racial categorization task. In other words, as identification with in-group gets stronger with Black participants, they become more stringent or exclusive in what they consider to be an in-group. This was only hypothesized for Black participants and not White participants (an identity by race interaction effect), because racial identity tends to be more important for racial minorities than for White individuals (Crocker, Luhtanen, Blaine, & Broadnax, 1994).

## Method

### Participants

Snowball sampling, which is a type of nonprobability sampling where participants refer their acquaintances to the study, was used to gather participants for this study. Initial participants were recruited through recruitment emails sent to various multicultural listserv at the Pennsylvania State University. We recruited an initial sample of 45 participants, 20 Black (six males and 14 females), 15 White (six males and nine females), and 10 describing themselves as "other" or unspecified. Since the visual stimuli used in the present study is a morph between Black and White faces, participants who were not Black or White were dropped from analyses. The final sample included a total of 35 participants, 20 Black subjects and 15 White subjects.

### Materials

**Forced-choice categorization task.** Participants completed a forced choice categorization task where they were shown a morphed-race picture of an individual which they had to categorize as either Black or White. In all there were 202 pictures, 101 male and 101 female. The individual pictures were created as averages of White and Black faces (separated within gender) using 100 faces of each category from the Chicago Face Database (Ma, Correll, & Wittenbrink, 2015). We did this by using a morphing procedure in order to pull out the most phenotypically average traits of each racial category. We then morphed the facial averages from each racial category in increments of 1% in order to create a continuum. The continuum consisted of faces that started at the morphed phenotypically averaged White face and ended at the morphed phenotypical averaged Black face. Pictures were randomized to control for

anchoring effects. We used the categorization breaking point as our main dependent variable. The breaking point refers to the percentage of Black face morphed into a White face required for the subject to categorize a face as Black. Participants' breaking points were averaged for both the male and female visual stimuli to give each participant one overall breaking point.

**Self-Report Measures**. After completing the racial categorization task, participants completed a number of self-report measures to assess racial/ethnic identity. These scales are described below. Finally, we asked participants to provide some basic demographic information which included race, education, class standing, and gender.

***Race Specific Collective Self-Esteem***. The Race-Specific Collective Self-Esteem Scale, developed by Crocker, Luhtanen, Blaine, & Broadnax (1994), is a 16-item seven-point Likert scale that measures feelings towards social group membership. In the race specific CSE, rather than asking questions about belonging to any social group (e.g., religion, sex, etc.) questions are phrased to consider race. The CSE has four subscales. The first subscale is membership esteem, which evaluates whether an individual feels worthy of belonging to a social group. The second subscale is the private collective self-esteem scale which measures how an individual personally feels about the value of their social group. The third subscale is the public collective self-esteem, which investigates how an individual believes other people perceive their social group. The public self-esteem scale was not used in this study because there is no correlation between any other subscales for black participants due to awareness of prejudice and discrimination (Crocker et al., 1994). The public self-esteem subscale was not used because it is not a valid measurement of identity for Black participants. The last subscale of the CSE is importance to identity which determines how important belonging to a social group is to the individual's character. The race specific CSE has been shown to be a reliable measure (alphas above .70).

***Multigroup Ethnicity Identity Measure.*** The Multigroup Ethnicity Identity Measure (MEIM), developed by Phinney (1992), is a measure that evaluates the strength of an individual's ethnic identity. There are two factors in the MEIM. One is ethnic identity search, which gets at the developmental and cognitive aspect of identity formation. The other is affirmation, belonging, and commitment, which gets at the affective aspect of identity. The MEIM has been shown to be a reliable (alpha above .80) measure across all ages and ethnic groups.

## Procedure

Participants received a link for participation through a recruitment email. The study was administered online via Qualtrics. After participants viewed a consent form and agreed to take the study, the study began with a racial categorization task. Participants were shown the visual stimuli of morphed faces, both male and female, one at a time in a randomized order and instructed that "for the following trials, you will be shown a face one at a time and be asked to categorize it as either a White or Black individual." Afterwards, participants completed the self-report measures described above.

# Results

## Preliminary Analyses and Descriptives

We calculated the means and standard deviations for our primary variables to look for outliers, or individuals whose data fell three standard deviations above or below the mean. One Black female was excluded from analyses because her breaking point was an outlier, being over three standard deviations below the mean. Thus the final analyses included a total of 34

participants: 19 Black participants and 15 White participants. Table 1 presents means and standard deviations for our primary variables which includes the breakpoint and subscales used in the study. Both Black and White participants' breakpoint average was around 43% and not significantly different from each other. However, Black participants, on average, scored significantly higher than White participants in membership self-esteem (5.12 vs. 4.43), private self-esteem (6.45 vs. 4.92), importance to identity (5.68 vs 3.10), ethnic identity search (3.24 vs 2.41), and affirmation, belonging, and commitment (3.29 vs. 2.59) (see Table 1).

We next determined the Pearson-correlation coefficient between our racial identity measures and the racial categorization breakpoint variables. None of these variables were related across the whole sample, as shown in Table 2. The lack of an overall correlation is not necessarily surprising because we expected these variables to relate differently within each group. Our hypotheses expecting a moderation by race are tested below.

**Primary Analyses**

The primary purpose of this study was to investigate how racial identity impacted racial categorization. We expected that for Black participants, those with a strong racial/ethnic identity would have a higher breakpoint than those with a low racial/ethnic identity. We ran a set of regression analyses to see if any of the five subscales used to measure racial identity could predict breakpoint scores and whether these identity measures interacted with race to predict breakpoint scores. Table 3 presents the results of these regressions. We found that the subscales used to measure racial identity were not a significant predictor for breakpoint. Race and gender were also not a significant predictor of breakpoint scores. Contrary to the hypothesis, we did not find that race and identity significantly interacted to predict breakpoint scores. There were no significant main effects and no significant interactions between race and any of the identity variables in predicting breakpoint.

**Post-Hoc Analyses**

We decided to examine gender of the participants as an additional variable in the regressions described above, because the visual stimuli presented were both male and female, and because prior research has shown that both race and gender of the observer can impact racial categorization (Johnson, Freeman, & Pauker, 2012). Results are presented in Table 4.We found a significant main effect of gender of the participant for predicting breakpoint score in the regression model for membership esteem, ß = -.040 (.014), $p$ = .007. There was also a two-way interaction effect between gender of the participant and membership self-esteem, but this two-way interaction was qualified by a significant three way interaction between race, gender, and membership self-esteem in predicting breakpoint scores, ß = -.048 (.014), $p$ = .001(see Table 4). Black women who scored low on this scale had a lower breaking point than Black men who scored low on this scale. In other words, Black women who did not feel as though they are worthy of belonging to their racial group were more inclusive while categorizing faces as Black. On the other hand Black men who did not feel as though they were worthy members of their racial group were more exclusive while categorizing faces as Black (see Figure 1a).

The only other significant effect among our regression analyses was a three-way interaction between race, gender, and private self-esteem, ß = -.096(.044), p = .039. Similar to the previous three way interaction, Black women who scored low on this scale had a lower breaking point than Black men who scored low on this scale. In other words, Black women who personally felt poorly about their racial group were more inclusive while categorizing faces as

Black, while Black men who personally felt poorly about their racial group were more exclusive while categorizing faces as Black (see Figure 1b).

## Discussion

Prior research has demonstrated a relationship between categorization and strength of racial identity. This study aimed to test the relationship between racial categorization and racial identity in Black and White individuals. Our hypothesis, which expected Black participants who had a strong racial identity to categorize racially ambiguous faces as out-group, was not supported when we only examined race and identity in our analyses. However, when we included gender with race and racial identity, we did find an interaction effect along the lines of what we expected. There was a three-way interaction between race, gender, and membership self-esteem and collective private esteem. When membership self-esteem was low, Black males were more exclusive when categorizing faces, while Black females were more inclusive. Among Black participants with low private self-esteem, Black men showed the more exclusive tendency predicted, but women did not. Black women who are low in collective private self-esteem look like everyone else in terms of their categorization tendencies, while Black men who are low in private esteem scored higher than everyone else, meaning Black men required a higher percentage of Black face morphed into a White face relative to Black women and White men and women.

This difference between Black men and Black women who scored low on the membership and private self-esteem could be a result of gendered racial socialization, which refers to the contrasting message families share with Black boys and girls about the racial climate and the experiences they may face due to both race and gender. Black boys are taught to value gender roles such as success, aggression, and competition, but also face cultural expectations of cooperation, resilience, promotion of their group, and survival of their group. In other words, Black boys are taught that as men they should be protectors and providers of both their family and their community which sometimes results in hyper masculine behaviors (Allen, 2016). Thus, Black males with low collective esteem might be overly exclusive when racially categorizing ambiguous faces in order to protect their in-group from outsiders as a means of overcompensating for their feeling less positive about their group (low private collective esteem) or like they are not valuable members of the group (low membership esteem).

Black women face the additional challenge of being a member of two undervalued groups and face gendered racism when seeing depictions of their gender roles. In the public lens, Black women have been stereotyped and socialized as self-sacrificing and nurturing, which is referred to as the Mammy stereotype (West, 1995). The acceptance of these stereotypes has also been linked with lower self-esteem (Thomas, Witherspoon, & Speight 2004). Black girls are also socialized with traditional and nontraditional gender roles by family. Studies have shown that Black girls are taught to value traits such as economic independence, assertiveness, strength, self-reliance, community leadership, and nurturance (Buckley & Carter, 2005). Black females with low collective self-esteem might feel the need to display extreme nurturance, either succumbing to the Mammy stereotype or promoting the emphasized trait nurturance, in effort to compensate for the lack of membership or private self-esteem which results in low-esteem Black females being more inclusive when categorizing racially ambiguous faces.

Interestingly, the only two subscales that had significant results were membership self-esteem and private self-esteem. Neither subscales on the MEIM, ethnic identity search or

affirmation, belonging, and commitment, or the importance to identity subscale on the race specific CSE were predictive of breakpoint scores in the racial categorization task. This could be a result of low self-esteem, in general. Luhtanen and Crocker (1992) found that all of the subscales on the CSE were correlated with personal self-esteem; however, the correlation between personal self-esteem and importance to identity had the weakest correlation. Low personal self-esteem could change the outlook on how an individual thinks of themselves as a member of a social group or their social group overall. In the present study, we did not measure or control for personal self-esteem.

**Limitations and Future Directions**

A major limitation of our study is the small sample size. This sample only included a total of 34 people, therefore this data must be considered a preliminary test of our hypotheses. Data were gathered over a four week time period on a volunteer basis, which contributed to the low sample size and makes it necessary to interpret our findings with caution. In fact, the two groups that appeared to drive the significant interaction (Black men and women) were the smallest subgroups (two individuals from each group). Another limitation of our study was that it was completed online by participants, as opposed to in the laboratory. Thus, participants could complete the study from any location and we were therefore unable to control the environment where the study was completed. Finally, this study used convenience samples and snowball sampling and as a result might not be reflective of what we may see in the general population. Future directions should try to replicate these analyses with a larger and more representative sample to examine how robust our findings were. Also future testing should involve controlling for personal self-esteem, which would allow us to determine whether collective esteem is uniquely predictive of racial categorization or if it our findings are driven by differences in personal self-esteem.

**Conclusion**

This study, when taken in consideration with prior research (Castano et al., 2002), demonstrates that identity is a possible factor in how people engage in racial categorization. Since racial categorization has implications for how people are treated (e.g., stereotypes prejudices faced), it will be important for research to continue to look at what other personal factors might drive the process of categorization. Strategies that individuals use for social categorization have implications for their social surroundings and can create positive or negative racial environments. Research has shown that the presence of traits that are perceived to belong to African Americans (e.g., skin tone, thick lips, wide nose) leads can activates stereotypes (e.g., violent, uneducated, criminal, etc.) affiliated with that group regardless of whether a racial categorization decision is being made(Blair et al., 2002). However, much more research should be done to examine what guides the process of racial categorization. We know that there are negative results from racial categorization, so by studying the processes involved in racial categorization we can try to prevent some of these negative outcomes. As we find more evidence for the relationship between collective/ethnic identity and racial categorization, this knowledge could be used to develop and implement anti-stereotype and anti-prejudice programs.

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Tables

Table 1: *Descriptive Statistics*

| | Overall M(SD) | Black M(SD) | White M(SD) |
|---|---|---|---|
| Membership SE | 4.81(0.09) | 5.12(0.09)** | 4.43(.14)** |
| Private SE | 5.77(0.21) | 6.45(0.21)** | 4.92(0.26)** |
| Importance to Identity | 4.54(.29) | 5.68(0.28)** | 3.10(0.28)** |
| Ethnic Identity Search | 2.88(0.12) | 3.24(0.15)** | 2.41(0.13)** |
| Affirmation, Belonging, & Commitment | 2.98(0.13) | 3.29(0.16)** | 2.59(0.16)** |
| Female Breakpoint | 0.44(0.01) | 0.45(0.02) | 0.44(0.01) |
| Male Breakpoint | 0.42(0.01) | 0.42(0.02) | 0.43(0.01) |
| Breakpoint Average | 0.43(0.01) | 0.43(0.02) | 0.43(0.01) |

*p<0.05

**p<0.01

Table 2: *Correlation Between Racial Identity and Racial Categorization*

| | | Female Breakpoint | Male Breakpoint | Overall Breakpoint |
|---|---|---|---|---|
| Membership SE | Pearson Correlation | -.030 | .059 | .014 |
| | Sig. (2-tailed) | .866 | .738 | .935 |
| | N | 34 | 34 | 34 |
| Private SE | Pearson Correlation | -.029 | .022 | -.004 |
| | Sig. (2-tailed) | .873 | .903 | .981 |
| | N | 34 | 34 | 34 |
| Importance to Identity | Pearson Correlation | -.010 | -.087 | -.050 |
| | Sig. (2-tailed) | .957 | .626 | .777 |
| | N | 34 | 34 | 34 |
| Ethnic Identity Search | Pearson Correlation | .001 | -.040 | -.020 |
| | Sig. (2-tailed) | .995 | .821 | .909 |
| | N | 34 | 34 | 34 |
| Affirmation, Belonging, & Commitment | Pearson Correlation | .112 | -.009 | .056 |
| | Sig. (2-tailed) | .528 | .958 | .751 |
| | N | 34 | 34 | 34 |

Table 3: *Regression Model Predicting Breakpoint from Racial Identity Subscales*

| | Membership SE | Private SE | Importance to Identity | Ethnic Identity Search | Affirmation, Belonging, & Commitment |
|---|---|---|---|---|---|
| Race | -.001(.014) | .001(0.15) | .000(.018) | .003(.015) | .001(.013) |
| Identity Subscale | .003(.015) | .000(.015) | -.005(.017) | -.003(.015) | .003(.013) |
| Race x Identity Subscale | .005(.015) | .002(0.15) | -.025(.018) | .004(.015) | .016(.013) |

*p <0.05
**p<0.01
***p<0.01

Table 4: *Regression Model Predicting Breakpoint from Racial Identity Subscales, Race, and Gender*

| | Membership SE | Private SE | Importance to Identity | Ethnic Identity Search | Affirmation, Belonging, & Commitment |
|---|---|---|---|---|---|
| Race | .002(.012) | .059(.031) | .001(.019) | .013(.018) | .006(.015) |
| Gender | .025(.012)* | .087(.043) | -.017(.018) | -.008(.017) | .005(.014) |
| Identity Subscale | -.004(.013) | -.071(.037) | -.005(.019) | -.015(.019) | .000(.016) |
| Race x Gender x Identity Subscale | -.048 (.014)*** | -0.96 (.044)* | .020(.018) | .010(.020) | -.005(.017) |

*p <0.05
**p<0.01
***p<0.01

Figure 1a: *Interaction between race, gender, and membership self esteem*

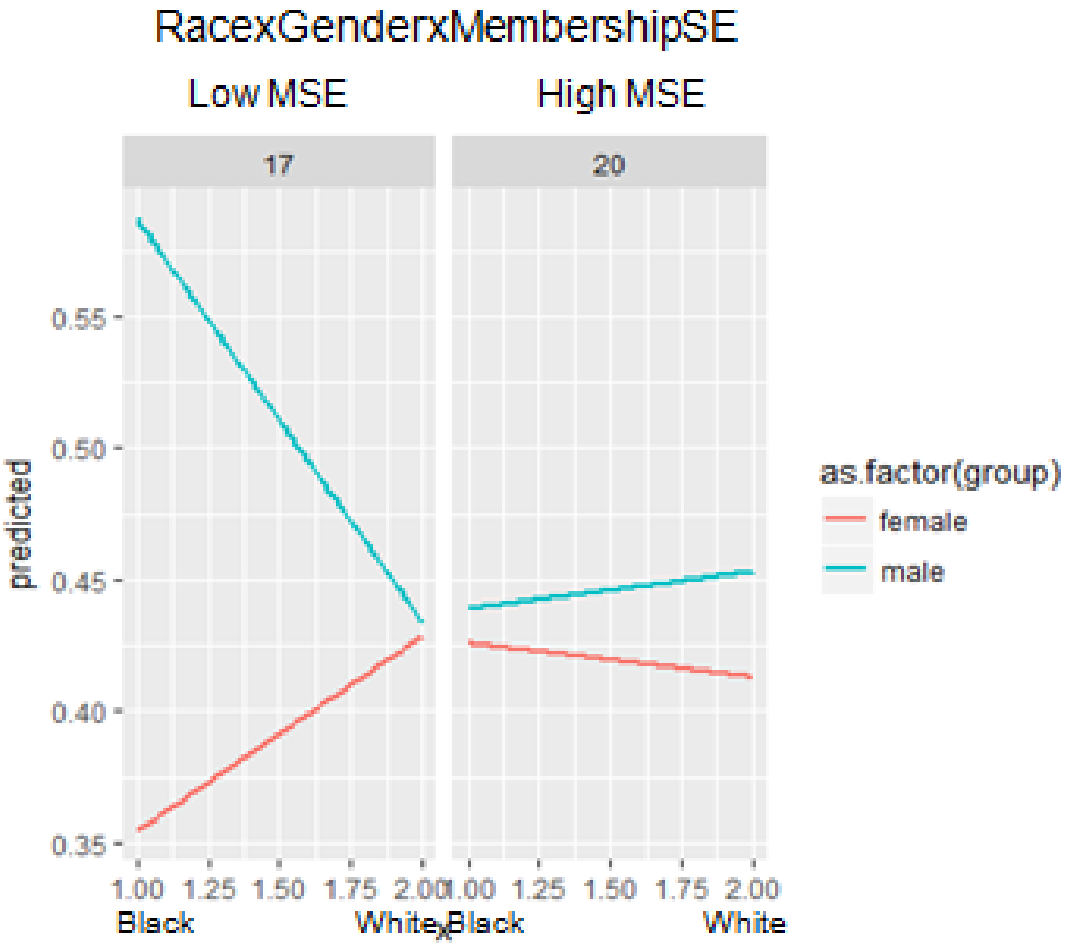
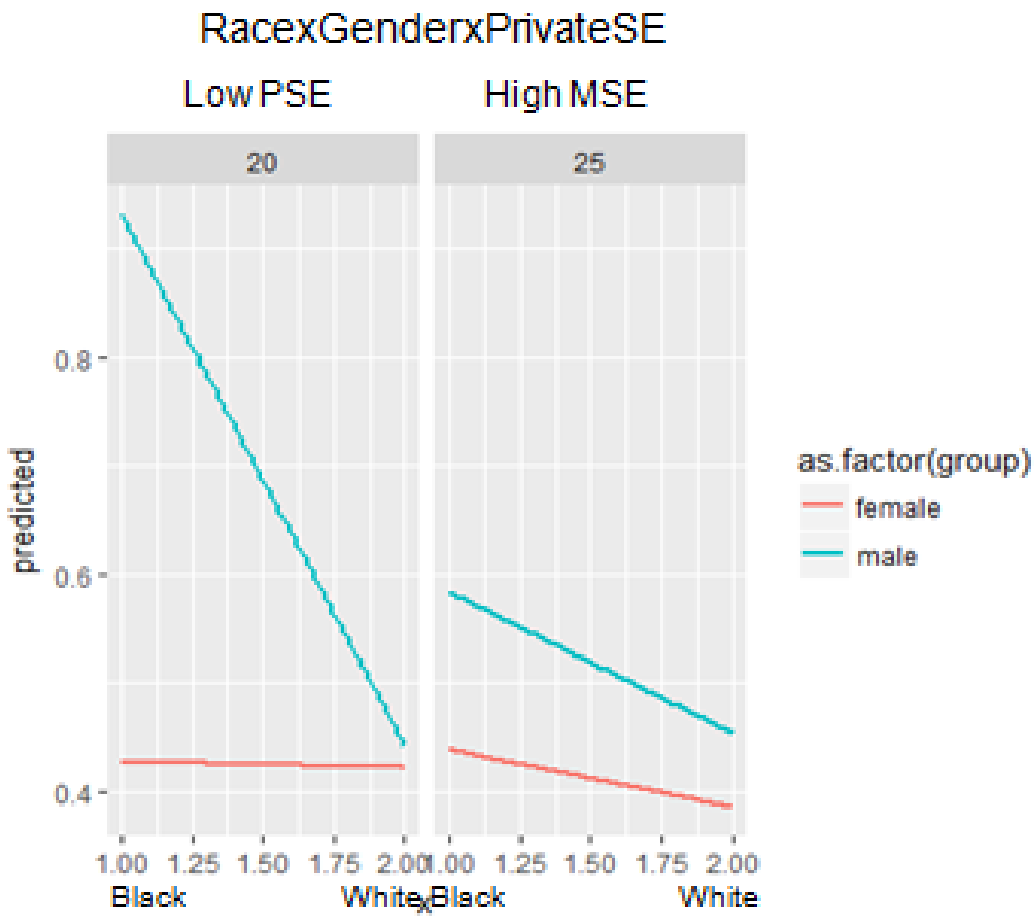


Figure 1b: *Interaction between race, gender, and private self esteem*



# *Developmental Timing of Trauma and Rejection Sensitivity*

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Abstract

Trauma exposure at different times during development may create different effects on psychopathology and social functioning. Rejection sensitivity, or the expectation of rejection in various social settings, is a construct not heavily researched, but is vital to interpersonal relationships. To test the relationship between developmental timing of trauma exposure and rejection sensitivity, Penn State students in introductory psychology courses completed an online survey in exchange for class credit. This survey contains detailed questions regarding potentially traumatic events participants may have experienced as well as a questionnaire about their tendencies to expect rejection in social situations. We hypothesized that trauma exposure during puberty, when brain functions designed for navigating social relationships are developing most, will most strongly predict later rejection sensitivity. Results of multiple regression analyses and bivariate correlation tests support this hypothesis, indicating that a significant and unique relationship exists between rejection sensitivity and trauma exposure during puberty.

## Introduction

A potentially traumatic event (PTE) is defined as actual or threatened death that an individual directly experienced once or repeatedly, witnessed, or learned second-hand about a close family member or friend, with the actual or threatened death being either violent or accidental (American Psychiatric Association, 2013). Such events have been experienced by roughly 82.7% of the adult United States population (Liu et al., 2017). A majority of adolescents in the United States, 61.8%, have experienced at least one PTE with the most commonly reported being an unexpected death of a loved one (McLaughlin et al., 2013). Additionally, studies show that an average of 85% of undergraduate students have experienced a PTE at some point in their life, most common also being unexpected death of a loved one (Frazier et al., 2009). This rate is similar to that of adults across the lifespan, potentially due to the high prevalence of interpersonal trauma in early adulthood (including sexual assault on college campuses; McLaughlin et al., 2013) and/or younger adults may have enhanced perception and memory for potentially traumatic events.

Mental health disorders, such as posttraumatic stress disorder (PTSD) and depression, are among the most commonly discussed consequences of experiencing a trauma (Kessler, 2000). Collectively, people who have experienced a PTE have lower self-esteem (Smith, 2016), which

may suggest a higher susceptibility to comorbid mental disorders, or it can also suggest decreased self-esteem being a consequence of having such disorders. Overall global distress also tends to be higher in people diagnosed with PTSD (Taft, 2011). Like low self-esteem, feelings of shame and guilt are also associated with potentially traumatic events and can cause more psychological damage to the victims (DeCou, 2017). It is also important to recognize that adolescents who have experienced a PTE, especially women or adolescents with pre-existing fear or distress disorders or previous PTE exposure, are at a higher risk of being diagnosed with PTSD, with one-third being predicted to not recover (McLaughlin et al., 2013). Other consequences of trauma can include increased suicide rates, 150% elevated odds of unemployment, work impairment (averaging almost 4 fewer completed work days per month) causing decreased average income, and a 60% higher chance of marriage instability (Kessler, 2000). Indeed, posttraumatic stress disorder is also associated with more physical and psychological aggression perpetration in intimate relationships (Taft, 2011).

All of these consequences of PTE exposure are highly intertwined with social functioning issues. For example, higher psychological aggression perpetration associated with PTE exposure may explain marriage instability. Rejection sensitivity is the expectation of rejection across various social contexts, such as with peers, family, or others. Rejection sensitivity is vital in social interactions and it is associated with higher anxiety and worry, as well as lower self-esteem (Feldman and Downey, 1994). Higher rejection sensitivity is also associated with avoidant and ambivalent adult attachment styles (Feldman and Downey, 1994) and more relationship conflicts overall (Downey, Freitas, Michaelis, and Khouri, 1998). Avoidant and ambivalent attachment styles are associated with lower self-esteem and increased anxiety and worry as well. Attachment styles can change based on events that occur, like trauma, and can become insecure (Feldman and Downey, 1994). This can indicate that rejection sensitivity can also change after exposure to a trauma. Understanding rejection sensitivity more thoroughly can be a key factor in more fully comprehending trauma's impact on social functioning.

Some research suggests a sensitive period during puberty exists and has a direct influence over social constructs like rejection sensitivity. Research indicates that trauma exposure during puberty increases susceptibility to the development of anxiety disorders (particularly social phobia), potentially due to the increase of hormones in the body, neuroplasticity, and neural development during puberty (Marshall, 2016). In such a sensitive period, it is suggested that a trauma's impact on a breadth of social constructs will be greater than trauma during other periods in development (Holder and Blaustein, 2014; Marshall, 2016; Lupien, McEwen, Gunnar, and Heim, 2009). Rodents that experience a PTE of being transported across country to labs during puberty are more likely to express depression-like behaviors and a decrease in hormone production compared to mice transported during any other developmental period (Holder and Blaustein, 2014). This suggests that trauma during puberty "remodels" the brain as a response, potentially resulting in a higher vulnerability to mental health disorders and associated difficulties (Holder and Blaustein, 2014). Rejection sensitivity is one of the lesser studied social concepts, but it is important to study in order to fully understand the effect trauma has on interpersonal relationships and social cognition. Research has shown that adolescents use their dorsomedial prefrontal cortex (dmPFT) more often than adults when completing a task in which social cues are needed (Blakemore and Mills, 2014). This has been interpreted to mean that, in social and emotional conditions, adolescents use brain regions involved in understanding mentalization, even when it is unnecessary (Blakemore and Mills, 2014). This demonstrates that

social components, such as rejection, are processed differently during puberty, increasing the sensitivity during this time (Blakemore and Mills, 2014).

The current study is designed to determine if there is a relationship between the time during development at which a PTE exposure occurs and a difference in rejection sensitivity in early adulthood. We hypothesize that trauma exposure during puberty, the time when the neuroplasticity and neural development related to social cognition and processes is increased, will be uniquely associated with the most severe and negative impact on individuals' sensitivity to potential rejection.

## Methods

### Participants:

Participants included 30 students enrolled in an introductory Psychology course at The Pennsylvania State University during the summer of 2017; 3 did not complete all measures. Age of participants ranged from 18 to 37 years, with a mean of 24 ($SD$ = 5.75). The majority (85.7%) of participants who completed this study were female. Twenty-two (78.6%) participants were White, three (10.7%) were Asian, two (7.1%) were more than one race, and one (3.6%) was African American. All participants had at least a high school education, with the highest being 18 years of education ($M$ = 12.52, $SD$ = 6.25). Eight participants reported having children, ranging from 1 to 4. Most (63%) participants stated they are currently in a relationship, defined as "dating or committed intimate relationship, whether or not sexual intimacy occurs."

### Procedure:

This study contained an online series of questionnaires. Participants signed up to take this survey in exchange for partial course credit. Participants completed the survey at their convenience. The full survey, including measures not contained in the current report, took participants anywhere from 45 minutes to 6 hours to fully complete.

### Measures:

*Traumatic Life Events Questionnaire (TLEQ):* The TLEQ is a 24-question survey used to identify 22 life events that are considered potential traumatic events based on the Diagnostic and Statistical Manual of Mental Disorders (DSM) criteria for stressors that may lead to PTSD (Kubany et al., 2000). A 1-week test-retest analysis shows Kappa coefficients that were .60 or higher for 8 of the 16 items, and .40 or higher for 14 of the 16 items (Kubany et al., 2000). The overall average for test-retest agreements was 88% (Kubany et al., 2000). This questionnaire was adapted for computer usage and to assess the age at each occurrence, to align with the number of times each event happened. Although the experience of fear, helplessness, or horror is assessed in the original TLEQ in order to align with DSM-IV criteria, we excluded such questions in order to align with DSM5 criteria. Participants also did not report if they were seriously injured, if the event was caused by more than one person, or details regarding assaults.

*Rejection sensitivity questionnaire (RSQ):* The RSQ includes 9 hypothetical scenarios and two questions per scenario answered using a 6-point Likert scale measuring 1) the amount of concern or anxiety participants would experience in response to each given situation, and 2) the expectation of rejection in response to the same event (Downey, Freitas, Michaelis, & Khouri, 1998). An example scenario includes, "You bring up the issue of sexual protection with your significant other and tell him/her how important you think it is." Participants are then asked, "How concerned or anxious would you be over his/her reaction?" and can respond with a 6-point Likert scale ranging from 1 ("very unconcerned,") to 6 ("very concerned.") Regarding the same scenario, participants are then asked another 6-point Likert scale question addressing their expectation of rejection, "I would expect that he/she would be willing to discuss our possible options without getting defensive," with 1 indicating "very unlikely" and 6 indicating "very likely." Test-retest reliability was .83 over a 2-3 week period and .78 over a 4-month period (Downey et al., 1998). For the purpose of this study, these questions were adapted for computer usage. To calculate total rejection sensitivity scores, items regarding expectation of rejection were reversed scored to allow higher scores to indicate higher rejection expectation, then multiplied by scores given for anxiety/concern. These scores for all scenarios were summed, then divided by number of scenarios, as described by Downey et al. (1998).

**Statistical analyses:**

Data on participants' earliest experiences of trauma were structured such that participants received 4 continuous scores representing the number of traumas experienced during the following: 3 to 5 years after birth ("infancy-preschool"), 2 to 6 years before the puberty period ("grade school"), 3 years before and the last year of puberty, based on age of menarche for women and the last reported age of any pubertal process (i.e., voice changes, body hair growth, skin changes) for men ("puberty"), and 1 year after reported age of puberty to present day ("postpuberty"). The number of years included in the infancy-preschool and grade school periods varied because of the variability in number of years for birth to puberty, as indicated in Table 1. Although both girls and boys typically complete puberty within 4 years, this timespan for puberty was used conservatively to ensure full coverage of adrenarche and spermarche.

Descriptive statistics, bivariate correlations, and multiple regression analyses were conducted to test for a relationship between trauma exposure during the developmental periods and scores on the RSQ. Regression models were adjusted for current age to minimize bias due to a possible relationship between recency of trauma and rejection sensitivity. Models were also adjusted for participants' age at the end of puberty to minimize bias due to the following: differing number of years included in the infancy-preschool and grade school periods; possible relationships between trauma exposures or other forms of adversity and pubertal timing; and possible increased sensitivity to the effects of trauma among early maturers.

Table 1: Ages Included in Each Developmental Period Based on Age of Last Year of Puberty

| | 9y | 10y | 11y | 12y | 13y | 14y | 15y | 16y | Years, Mean | Rate of Trauma % (n) | No. of Traumas Mean (SD) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Infancy | 0-3 | 0-3 | 0-3 | 0-4 | 0-4 | 0-4 | 0-5 | 0-5 | 4.8 | 18.5% (27) | 0.1121 (0.364) |
| Grade school | 4-5 | 4-6 | 4-7 | 5-8 | 5-9 | 5-10 | 5-10 | 5-11 | 4.6 | 48.1% (27) | 0.3947 (0.740) |
| Puberty | 6-9 | 7-10 | 8-11 | 9-12 | 10-13 | 11-14 | 12-15 | 13-16 | 4 | 55.6% (27) | 0.5325 (0.988) |
| Postpuberty | 10+ | 11+ | 12+ | 13+ | 14+ | 15+ | 16+ | 17+ | 12 | 96.3% (27) | 0.7703 (0.987) |

## Results

Of the 27 participants who fully completed the survey, 100% experienced at least one potentially traumatic event in their lifetimes. The most commonly reported PTEs were "sudden/unexpected death of a close friend or loved one" and "seeing or hearing family violence" with a prevalence of 55.6% and 29.6% respectively. Trauma exposure rates increased across developmental periods, most notably from infancy (18.5%) to grade school (48.1%) and from puberty (55.6%) to postpuberty (96.3%), as shown in Figure 1. Broken down further by age as a continuous score, frequency of PTE exposure peaks at two age periods: the typical ages of puberty (9-14 years) and late adolescence (15-18 years), as shown in Figure 2.

The average score on the Rejection Sensitivity Questionnaire (RSQ) was 10.33 (*SD* = 4.64), with a range from 3.33 to 20.67. Scores above the median RSQ score (10.05) were consider "high," indicating high rejection sensitivity, and scores below the median were considered low in rejection sensitivity. In infancy, the average number of traumas experienced was .1121 (*SD* = .36) and ranged from 0 to 1.85. Participants experienced an average of .3947 (*SD* = .74) traumas in the grade school developmental period, ranging from 0 to 3.17. The number of traumas during puberty ranged from 0 to 4.50, with a mean of .533 (*SD* = .99). The number of traumas participants experienced during the postpuberty stage ranged from 0 to 4.79 and averaged .77 (*SD* = .99).

Figure 1

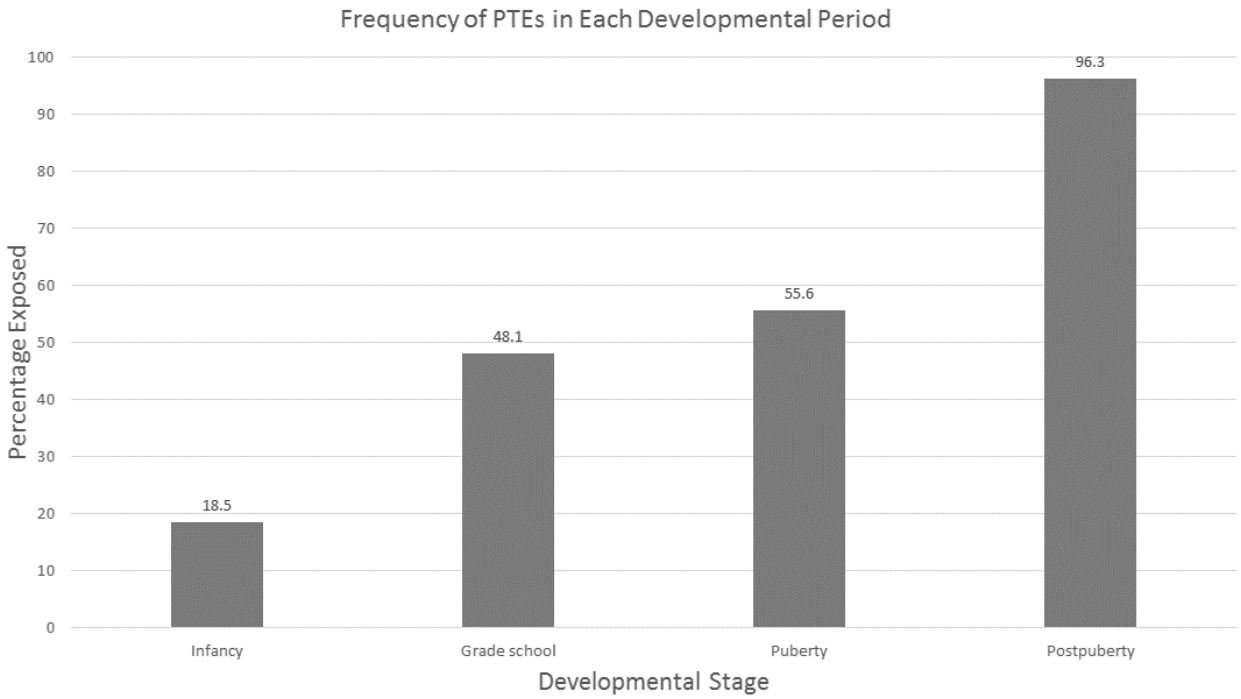
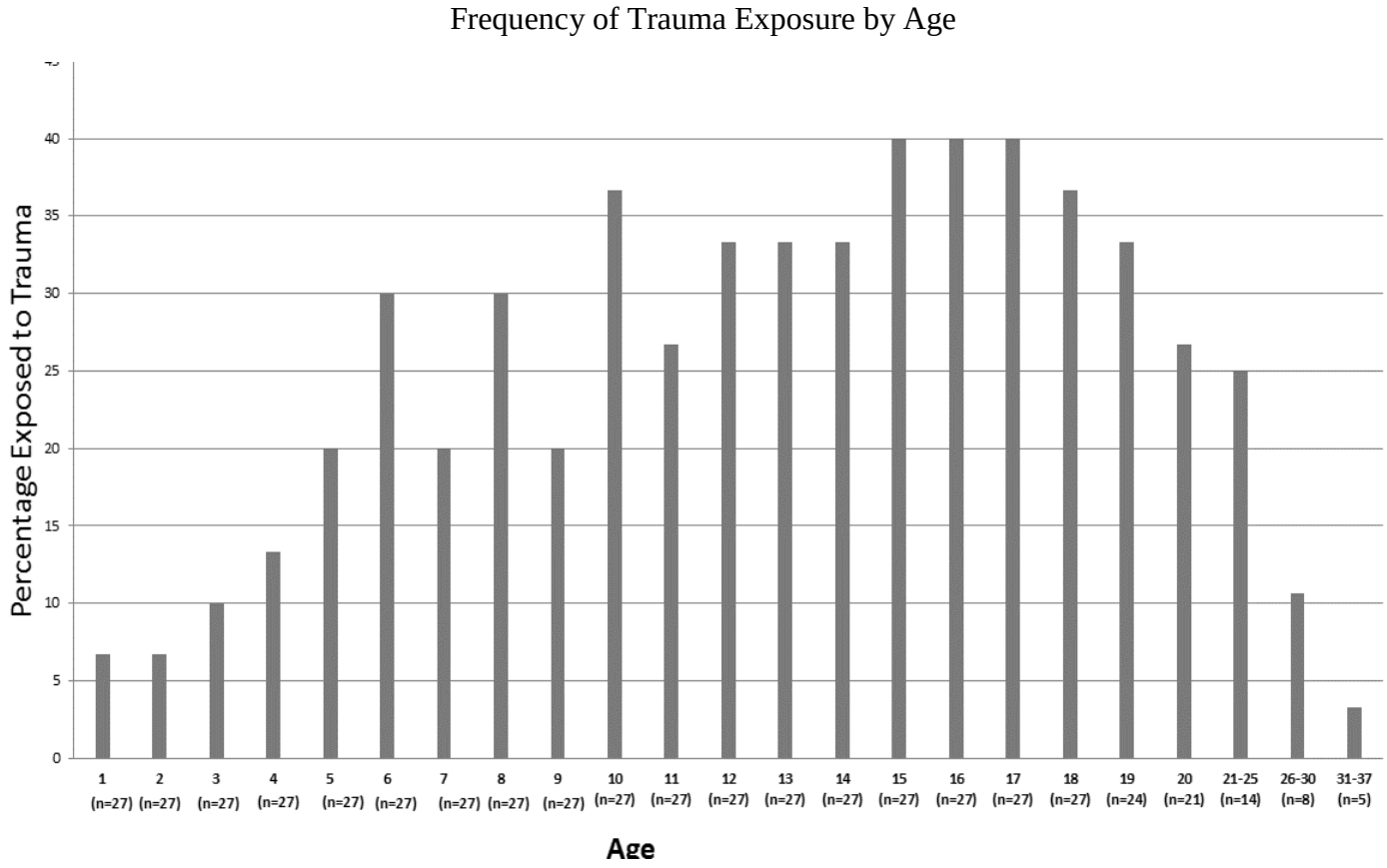



Figure 2



Bivariate correlations between each developmental period's continuous trauma exposure scores and the RSQ indicated that only one statistically significant relationship occurred. Specifically, the number of potentially traumatic events experienced during puberty was positively correlated with the RSQ total score ($r$ = .40, $p$ = .040). A moderate ($r$ = 34), but statistically nonsignificant ($p$ = .079) relationship was found between the number of potentially traumatic events experienced during grade school and RSQ scores. All correlations are reported in Table 2.

Table 2

| Developmental Period | Pearson Correlation to RSQ score | Significance of Correlation between RSQ score and Developmental Period |
|---|---|---|
| Infancy | .230 | .247 |
| Grade School | .344 | .079 |
| Puberty | .398* | .040 |
| Postpuberty | .085 | .674 |

When running a multiple regression analysis to simultaneously examine the predictive values of trauma exposure during each developmental period while controlling for current age and age at the end of puberty, trauma during puberty significantly and uniquely predicted rejection sensitivity in adulthood. These results are displayed in Table 3. Trauma exposure accounted for a substantial amount of the variance in rejection sensitivity (24%). The pattern of results remained the same when using dichotomous scores representing the presence or absence of trauma exposure during each developmental period to predict rejection sensitivity.

Table 3

| | Unstandardized *B* | Standard Error | Standardized Beta | *t* | Sig. |
|---|---|---|---|---|---|
| Infancy | -6.077 | 4.006 | -0.512 | -1.517 | 0.150 |
| Grade school | 4.058 | 2.893 | 0.460 | 1.403 | 0.181 |
| Puberty | 5.445 | 2.356 | 0.742 | 2.311 | 0.035 |
| Postpuberty | -2.496 | 2.028 | -0.292 | -1.230 | 0.237 |

## Discussion

Trauma is an occurrence that can happen to anyone at any time and is difficult to prevent entirely. Fully comprehending the effects of a potentially traumatic event as well as why and how it impacts victims can contribute to the treatment of associated consequences such as psychopathology, economic difficulties, and interpersonal relationship problems (Kessler, 2000; Taft, 2011; Feldman and Downey, 1994). Research on rejection sensitivity, in particular, is vital to understanding the workings of relationships with anyone from family to significant others to coworkers. It is especially important to study how this sensitivity may change in accordance to trauma exposure, as well as when the brain is most susceptible to these changes in rejection sensitivity. Studies show this is a consequence of trauma exposure due to sensitive periods in the brain during various times of development (i.e., puberty and social cognition and functioning; Holder and Blaustein, 2014).

Results of the current study indicate that 100% of participants experienced at least one traumatic event in their lifetimes. Although this prevalence rate is higher than both adult and college student averages in the United States (Liu et al., 2017; Frazier et al., 2009), it magnifies the crisis that is trauma exposure and demonstrates that it needs to be researched as thoroughly as possible. The peak in frequency of trauma exposure that occurs in late adolescence also shows the importance of researching this particular age demographic: college-aged students. Because the likelihood that a person experienced a PTE is highest right before entering college, looking into the effects of this age cohort will give the best results on the effects because the experience occurred so recently. Discovering PTE exposure more recently in relation to the event can also cause earlier detection of psychological damage, like PTSD, leading to earlier treatment and potentially more successful outcomes.

Bivariate correlations and, more notably, multiple regression analyses indicate a significant relationship between trauma experienced during puberty and rejection sensitivity, as hypothesized. This supports Holder and Blaustein's (2014) research that social cognition and related social processes are more susceptible to injury, such as that imposed by trauma exposure, during puberty than other developmental periods. This may be a consequence of the increased neuroplasticity in particular areas of the brain during this time. Results also showed a moderately significant relationship during grade school, but this effect was no longer present to a substantial degree when simultaneously considering the impact of trauma exposure during puberty. Further research is needed to fully comprehend trauma exposure's impact across developmental periods on rejection sensitivity.

In order to research this further, a larger sample size would be required. It is important to recognize that a small sample size is problematic because, although the regression results were significant, it is uncertain if the results are a function of the small sample or if they can be generalized to a larger population. Gender differences are also unable to be accounted for due to the small number of men included in the sample. However, these preliminary findings demonstrate that some relationship occurs between the two variables, and should continue being researched to entirely comprehend. This research will be continuing at The Pennsylvania State University during the fall 2017 semester, when a greater and more diverse sample is anticipated to partake in the research.

While preliminary findings of this study indicate an unmistaken need for further research, there are additional limitations of this study. Because this survey was self-report, there can be

issues with reporting. When asked to recall the age at which an event occurred, participants may have guessed an age that is not accurate, causing an unintentional error in developmental period trauma frequencies. There is also an issue with disclosing personal information, which can cause participants to not be honest when completing the survey. Solutions could have included using interviews to help participants think through ages, having parents report on ages of experiences, or the use of clinical techniques to decrease impression management. However, accounting for error by adjusting developmental periods and allowing participants to remain anonymous and complete this survey in the privacy of their homes likely lessened these errors.

While PTE exposure is generally not avoidable, the consequences can be lessened if fully understood. Interventions and research focused on identifying and treating trauma exposure during puberty is necessary based on previous literature indicating the presence of a sensitive period during puberty in regards to injury and social functioning. If puberty serves as a sensitive period for the development of rejection sensitivity, it may be that interventions provided during puberty can be especially effective in this regard. Research conducted on various effects of trauma, like rejection sensitivity, is crucial in grasping the trauma's impact on victims. Said research on these constructs is not complete, and should be continued as thoroughly as possible.

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# *Referent Power: A Look into Who Gives Power and Who Receives Power*

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*Abstract*

Referent power is defined as the desire to closely associate with another, usually referring to the power of a cherished mentor. We predicted that members of marginalized (vs. dominant) groups will be more motivated to give referent power to high-status others in attempts to appease belonging uncertainty in academic domains. To test predictions, we administered surveys to 56 marginalized group members and 29 dominant group members. Contrary to predictions, we failed to replicate prior findings showing that members of marginalized (vs. dominant) groups feel more belonging uncertainty and are, therefore, more motivated to give referent power. Exploratory analyses show relationships between group identity and (1) aspects of empowerment and (2) types of traits deemed important in mentors. Contrary to predictions, marginalized and dominant groups did not differ in the numbers of people to whom they gave referent power or how much self-other overlap they felt. Consistent with the notion that referent power reduces psychological distance and facilitates feelings of belonging, we found participants with higher numbers of mentors were more likely to give referent power.

*Keywords:* referent power, marginalized groups, college students, mentors

## Introduction

Racial disparities in higher education are pervasive and persistent. Black, Hispanic/Latino, and Asian students are enrolling in higher numbers than in the past, but are still lagging compared to White students. A study conducted by the National Student Clearinghouse Research Center indicates that of the students enrolled in higher education in 2010, 57.8% were White, 11.9% were Black, 11.4% were Hispanic/Latino, 4.8% were Asian, and of the remain 14.1%, 2.4% identified as having two or more races, 4.0% identified as other, and 7.7% did not share their race or ethnicity (Shapiro et al., 2010). Although more than half of the total number of students enrolled in higher education are women, a racial gap exists between the number of students who enroll in two- year institutions and four-year institutions (Shapiro et al., 2010). 45.1% of Asian and 45.9% of White students enrolled in four-year institutions, while only 36.6% and 36.3% of Black and Hispanic/Latino students, respectively, enrolled in four-year institutions. These rates switch when looking at two-year institutions with Blacks and Hispanic/Latinos

making up 48.5% and 50.8% of students enrolled and Whites and Asian making up 35.6% and 37.8% (Shapiro et al., 2010).

There are also disparities in student drop-out or non-completion rates. Asian and White students have the highest completion rates (63.2% and 62%), followed by Hispanic/Latino students (45.8%). Black students have the lowest completion rates (38%), with Black men, having the lowest completion rate at 33.5% (Shapiro et al., 2010). Given these statistics, it is important to understand factors that exacerbate and attenuate disparities in enrollment and completion rates in higher education.

The goal of this research is to examine whether students who are members of marginalized groups are more motivated than students who are members of dominant groups to give referent power to high-status others to increase feelings of belonging. To examine this possibility, we formulated two hypotheses. First, because members of marginalized (vs. dominant) groups feel more belonging uncertainty in academic domains (Walton & Cohen, 2007), we predicted that students who belong to marginalized (vs. dominant) groups are more motivated to give referent power to high-status others. Their motivation to give referent power can be seen in their (1) greater focus on the need to belong, (2) desire to identify with a greater number of others, and (3) feelings of more self-other overlap with one's closest mentors. Our second hypothesis states that students who belong to marginalized (vs. dominant) group members are more attentive to cues in powerful others that suggest that a high-status other can be trusted and will validate their position in a given domain. Validating students from marginalized groups requires that a high-status other (1) see and respect their unique skills and abilities, (2) understand their experiences as a marginalized group member including the pervasiveness of prejudice and discrimination, (3) has successfully helped others similar to them in a given domain, and (4) has the ability to include. To examine these two hypotheses, we will first discuss who belongs to groups that are marginalized in academic domains. We will then discuss conceptualizations of power and distinguish referent power from other forms of power. Our final section of the introduction will review theory and research on belonging and forward predictions that the giving of referent power to high status others may reduce feelings of belonging uncertainty.

**Marginalized and Dominant Groups**

Individuals who are categorized as members of a marginalized group belong to groups that are negatively stereotyped in society and that are underrepresented in valued domains. Members of these groups tend to receive poor interpersonal and economic outcomes when compared to members of dominant groups. These disproportionate outcomes are a result of discrimination and prejudice against members of marginalized groups (Crocker & Major, 1989). For our study, we have chosen students from four main marginalized groups, which include: women, LGBTQ individuals, people of color, and people from low socio-economic status families. Given the foregoing definition of marginalized groups, dominant groups would then be individuals who belong to a group that is not negatively stigmatized and who are typically numeric majorities in valued domains – Whites and White men, in particular. Individuals in dominant groups are not the targets of discrimination and prejudice; therefore, dominant group members less often face poor interpersonal and economic outcomes. In this study, dominant group members will be classified as White men who are able-bodied, straight, cis-gendered, and have a high or medium socio-economic status.

**Power**

To understand referent power, we must first define power and articulate the different ways in which power differentials emerge. We define power as the potential to influence others in psychologically meaningful ways (French & Raven, 1959) through the giving or withholding of rewards and/or punishments (Keltner, Gruenfeld, & Anderson, 2003) and/or control of valued outcomes (Fiske, 1993). Rewards include anything that has a positive effect on one's life and is valued by an individual. Inversely, punishments involve anything that has an adverse effect and is disliked by an individual. We define power as the potential to influence, rather than actual influence, because we are interested in the effect of power on low power people. The behaviors, attitudes, cognitions, and effects of low power people can be influenced by how powerful people may potentially respond in the future, as well as their actual behavior. Thus, in the same way that an employee is meaningfully affected by how they anticipate how their boss will behave, students are influenced by potential behaviors they imagine, as well as actual behaviors, of academic faculty. Students will alter their actions regarding high power others in order to be rewarded or avoid punishment. For the purposes of this study, a reward will be defined as anything that has a positive effect on an individual's life and is valued by said individual and punishment will be defined as anything that has an adverse effect and is disliked by an individual.

Power differential emerges in several ways. According to French and Raven (1959), there are the Five Bases of Power. People with power hold one or more of the bases. The first base of power is *legitimate power*, where person one (O) believes person two (T) has a right to influence them and O is obligated to accept the influence. The second base of power is *reward power*, where O perceives that T can administer positive valences and remove or decrease negative valances. The third base of power is *expert power*, where O attributes T with a high level of knowledge that can influence O. The fourth base of power is *coercive power*, where O expects to be punished by T if they fail to conform to T's influence. The final base of power is *referent power*, where O has a desire to closely associate with T (usually someone high in status or power). In the first four bases of power, T has prior power. In the fifth base, however, T gains power only after it is offered by O. The last of the five bases, referent power, has received the least amount of attention within research. We are interested in changing this and learning what motivates someone to willingly give another power over them, specifically in an academic setting.

**Referent Power.** Referent power refers to the desire to identify with another by forming feelings of oneness (French & Raven, 1959). In this context, feelings of oneness are described as desires to share beliefs, opinions, and behaviors. As French and Raven note, this can take the form of thoughts like the following: "I am like O, and therefore I shall behave or believe as O does" or "I want to be like O, and I will be more like O if I behave or believe as O does." (p. 154-155). French and Raven's conceptualization of referent power, in terms of feelings of oneness, parallels conceptualizations of interpersonal closeness and self-other overlap that have been forwarded by relationship researchers Aron, Aron, and Smollen (1992). Aron et al. (1992) conceptualize interconnected selves in terms of interpersonal closeness. More specifically, interconnected selves refer to instances in which people feel psychologically, physically, and emotionally like another. One is said to have an interconnected oneself (or have included another in the self) to the degree that one's partner and oneself are perceived to share resources, perspectives, and characteristics.

Closeness is described as interconnectedness with another and intimacy as reciprocal self-disclosure which leads to feeling of one's inner most self being validated, understood, and cared by another (Aron, Aron, & Smollen, 1992). French and Raven's (1959) classification of referent power can be compared to Aron et al.'s (1992) description of closeness and intimacy in the sense that all require a person to feel that having shared self-aspects with their partner is critical. Importantly, however, there are also key differences between French and Raven's (1959) conceptualization of referent power and Aron et al.'s (1992) conceptualization of interconnected selves. Aron et al. (1992) state that feelings of closeness, intimacy, and interconnected selves emerge when there is reciprocal self-disclosure between partners. This suggest that both individuals must acknowledge the other's feeling for closeness and intimacy, before interconnected selves emerge. By contrast, French and Raven (1959) explicitly state that an individual can give referent power to another without referent power being reciprocated; thus, one person can desire feelings of oneness with another independent of the desires for closeness that the other person feels. In the present work, we will define "referent power" as feelings of oneness as well as feelings of closeness.

## Belonging

Belonging is a basic human need. It calls for all aspects of the self to be acknowledged and appreciated by another to feel socially connected. Individuals who feel as though they belong demonstrate better mental and physical health (Baumeister & Leary, 1995), as well as higher levels of self-concept, self-esteem, motivation, and optimism (Walton & Cohen, 2007). The outcomes of belonging are also impactful within academic settings. Students who believe they belong have higher scholarly achievements, GPA, involvement, and motivation (Walton & Cohen, 2007).

**Belonging Uncertainty.** Members of marginalized groups often experience belonging uncertainty, or concerns about their social bonds and connectedness, that lead to members of marginalized groups to be more sensitive to issues regarding social belonging (Walton & Cohen, 2007). Belonging uncertainty can be felt in academia and professional settings alike. It takes a broad-based form where individuals who are experiencing belonging uncertainty have thoughts such as, "People like me do not belong here." (Walton & Cohen, 2007). The broadness of belonging uncertainty differentiates it from other similar topics like the fear of being stereotyped, perceived bias, and evaluative contexts. It is a concept that can be reinforced by a hypothesis rather than a belief. This means that members of marginalized groups will acknowledge instances that are consistent with the hypothesis that "I do not belong", while being skeptical of any evidence that is inconsistent (Walton & Cohen, 2007).

The presence of belonging uncertainty within a student's life can affect their performance. Prior research has shown that belonging uncertainty can directly affect intellectual achievements by reducing a student level of motivation as a result of not feeling socially connected to others. Students who are members of marginalized groups are at a higher chance of dropping out of school, having lower GPAs, not interacting with peers, and having fewer mentors due to being more at risk of feeling belonging uncertainty (Walton & Cohen, 2007).

## Group Prototypicality and Status

In a group, prototypic group members have higher status and are given power to keep them in the group (Emerson, 1962). In academics, professors, advisors, counselors, and lab managers all have higher status than undergraduate students. Each possesses legitimate power

due to their status. Professors and lab managers are able withhold knowledge (i.e. expert power) as well as punish and reward the students they engage with (i.e. coercive power and reward power) (French & Raven, 1959). Prior research has shown that status, like that of a professor's, can only be maintained if the individual is valued, appreciated, and held to high standard by others (Fragale, Overbeck, & Neale, 2011). High status individuals are then thought to possess the qualities of a prototypical member of their group. This notion comes from the previous research which states that members of groups who are highly prototypical are usually admired and trusted by others within the group. Prototypical group members set the standards for how members within their group must behave, as well as standards for those who are not members but would like to join (Barreto & Hogg, 2017).

**Overview of the Hypotheses and Research**

Given the foregoing points, we predicted that, because members of marginalized (vs. dominant) groups feel more belonging uncertainty in academic domains (Walton & Cohen, 2007), students who belong to marginalized (vs. dominant) groups are more motivated to give referent power to high-status others (Hypothesis 1). We also predicted that students who belong to marginalized (vs. dominant) group members are more attentive to cues in powerful others that suggest that a high-status other can be trusted and will validate their position in a given domain (Hypothesis 2). To test these hypotheses, students from marginalized groups [i.e., LGBTQ, African American, Latinx, low socioeconomic status (SES)] and dominant groups (White, straight, men) completed a questionnaire that asked questions about feelings of belonging, mentors, student empowerment, and traits believed to be important in mentors. If, as suggested by Hypothesis 1, students from marginalized (vs. dominant) groups are more motivated to give referent power, we expected that they would (1) report more concerns about belonging (replicating prior work, Walton & Cohen, 2007), (2) identify with a greater number of others, and (3) feel more self-other overlap with one's closest mentor. According to Hypothesis 2, we also expected students from marginalized (vs. dominant) groups to prefer that mentors (1) see and respect their unique skills and abilities, (2) understand their experiences as a marginalized group member including the pervasiveness of prejudice and discrimination, (3) has successfully help other similar to them belong in a given domain, and (4) has the ability to include.

## Methods

**Participants**

Participants (N=85) volunteered to participate in the study. When categorized by SES, 56 participants identified as having low SES (i.e. poor and working class) and 29 identified as having high SES (i.e. middle, upper-middle, upper, and wealthy class). When categorized by gender, 62 identified as female and 22 identified as male. We had 8 participants who identified as White males and 72 who did not. Participants' sexual orientation were as follows: asexual 2.4%, bisexual 12.9%, heterosexual 71.8%, homosexual 4.7%, pansexual/omnisexual 5.9%, and other 2.4%. Participants' race/ethnicity were as follows: Asian/Asian American 5.9%, Black/African American 12.9%, Latinx/Hispanic 20.0%, Pacific Islanders/Native Hawaiians 2.4%, Native American/Alaska Native 2.4%, White/European American 37.6%, and multiracial 21.2% Participants from marginalized groups (e.g., LGBTQA people, people of color, people with disabilities, and students from low SES backgrounds) were actively recruited through social

media outlets, academic listservs, and public flyers. Study participants used the appropriate link within the recruitment information.

## Measures

**Belonging.** Two scales were combined to measure belonging. The first scale was the Sense of Social and Academic Fit (SOSAF), which is a seven-point 17-item self-report survey (Walton & Cohen, 2007). The items in this scale were intended to measure one's sense of belonging in an academic setting. Scoring for the SOSAF ranges from 17-119. Scores higher than 68 indicated high levels of belong in an academic setting. The second scale was the Belonging Uncertainty (BU) scale, which is a seven-point 3-item self-report survey (Walton & Cohen, 2007). The three items on this scale measured feelings of belonging uncertainty within an academic setting. Scores that were lower than 12 indicated higher levels of belonging uncertainty (Appendix A).

**Mentors, Referent Power and Preferred Mentor Traits.** Participants completed two measures of referent power. First, participants identified the number of areas in which their current mentors worked. We then summed up the number of areas from which the participants recruited their mentors. Second, participants were asked to consider their most important mentor and completed the Inclusion of Other in the Self Scale (IOS). The IOS used seven pairs of circles that overlapped at varying degrees to signify levels of interpersonal closeness between another and the self (Aron, Aron, & Smollan, 1992). In addition, participants completed a 20-item survey indicating what traits a potential mentor should possess. Participants were asked to rate the importance of each trait when considering a potential mentor (e.g., 1 = extremely unimportant… 7 = extremely important) (Appendix B).

**Student Empowerment Scale.** We used a 16-item scale that was adapted from the Organizational Empowerment Scale (Mathews, Diaz, & Cole, 2002). The items on the scale measured participants' sense of power within an academic setting (Appendix C).

**Demographics.** Participants were given a questionnaire with questions regarding their university or college, gender, nationality, race/ethnicity, sexual orientation, religious preference, and social class. The answers within this section of the survey were used to identify marginalized group membership (Appendix D).

## Procedure

After logging on to the site with the survey, participants were prompted to the first page of the study which contained a consent form. They were asked to read over the form before continuing to the rest of the study; continuing onto the next page of the study implied consent.

Participants completed all experimental materials online. This included measures of belonging, the giving of referent power, the rating of cues that are looked for in mentors, student empowerment, and demographic information. Each measure is described above.

**Participant Grouping.** Based on the previous research, we developed three ways to divide participants into marginalized and dominant groups. Our first method categorized White males as being the dominant group and all other participants as the marginalized group. Past research has shown that White males are the least likely to face any form of discrimination within several domains. Our second method categorized participants by gender, with males being the dominant group and females being the marginalized group. Our third and final method used to categorize participants focused on socioeconomic status. Participants who identified as being

from families with middle, upper-middle, upper and wealthy incomes were categorized as the dominant group, while participants who identified as being from families with poor and working-class incomes were categorized as the marginalized group. We used contrast coding when coding for dominant (1) and marginalized (-1) group membership.

**Factor and Reliability Analysis.**

**Belonging.** The SOSAF and BU were combined and used to measure feelings of belonging. All items from the BU scale as well as five items from the SOSAF were reversed coded so higher scores on these items indicated higher levels of belonging. All items were loaded on one factor to create a new variable that measures overall feeling of belonging. Cronbach's alpha for all items in the belonging survey was shown to be .878

**Empowerment.** An adapted version of the Organizational Empowerment scale was used to measure student empowerment within an academic setting. Three items from this scale were reverse-coded to show that higher scores on these items indicated higher levels of empowerment. With the exception of two items that cross-loaded, all items were loaded on three factors to create three new variables. The names given to each variable indicated the subject focus of the items within the variable. The first variable included four items surrounding student choice and had a Cronbach's alpha of .675. The second variable included four items surrounding academic information and had a Cronbach's alpha of .601. The third variable included four items surrounding independent thinking and had a Cronbach's alpha of .521.

**Traits.** A 20-item survey was created to measure the importance of certain traits when a participant is considering a potential mentor. With the exception of three items that cross-loaded, all items were loaded onto four factors to create four new variables. The names given to each variable indicated the subject focus of the items within the variable. The first variable included six items surrounding experience with diverse populations and had a Cronbach's alpha of .804. The second variable included three items surrounding demographic information and had a Cronbach's alpha of .823. The third variable included four items surrounding status and had a Cronbach's alpha of .512. The fourth variable included four items surrounding knowledge and ethics and had a Cronbach's alpha of .550.

## Results

**Hypothesis 1**

To begin, we conducted a one-way between-participants Analyses of Variance (ANOVAs) to test whether feelings of belonging would be lower among marginalized group members than dominant group members (Walton & Cohen, 2007). However, we were unable to replicate these finding with statistical significance, although the means do suggest the aforementioned trend. Those with low SES reported lower feelings of belonging (mean=2.09) than those with higher SES (mean=5.11) but the difference was not significant (p=.983). Similarly, White males felt greater feelings of belonging (mean=5.19) than all other participants (mean=5.05), but the difference was not significant (p=.659). The lack of significant results was likely due to the small N. However, based on these results we estimated correlations to examine relations among variables independent of group status.

**Correlations.** A Pearson correlation was computed to assess the relationship between group type and: (1) feelings of belonging, (2) number of mentors, (3) referent power, and (4) feelings of empowerment. Several relationships were found between group type and different

variables. A significant relationship was found between group type (dominant defined as high SES and marginalized defined as low SES) and number of mentors (r = -.220, N=85, p=.043. ), such that participants who identified as having low SES also reported having more mentors We also found significant relationships between group type (dominant defined as high SES and marginalized defined as low SES) and our subscale of empowerment relating to student choice (r=.261, N=84, p=.017), as well as between gender and our subscale of empowerment relating to independent thinking (r=-.215, N=84, p=.049). Dominant (vs. marginalized) groups based on SES and women (vs. men) reported feeling more student empowerment in the ability to exercise independent choice. Additionally, we found significant relationships between number of mentors and referent power (r=.234, N=85, p=.031) such that those with more mentors reported greater feelings of self-other overlap with their closest mentor. Of greatest relevance to the notion that there are benefits to giving referent power, referent power was significantly associated with our subscale of empowerment relating to independent thinking (r=.329, N=85, p=.002); those with more mentors reported greater experiences of being encouraged to think independently.

**Hypothesis 2**

To understand how dominant and marginalized group members differ in rating the importance of various traits for a mentor we conducted a series of one-way between- participants ANOVAs. No significant effect of group membership existed for traits dealing with a mentor's experience with diverse populations [SES: F(1, 79) =.03, p=.868; gender: F(1, 79) =.321, p=.573; White men vs. all: F(1, 79) =1.77, p=.188]. No significant effect of group membership existed for traits dealing with a mentor's demographic information [SES: F(1, 80) =.631, p=.429; gender: F(1, 80) =.107, p=.744; White men vs. all: F(1, 80) =1.21, p=.275]. No significant effect of group membership existed for traits dealing with a mentor's status [SES: F(1, 80) =.43, p=.514; gender: F(1, 80) =.273, p=.103; White men vs. all: F(1, 80) =1.53, p=.220]. No significant effect of group membership existed for traits dealing with a mentor's knowledge and ethics [SES: F(1, 80) =.69, p=.409; gender: F(1, 80) =.96, p=.331; White men vs. all: F(1, 80) =1.47, p=.229]. Based on these findings, we conducted an exploratory correlation to see if a relationship existed between traits and other variables.

**Correlations.** A Pearson correlation was computed to assess the relationship between group type and a mentor's: (1) experience with diverse populations, (2) demographic information, (3) status, and (4) knowledge and ethics. Correlations also examined the relationship between trait variables, feelings of belonging, feelings of empowerment, number of mentors, and referent power. Several relationships were found. Significant relationships were found between group type (White men vs. all) and experience with diverse populations (r=-.266, N=79, p=.018); marginalized group members gave more importance to experiences. There was also a correlation between group type (White men vs. all) and demographic information (r=-.265, N=80, p=.018) indicating that being a member of a marginalized group is associated with greater importance being ascribed to having a mentor who shares demographic backgrounds. We also found a significant relationship between gender group type (males vs. females) and demographic information (r=-.217, N=84, p=.047), as well as a significant relation between gender group type (males vs. females) and status (r=-.234, N=84, p=.032); being marginalized group member is associated with greater reported importance of a mentor's status. A significant relationship was also found between demographic information and feelings of belonging (r=.-322, N=84, p=.003), such that the reported importance having a mentor who shares a demographics background is related to higher levels of belonging as well as status and our subscale of empowerment relating

to student choice (r=.349, N=84, p=.001). This shows individuals who see status as an important trait of their mentors feel they have more choice. There was also a significant relationship between diversity and number of mentors (r=.234, N=84, p=.032), suggesting that those with more mentors also rated more importance on traits relating to diversity.

## Discussion

The purpose of this study was to examine whether members of marginalized groups were more motivated than members of dominant groups to give high-status others referent power to appease belonging uncertainty. We were also interested in examining whether members of marginalized (vs dominant) groups were more attentive to cues that suggested that a high-power other could be trusted to validate their position within a given domain.

Our results showed that when the dominant group is defined as middle, upper-middle, upper, and wealthy class and marginalized group is defined as poor and working class, marginalized group member report having more mentors than dominant group members. These results are consistent with our hypothesis. We believed that to appease belonging uncertainty, marginalized groups are more likely to identify with more mentors. Having a higher number of mentors allows students to learn about the qualities needed to become a prototypical group member to join the groups their already mentors belong to.

Our results also found that when the dominant group and marginalized groups were defined in these same forms, marginalized group members reported feeling lower levels of empowerment relating to student choice. We predicted that marginalized group members would feel less power regarding academic lives. This notion stems from the thought that students who feel like they belong within their academic domains will feel more empowered to make decisions. Several prior studies have shown that marginalized group members are more likely than dominant group to feel like they don't belong with in academia.

When we defined the dominant group as male and the marginalized group as female we found that female participants reported feeling higher levels of empowerment relating to independent thinking. These results were inconsistent with our predications and could be due to the limitations of our study. Our sample size included a disproportionate number of females to males, with female being the majority. These disparity in gender could have resulted in inaccurate results. Future research should seek to recruit equal numbers of men and women, within each ethnic group and socio-economic status group.

Consistent with the notion that the motivation to give referent power would manifest both in students having more mentors and having more self-overlap with their closet mentor, results of our study showed there to be a positive correlation between the numbers of mentors a student has and the amount of referent power they give. Importantly, this did not differ for marginalized and dominant groups, given that we failed to replicate the prior finding that marginalized group members experience more belonging uncertainty in academics than do dominant group members. But this finding does suggest a relationship between our different variables that were conceived of as measures of the motivation to give referent power.

Of greater relevance to the potential benefits of giving referent power, our results also showed that a positive correlation between the amounts of referent power a student gives and feeling higher levels of empowerment relating to independent thinking. These benefits are not group specific; rather they point to the importance of mentors for all.

The results of our correlations show a relationship between group member type and the traits a mentor possesses. However, the ANOVAs performed on these variables did not show a statistically significant difference. The relationships indicated by the correlation, specifically, suggest marginalized group members prioritize diversity, demographic, and status based traits compared to dominant group members. As suggested previously, future research should seek equal participation within participants who identify as dominant group members and participants who identify as marginalized group members to better evaluate these relationships.

Participants who gave high ratings to their mentors' status also reported high feelings of empowerment regarding student choice. By our definition, a mentor's status is composed of open-mindedness, eagerness to teach mentees, willingness to work with mentees through challenges, and how well-known they are within their domain. This would suggest that participants who place high importance on their mentor having high status feel more empowered to make decisions regarding their academic careers than participants who do not place high importance on their mentor having high status. These findings are important to note because they suggest that a mentor's behavior, instead of their physical traits (i.e. having similar demographics and being from a similar background), is what leads to a mentee feeling more empowered. Future research should look to explore the relationship between mentor status and mentee empowerment.

Importantly, however, the results reported here are preliminary, as data collection is ongoing. As a result, the current number of participants is likely too small to provide reliable tests of our predictions. Thus, although our results did not replicate prior findings, the outcome of our preliminary analysis points to important potential relations to be fully tested and explained in future research and a complete population of participants; this will allow for critical tests of the relations between marginalized groups, belonging, and referent power. The relationship which is shown to exist within empowerment and several group types should be further studied for better understanding. Future studies should recruit equal numbers of dominant group members and marginalized group members to further explore the relationship between group types, belonging, and referent power.

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## Appendix A

**Belonging:**
Please answer the following questions about *what [school name] is like for you.* Indicate the extent to which you agree or disagree with each statement using scale below. Please use the whole range of each scale.

**Scale:**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Strongly Disagree | Disagree | Moderately Disagree | Neutral | Moderately Agree | Agree | Strongly Agree |

1) Sometimes I feel that I belong at [school name], and sometimes I feel that I don't belong at [school name].
2) When something good happens, I feel that I really belong at [school name].
3) When something bad happens, I feel that maybe I don't belong at [school name].
4) People at [school name] accept me.
5) I feel like an outsider at [school name].
6) Other people understand more than I do about what is going on at [school name].
7) I think in the same way as do people who do well at [school name].
8) It is a mystery to me how [school name] works.
9) I feel alienated from [school name].
10) I fit in well at [school name].
11) I am similar to kind of people who succeed at [school name].
12) I know what kind of people [school name] professor are.
13) I get along well with people at [school name].
14) I belong at [school name].
15) I know how to do well at [school name].
16) I do <u>not</u> know what I would need to do make a [school name] professor like me.
17) I feel comfortable at [school name].
18) People at [school name] like me.
19) If I wanted to, I could potentially do very well at [school name].
20) People at [school name] are a lot like me.

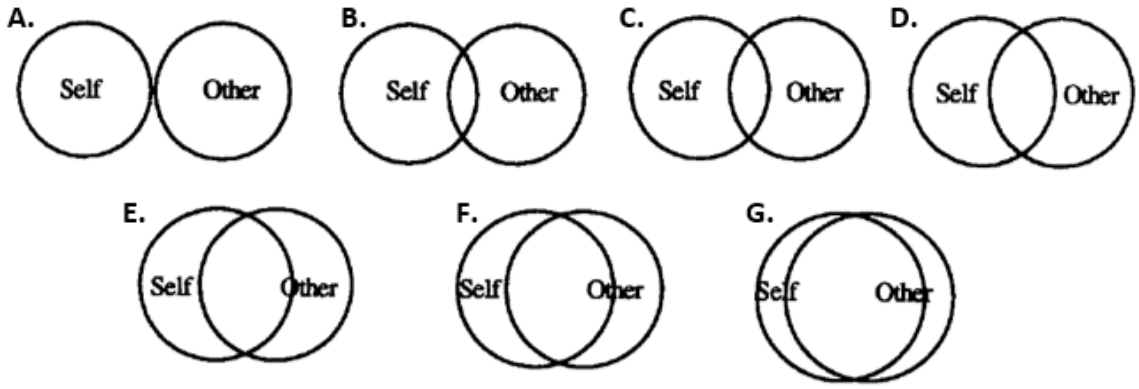
## Appendix B

**Referent Power:**
Pleases answer the following question.
NOTE: For the purpose of this study, a mentor is considered to be "an experienced person in a company or educational institution who trains and counsels employees or students".

Please think about all of your mentors, or people who you go to for advice and counsel. Indicate the roles or formal positions that your current mentors hold (select all that apply).

- Adviser
- Counselor
- Professor
- Lab Manager
- Alumnus/Alumna
- Graduate Student
- Peer

**Consider the most important mentor that you have. This is the person to whom you go to most often for advice and whose opinions are most influential. Please select which pair of circles best describes your relationship with your mentor. (e.g., Overlapping between circles signifies your mentor's influence on you.)**




**When you seek out a mentor, how important is it that your potential mentor have the following traits.**

1. **Well-known and respected within their specific domain**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely | Unimportant | Somewhat | Neutral | Somewhat | Important | Extremely |

unimportant unimportant important important

2. **Knowledgeable in their specific domain**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

3. **Reliable**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

4. **Has experience mentoring students from diverse backgrounds**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

5. **Honest**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

6. **Willing to work with you through challenges**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

7. **Is the same gender as you**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

8. **Is eager to teach you the skills needed to succeed in their domain of expertise**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

9. **Open-minded**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

**10. Is the same race/ethnicity as you**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

**11. Actively listens to your concerns and challenges**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

**12. Respects you**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

**13. Has access to useful resources**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

**14. Is the same sexual orientation as you**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

**15. Understands the experiences of people from your background**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

**16. Empathetic**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

**17. Shares similar political views as you**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

**18. Experience mentoring students with similar backgrounds to your own**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

**19. Is interested in your opinions**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

**20. Trusts your judgment**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely unimportant | Unimportant | Somewhat unimportant | Neutral | Somewhat important | Important | Extremely important |

## Appendix C

**Student Empowerment Scale:**
Please answer the following questions. Indicate the extent to which you agree or disagree with each statement using scale below. Please use the whole range of each scale.

**Scale:**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Strongly Disagree | Disagree | Moderately Disagree | Neutral | Moderately Agree | Agree | Strongly Agree |

1) Students do not provide reviews of their mentors.
2) My mentor provides information on how academic goals can be achieved.
3) Students have a say in changing academic plans.
4) Students have discretion in how they prioritize their work.
5) My mentor does not encourage risk taking with regard to work production.
6) My mentor appreciates "thinking out of the box" behavior.
7) My mentor provided information on what we want to accomplish together in the future.
8) Students have a say in defining their research responsibilities.
9) Students have a say in the mentors to whom they may turn to for guidance.
10) My mentor provides students with information about academics.
11) While performing academic duties, students are not encouraged to use independent problem-solving skills.
12) Students have access to the information in their personal performance-files.
13) My mentor provides information on the reward structure in academia.
14) My mentor has established professional guidelines.
15) Students have a say in setting their own academic goals.

## Appendix D

**Please provide some basic information about yourself by responding to the following items:**

- What kind of institution do you attend?
  - Four year public university
  - Four year private university or college
  - Two year public college or technical institute
  - Two year private college or technical institute

- You are an _____ American Student _____ International Student

- What is your gender?
  - Female
    - Biologically born female
    - Transgender Female
  - Male
    - Biologically born male
    - Transgender Male
  - Non-binary/Queer
  - Not listed
  - Prefer not to answer

- What is your race/ethnicity? (pick all that apply)
  - Asian/Asian American
  - Black/African American
  - Hispanic/Latinx/Latinx American
  - Pacific Islander/Native Hawaiian
  - Native American/ Alaska Native
  - White/European American

- What is your sexual orientation?
  - Asexual
  - Bisexual
  - Heterosexual
  - Homosexual
  - Pansexual/omnisexual
  - Other non-listed sexual orientation

- Religious Preference
  - Buddhist
  - Hindu
  - Jewish
  - Mormon
  - Muslim

- Christian
- Atheist
- Agnostic
- Other _____

- How would you describe the yearly income of your family of origin?
  - Poor
  - Working class
  - Middle class
  - Upper-middle class
  - Upper class
  - Wealthy class

# *Household Tasks and Academic Functioning Among African American Adolescents*

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*Abstract*

Academic functioning has been a focus of substantial research because it is essential for youth's future. Grounded in an ecological perspective that daily molar activities shape youth development, I examined the association between academic functioning and *time spent* performing household tasks among 344 African American adolescents age 10 to 18 ($M_{age}$ = 12.23, *SD* = 2.50). I also tested if the association between academic functioning and time spent performing household tasks differs for boys and girls. In home interviews, adolescents completed questionnaires about their school experiences (school self-esteem and school trouble), and mothers reported adolescents' report card grades. Adolescents reported the amount of time they spent performing household tasks in a series of 7 nightly phone interviews. Results showed that adolescents who spent more time performing household tasks reported more school trouble and lower GPA; however, these associations did not differ for boys versus girls. Conversely, time spent performing household tasks was not significantly related to school self-esteem for either boys or girls. These findings highlight the role of family responsibilities in understanding academic functioning among African American adolescents.

*Keywords:* African American adolescents; academic functioning; household tasks

## Introduction

Academic success is important for youth because it prepares them for their future careers. It is also a significant social issue: when students do not excel in school by doing well on exams and earning good grades, then their opportunities, including attending college and finding good jobs, will be limited. Unfortunately, there are several students in the United States who are at risk for not reaching their full academic potential. During adolescence, many youth experience declines in their academic functioning (Dotterer, McHale, & Crouter, 2009), which includes their school engagement and academic achievement. In particular, African American adolescents appear to be less engaged in school than youth from other racial and ethnic groups (Ainsworth-Darnell & Downey, 1998). They also tend to have lower performances in the classroom than their White peers. Prior research suggests that there are many factors associated with African American youth's academic functioning including their experiences with teachers and lack of educational resources such as books and other necessary school supplies (Chesmore, Winston, &

Brady, 2015). Although many different factors contribute to African American adolescents' academic functioning, it is important to understand whether and how their experiences at home are related to their academic functioning because home and school is where youth spend most of their time, and these two settings are closest to the child.

Indeed, a large body of work focuses on links between the home environment and academic outcomes and has established that home-school connections have implications for youth's achievement. For example, Louque and Latunde (2014) found that when African American families were engaged in the school setting by attending school events and workshops, youth experienced greater academic success. Additionally, one study showed that parental-school involvement was associated with adolescents' achievement and future aspirations across both middle school and high school (Hill & Taylor, 2004). Nonetheless, it is most important to understand youths' experience in the home and how it is related to their academic functioning. These experiences can include the quality of their relationships with their parents, as well as parental monitoring. For example, a study by Lowe and Dotterer (2013) found that youth were less likely to have behavioral problems at school when they felt high levels of their mother's warmth. This study also found that parental monitoring was also associated with better academic outcomes. Adolescents had higher levels of school self-esteem when their parents were aware of their activities and whereabouts (Lowe & Dotterer, 2013). If youth and their parents are building positive relationships at home, youth will have greater academic outcomes in school such as getting along with their teachers and peers, as well as doing well on school assignments like homework and exams. Positive relationships with parents in the home can promote competence and autonomy within the home which then becomes internalized and used in other settings like school (Furrer & Skinner, 2003).

The current study extends the literature on the role of connections between families and schools in adolescents' academic functioning to examine one domain of family life that has received limited attention, and that is adolescents' household responsibilities. The literature on youths' involvement in household tasks suggests that parents may see household tasks as a way for their children to become contributing members of the household and a way to prepare youth for their future (Dunn, Magalhaes, & Mancini, 2014). Task involvement, however, places time demands on youth and can create problems in the home such as conflict between parents and their children that may arise when youth are resistant to doing these tasks (Lam, Greene, & McHale, 2016). A study by Mandara and colleagues (2009), for example, found that African American parents gave their adolescents more household tasks than European American parents; they also had more arguments with their adolescents about rules than did European American parents (Mandara, Varner, Greene, & Richman, 2009). These authors argued that demanding family responsibilities and the parenting practices of African American families may contribute to the Black-White student achievement gap. In the current study, I built on this work, first, by using a finer-grained approach to measuring youth's task involvement. Specifically, I relied on a daily diary data collection method to assess the amount of time youth spent on household tasks each day, moving beyond the more global (yes/no) approach used by Mandara et. al. (2009). In addition, moving beyond an exclusive focus on school grades and academic achievement, I examined the links between time spent performing household tasks and three domains of academic functioning: performance (grades), affective (school self-esteem) and behavioral (school trouble).

## Theoretical Perspectives

This study was grounded in an ecological perspective which highlights the significance of daily molar activities, that is, regular daily activities that are perceived as having meaning or intent by individuals in a particular setting and are thought to shape and be shaped by youth development (Bronfenbrenner & Crouter, 1983). Positive development, for example, may depend on whether youth spend their time learning new skills or engaging in passive leisure (e.g. watching television). These molar activities can include time spent doing homework as well as time spent doing household tasks. In Bronfenbrenner's ecological model, the microsystem refers to the contexts of individuals' daily lives, and for most youth, this includes family and school. At the next level of ecology is the mesosystem, which refers to the connection between the microsystem settings of everyday life. From this perspective, youth's daily household tasks can be related to their academic outcomes because spending more time on household tasks may limit the time youth have to be involved in school related activities.

## Household Tasks in African American Families

Across many cultures, household tasks are viewed as an obligation and a daily requirement for adolescents (Hardway & Fuligni, 2006). Chores are common in the United States for children beginning at age 9, and these tasks average about 7 hours per week (Riggio, Valenzuela, & Weiser, 2010). Household tasks are communal and done in many homes to increase social participation and skills in youth. Children are given specific household duties to complete, and these duties tend to be significantly greater when both parents, especially mothers, are in the workforce full-time (Romich, 2007). For many adolescents, especially those who have parents who are employed, housework is typically an after-school responsibility. Caregivers expect children to assume more household tasks as they age (Rogoff, 2003). These tasks can include cleaning their rooms, taking out the trash, washing the dishes, and caring for younger siblings or elderly family members (Berridge & Romich, 2011). Household tasks are one of many ways that youth make important contributions to their families (Raley, 2006).

Several studies show that youth from poorer homes with single-employed mothers are more likely to engage in chores than youth from wealthier homes (Riggio et. al., 2009). In one study, it was shown that youth from low income families developed adult-like roles that were necessary to meet their family's daily needs (Burton, 2007). These adult-like roles include preparing meals and frequent care for siblings and elderly family members. Families that are economically disadvantaged may not have access to child-care, which will then lead them to rely on their oldest to care for their youngest (East, Weisner, & Reyes, 2006). Parents with minimum-wage jobs may have to work many hours and multiple jobs in order to make enough money to provide for their family. As a result, children assume more household responsibilities when their parents have to put in more hours at work (Burton, 2007).

The existing literature suggests that household tasks play a significant part of the in-home daily activities of African American children. African American families tend to have an egalitarian household where the division of labor is equally distributed among family members by appropriate age and development (Kamo & Cohen, 1998). A study by Smetana and colleagues found that African American mothers view household tasks as responsibilities that should be completed by both boys and girls (Smetana, Daddis, & Chuang, 2003). African American families may also use household tasks as a way to prepare their children for the world of work. Research show that family socialization of African American children into the world of work occurs within the context of several employment-related disadvantages (McLoyd, 2011). Thus, by giving their children responsibilities in the home, African American parents may

provide them with skills such as responsibility and independence that will help them when they enter the workforce. Even though parents may believe that giving their children household tasks will benefit them, the amount of time youth spend doing household tasks might actually have a negative influence on their schooling because it can take away time spent doing homework and studying. This study explores the relation between time spent performing household tasks and the academic functioning of African American adolescents.

**Gender Differences in Household Tasks**

Girls spend more time in household tasks than boys do, despite economic development or schooling. This practice may stem from the traditional belief that women are meant to be homemakers while men are head of the household and the "breadwinner" of the family. The increased responsibility placed on daughters is viewed as normative because daughters tend to identify with their mothers and household tasks are normally seen as "women's work" (Crouter, Head, Bumpus, & McHale, 2001). Mothers typically perform the largest share of household tasks, so they rely on their daughters to keep the home and family running smoothly while they are at work (Crouter et. al., 2001). Another reason why girls may assume more responsibility in the home is because gendered division of labor begins early on in life with girls doing more household tasks than boys from childhood and throughout adolescence (Berridge & Romich, 2011).

Household tasks are considered a structured activity for adolescents to engage in. However, the amount of time youth spend cooking, washing dishes, cleaning, and other tasks may take away time and energy from academic activities like doing homework and studying for exams. Mandara and colleagues (2009) found that when parents did not burden adolescents with excessive amounts of household chores, adolescents tended to score higher on exams. Nevertheless, there were several limitations in this study because their measures of household tasks consisted mainly of yes/no responses. Further, Mandara and colleagues' study was limited because they focused only on academic achievement using standardized test scores. School experience is multidimensional and can include other elements such as how the student feels about his/her school, and how often the student gets into trouble with school authority. These domains are important to examine because youths' overall academic success does not only depend on their grades, but it also depends on their school engagement and daily experiences.

**Household Tasks and Academic Achievement: Gender as a Moderator**

Despite gains in academic achievement, on average, African American adolescents still face educational barriers that put them behind their White and Asian peers. However, there are gender differences in school outcomes. In general, African American boys lag behind African American girls in many academic domains (Louque & Latunde, 2014). African American girls are more academically successful than African American boys and have higher grades and test scores (Mickelson & Greene, 2006). The achievement gap between African American girls and boys may be, at least in part, the result of parents' socialization. Although prior research showed that African American parents have egalitarian households, some work also suggests that African American mothers tend to "love their sons and raise their daughters" (Mandara, Varner, & Richman, 2010). This suggest that girls are given more responsibilities and are expected to have higher educational achievement than boys. Less may be expected from boys, so if they do have more household responsibilities, they may not know how to balance the tasks given and their school work. Therefore, household tasks may have fewer negative effects on girls than boys.

## The Current Study

In sum, the purpose of the current study was to contribute to the literature on the role of family experiences in African American adolescent's academic achievement by examining the relation between the amount of time youth spend performing household tasks and youth's academic functioning. More specifically, I tested whether time spent performing household tasks was related to school self-esteem, school trouble, and academic achievement, as measured by GPA. I also tested whether gender moderated the association between time spent on household tasks and academic functioning. I hypothesized that youth who spent more time performing household tasks would exhibit poorer academic functioning. Furthermore, I hypothesized that the relation between time spent performing household tasks and academic functioning would be stronger for boys than girls.

# Method

## Participants

Data were collected from 344 adolescents from 173 families who participated in the first phase of a longitudinal study of gender socialization and development in two-parent, Black/African American families. Families who self-identified as Black or African American, and had at least two middle-childhood and/or adolescent aged children, were recruited from urban and suburban communities in the mid-Atlantic region of the United States with large populations of African Americans. There were two strategies used to recruit these families. First, African American individuals who lived in the targeted communities were hired to recruit other families by posting flyers, providing information on the study in local churches, stores and other community sites, and handing out flyers at youth activities. Interested families contacted the project. The second recruitment strategy involved purchasing a marketing list that included names and addresses of African American students in grades 4 to 12. These families were telephoned and asked to participate.

## Procedures

Of the original 202 families originally recruited into the study, families in which parents were not in a couple relationship were excluded from the study (e.g., mother and grandfather were the parent figures; $n = 7$) and parents who were no longer married ($n = 7$). In addition, because the focus of the current study is on the school functioning of adolescents, we limited the sample to youth in grades 4-12. Families were interviewed by a team of two interviewers who were mostly African American. For children under 13 and family members with reading difficulties, all questions were presented orally. The second data collection procedure consisted of seven nightly telephone interviews with adolescents and their parents to obtain information about their daily activities. During each of these calls, youth reported on the activities they were involved in outside of school hours during the day of the call, the individuals who were involved in the activities, and how long each activity lasted. After completion of these interviews, families were sent a $200 honorarium.

## Measures

*School trouble* was measured using 4 items from a scale developed for the National Longitudinal Study of Adolescent to Adult Health (Add Health). Adolescents rated statements about how often they had trouble in school (e.g., paying attention in school or getting homework done) using a 1 to 5 scale (*1* = "never" and *5* = "every day"). Items were averaged to create an overall score of school trouble. Cronbach's alphas were .88 and .87 for older and younger siblings respectively, with higher scores meaning higher reliability.

*School self-esteem* was measured with ten items from the school subscale of the Hare Area-Specific Self-Esteem Scale (Hare, 1996). Items were averaged to create an overall score of school self-esteem. Students rated items about how they felt in school using a 4-point Likert scale ranging from *1* = strongly disagree to *4* = strongly agree. Higher scores on this scale represent greater school self-esteem (e.g., "school has been harder for me than for most people"). Cronbach's alphas were .75 and .72 for younger and older siblings.

*Grade-point average* was calculated from mothers' report of youth's grades in math, science, social studies, and language arts. Letter grades were assigned numerical scores (A = 4, B = 3, C = 2, D = 1, and E = 0) such that higher scores indicated higher grades.

*Time spent on household tasks* was assessed from the phone interview data. Youth reported the amount of time spent (in minutes) completing 16 household tasks (e.g., cleaning, sibling care, elderly care, laundry, doing the dishes, cooking, and shopping for food). I controlled for parent's education, birth order, and family income which were also collected from parents in the home interview.

## Results

Table 1 shows descriptive statistics that were computed for adolescents' time spent on household tasks and their academic functioning. Adolescents spent an average 254 minutes on household tasks over the course of 7 days ($M$ = 253.89, $SD$ = 196.87). According to an independent samples $t$ test, there was a marginally significant difference in the amounts of time boys ($M$ = 235.1, $SD$ = 202.2) and girls ($M$ = 272.0, $SD$ = 189.4) spent performing household tasks, $t(324) = 1.70$, $p$ = 09. An examination of adolescents' school engagement showed that youth scored above the midpoints on *school trouble* ($M$ = 3.30, $SD$ = 1.35), and *school self-esteem (*$M$ = 3.13, $SD$ = 0.46). In addition, students earned an average *GPA* of 2.80 ($M$ = 2.80, $SD$ = 0.78) on a 5-point scale. Table 2 shows the correlation between descriptive statistics.

**Relation between Household Tasks and Academic Functioning**

*School trouble*. Results from the model examining the relation between household tasks and school trouble showed that time spent performing household tasks was positively related to school trouble ($\gamma$ = .08, $SE$ = 0.04, $p$ = .03). However, gender did not moderate the association between household tasks and school trouble ($\gamma$ = .02, $SE$ = .15, $p$ = .90). In addition, there was no direct relation between gender and school trouble ($\gamma$ = -.03, $SE$ = .07, $p$ = .97).

*GPA*. There was a trend level effect for the relation between household tasks and GPA such that youth who spent more time spent performing household tasks earned lower grades in school ($\gamma$ = -.05, $SE$ = .02, , $p$ = .07). A positive effect for gender indicated that girls had higher grades than boys ($\gamma$ = -.18, $SE$ = .09, $p$ = .03), but gender did not moderate the association between household tasks and GPA ($\gamma$ = .09, $SE$ = .03, $p$ = .84).

*School self-esteem*. No significant association between household tasks and school self-esteem emerged ($\gamma$ = .03, $SE$ = .01, $p$ = .12), and gender did not moderate the association between household tasks and school self- esteem ($\gamma$ = -.03, $SE$ = .03, $p$ = .24). Among covariates, a positive effect for birth order indicated that younger children reported having higher school self-esteem than older children ($\gamma$ = .11, $SE$ = .05, $p$ = .03), but there were no significant gender differences ($\gamma$ = -.03, $SE$ = .05, $p$ = .60).

## Discussion

The primary purpose of this study was to examine whether time spent on household tasks was linked to academic functioning of African American youth. It is important to understand academic success in African American adolescents, because education brings opportunities and resources such as better paying jobs and greater financial stability, and those opportunities can alleviate some of the problems that are rampant in many African American communities. Although a prior study examined the relation between household tasks and academic outcomes among African American youth (e.g., Mandara et. al., 2009), the study was limited because there was an exclusive focus on academic achievement (i.e., test scores) rather than on school engagement more generally. Results from the present study indicated that there was a positive association between time spent performing household tasks and school trouble, and a trend for the link between household tasks and GPA. Inconsistent with my hypothesis, however, gender did not moderate these relations. In addition, there was no significant association between the amount of time that youth spent on household tasks and school self-esteem for either boys or girls. Below I discuss the academic functioning of these youths as measured by school trouble, school self-esteem and academic achievement.

Youth scored above the midpoint for school trouble meaning that they reported having trouble paying attention in school, getting homework done, and getting along with teachers and peers. They also scored above the midpoint for school self-esteem, meaning that overall, they felt good about their school experiences. Additionally, the students earned an average GPA of a solid C+. Consistent with previous literature on African American families, no gender differences emerged in school self-esteem or school trouble, and there was no significant difference in the amount of time spent boys and girls spent on household tasks. This finding is consistent with previous research suggesting that African American families have egalitarian households and both boys and girls are expected to engage in these household tasks (Kamo & Cohen, 1998).

Consistent with previous research by Mandara, et. al. (2009), I found that time spent performing household tasks was negatively related, at trend level, to academic achievement as measured by GPA. Also, constant with Bronfenbrenner's ecological model (Bronfenbrenner & Crouter, 1983), if youth are spending more time in household tasks, they may be spending less time in school-related activities such as studying or doing school assignments, which could have a negative impact on their GPA. Nonetheless, these findings do not suggest that youth should not engage in household tasks; rather it may suggest that too much time spent on other tasks like home responsibilities can take away time that youth may spend on school-related activities in the home. Prior research showed a positive association between household responsibilities and self-reliance and responsibility (Blair, 1992).

Other studies have looked at the relation between household tasks and academic achievement and found that when youth had excessive amounts of household tasks, they scored lower on exams (Mandara et. al., 2009). Moving beyond prior research, however, I found that time spent on household tasks was also related to school trouble, though not to school self-esteem. That is, time spent on household tasks was related to youth having more problems with getting homework done, paying attention in school, and getting along with teachers and peers but not problems with fitting into their school's setting or feeling important in their classes. A reason that African American adolescents had more school trouble when they spent more time performing household tasks may be that they already experience racial discrimination at school (Kurtz-Costes, Swinton, & Skinner, 2014), and the added stress of time demands at home puts

them at risk of not being academically successful when they are not able to get their homework done or pay attention in school. Time spent on household tasks may not relate to school self-esteem because, consistent with previous research, African American adolescents have strong school attachment and overall feel good about their school experiences and are thus protected from self-esteem problems (Sirin & Rogers-Sirin, 2004).

**Limitations and Directions for Future Study**

It is important that future research build on the literature about home-school connections for African American youth's academic functioning because positive and strong connections may lead to greater academic success. Despite the contributions of this study to the literature on the academic functioning of African American youth, there are several limitations. First, other potentially important factors were not assessed that could moderate the relation between household task and academic functioning. For instance, parent-youth conflict about household tasks may strengthen or weaken the relation because youth who have more conflict with their parents may be resistant to doing tasks as a form of rebellion.

In addition, youth familism values could also moderate the relation between time spent performing household tasks and youth's academic functioning. One study showed that the average time spent on household tasks was positively related to depressive symptoms when youth had low familism values (Lam, et. al., 2016). Youth who do not perceive family activities as important or valuable may have negative attitudes toward household tasks which could strengthen the negative relation between time spent performing household tasks and academic outcomes. Another limitation of my study was that I examined time spent performing household tasks at only one time point. The amount of time that youth spend on household tasks varies across adolescence. For example, prior research reported that time spent on household tasks increased from middle childhood to early adolescence (Raley, 2006), then leveled off after mid-adolescence (Hilbrecht, Zuzanek, & Mannell, 2008). Thus, measuring time spent on household tasks at one point in time may not accurately capture youth's experience. In addition, testing the relation between time spent on household tasks and academic functioning using data collected at only one time point makes it impossible to draw conclusions about directions of effects. For example, if youth have low GPAs, their parents might discipline them by requiring more household responsibilities.

To better understand the relation between academic functioning and time spent performing household tasks, future studies should also examine curvilinear relations between task time and academic functioning. It may be that both too little and too much time spent on household tasks is problematic, so future studies should determine whether a moderate amount of time is optimal. Consistent with Bronfenbrenner's theoretical perspective on molar activities, future studies should also examine the quality and meaning of these household tasks rather than just the amount of time. For example, caring for a younger sibling or an elderly family member may be a more meaningful contribution to the family than just washing dishes or taking out the garbage. Tasks may have different implications for youth development and their academic functioning because if youth are engaging in activities that are more important for their family well-being, then the quality of their school work and school behavior may be more positive. Furthermore, to maximize the academic success of African American adolescents, future researchers need to continue to build on the literature on their academic functioning rather than their academic achievement, because it is important to understand their school experiences and not just their grades and test scores. School experience does not only include academic

achievement, it also includes youth's behavior in the classroom setting and feelings about their school performance and school abilities.

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Table 1.

*Descriptive Statistics for Study Variables*

| Variables | Mean | *SD* |
|---|---|---|
| GPA | 2.80 | 0.78 |
| School trouble | 3.30 | 1.35 |
| School self-esteem | 3.12 | 0.46 |
| Household tasks | 253.89 | 196.87 |
| Mother's education | 14.65 | 1.83 |
| Father's education | 14.32 | 2.30 |
| Family income | $90807 | $57797 |

Table 2.

*Correlations between Study Variables*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1. GPA | | | | | | | | | |
| 2. School trouble | .19 | | | | | | | | |
| 3. School self-esteem | .01** | .02 | | | | | | | |
| 4. Household tasks | .03 | .06 | .42 | | | | | | |
| 5. Family income | .01 | .25 | .06 | .25 | | | | | |
| 6. Mother's education | .06 | .41 | .87 | .01 | .01** | | | | |
| 7. Father's education | .01* | .25 | .08 | .31 | .01** | .01** | | | |
| 8. Gender | .03 | .74 | .78 | .10 | .95 | .67 | .39 | | |
| 9. Birth order | .03 | .01** | .02 | .01** | .69 | .80 | .69 | .19 | |

*Note.* *=p <.01;** p <.001