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On the Cover: Devin Petersohn visualizing his McNair research and consulting with his mentor.

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Message from the Director

t is with great pride that I introduce this outstanding collection of articles from the 2015-16 participants of the MU McNair Scholars Program. The papers presented here represent the culmination of a year's worth of research and scholarly activity. They reflect the energy, creativity and effort of the scholars, themselves, as well as the careful guidance, support and diligence of their faculty mentors. Six very diverse topics are explored and reported in their entirety within this interdisciplinary journal. While their subject matter and journalistic styles may differ, they, along with the other McNair Scholars listed in this publication, are to be commended for their persistence and dedication to this rigorous undergraduate research experience that will benefit them greatly in their pursuits of graduate studies.

Since 1989, the McNair Program has been a Universitywide effort that continues to attract students and faculty mentors from a variety of academic departments and fields of inquiry. Students have had the opportunity to learn about the importance of earning an advanced degree, while gaining the skills and tools that will guide them through their future academic journeys. The program proudly bears the name of astronaut and scientist, Dr. Ronald E. McNair, who died in the Challenger explosion in 1986. His accomplishments and high standards set an outstanding example for these developing scholars.

am truly honored to be associated with an initiative such as this. So many faculty, staff and administrative members of the MU community have worked to ensure a supportive and cohesive environment that prepares these exceptional students for graduate programs. We are proud to highlight the work of these talented young researchers, in this, the twentieth edition of the MU McNair Journal. Our best wishes go out to all of them as they continue to move along their scholastic continuum.

NaTashua Davis, PhD Director McNair Scholars Program

The McNair Scholars Program

BACKGROUND

College students who are considering study beyond the baccalaureate level realize their dreams through the McNair Scholars Program at the University of Missouri-Columbia (MU). MU was one of the original fourteen universities selected to develop a program established by the U.S. Department of Education and named for astronaut and Challenger crew member Ronald E. McNair. The purpose of the program is to provide enriching experiences that prepare eligible students for doctoral study.

PROGRAM ELEMENTS

One of the most exciting aspects of the McNair Scholars Program is the opportunity for junior or senior undergraduate students to participate in research experiences. McNair Scholars receive stipends to conduct research and engage in other scholarly activities with faculty mentors from the areas in which they hope to pursue graduate study. These research internships are either for the academic year or for the summer session and are under the supervision of faculty mentors. For academic year internships, students work a minimum of ten hours per week during the fall and winter semesters. Summer interns work full-time for eight weeks.

McNair Scholars also attend professional conferences with their mentors, go to graduate school fairs, prepare for graduate school entrance exams, receive guidance through the graduate school application process and obtain information on securing fellowships, graduate assistantships, and loans. Participants learn about graduate school life, advanced library skills, and effective ways to present their work. At the completion of the research internships at MU, McNair Scholars make formal presentations of their research to faculty and peers at the McNair Scholars Conference and submit papers summarizing their work. Students who participated as juniors the previous year continue in the program during their senior year for graduate school placement and to further develop their skills.

ELIGIBILITY

Participants must meet grade point average standards; be U.S. citizens or permanent residents; and qualify as either a first generation college student with an income level established by the U.S. Department of Education, or a member of a group that is underrepresented in graduate education.

All students who wish to be involved submit an application to the program. A committee composed of faculty members and representatives from both the graduate dean's office and the McNair Scholars Program selects participants and approves faculty mentors. Research internships are offered to those students who are juniors or seniors and are identified as having the greatest potential for pursuing doctoral studies.

Large Scale Multi-species Palindrome Study Using Distributed In-memory Computing

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DEVIN PETERSOHN

Chi-Ren Shyu, PhD, Mentor Department of Computer Science



Devin Petersohn graduated this May Summa Cum Lade in Computer Science. The Upsilon Pi Espilon Honors Society President was also awarded the 2016 Excellence in Engineering Outstanding Senior Award.

Additionally, Devin was An Honors Scholar in Research and a two-time recipient of the Columbia Military Service Scholarship.

After completing a summer inernship at the Sandia National Labs working on pathogenic organism genomics, Devin started his doctoral program at the University of California, Berkley with a full ride NSF GRFP Fellowhisp as well as a Chancellor's Fellowship from Berkley. Abstract--Palindromic DNA has many interesting and functional properties, including the ability to form noncanonical DNA structures, such as hairpins, cruciforms, and slipped strand structures. Palindromes also serve important roles in binding sites and enzyme activity, and have a strong effect on mutation rates. Palindromes are abundant in most genomes, often occurring within coding sequences, though in many instances it is not clear how their presence affects genomic functions. The identification and study of palindromic DNA is essential to the progression of our understanding of its role in the genome. To address this need, we present a novel method using an in-memory computing environment for identifying, extracting, and indexing palindromes in a searchable database for all mammals in Ensembl release 80. We discuss the preliminary results of a multi-species study on palindromic DNA, focusing on the size, abundance, and distribution of palindromes. Utilizing a Big Data ecosystem enabled us to generate the largest palindrome database to date, comprising 42 genomes. Our study offers new insight into the dynamics of palindromes and facilitates future investigation.

Keywords: Palindromes, Sequence Analysis, Big Data

I. INTRODUCTION

DNA is often regarded as one-dimensional: a linear collection of nucleotides. In reality, DNA has an important helical structure and often adopts more complex secondary and tertiary formations. Interactions with certain proteins alter the structure of DNA, and the nucleotide sequence itself can even initiate intricate conformational changes. A variety of unorthodox configurations are formed by genetic palindromes which are defined as sequences that are identical to their own reverse complement. Importantly, nucleotides equidistant from the center of a palindrome center are complementary, allowing palindromic DNA to form same-strand bonds and generate hairpins (single-stranded), cruciform structures (doublestranded), and more [1]. Cruciforms in particular influence several important biological processes, including the initiation of DNA replication [2], the regulation of gene expression [3], and the management of supercoiling [4-6]. In fact, a highly conserved peptide sequence actively binds to cruciforms, indicating that palindromic DNA serves a specific purpose in a variety of species [2]. In literature, the term "palindrome" is often used loosely to describe multiple types of inverted repeats, but in this paper we will refer to palindromes in the strictest sense: sequences identical to their reverse complement. DNA palindromes have many adverse effects as well.



Figure 1 System Arhitecture. The system consists of 6 modules: Raw Sequence Processing, Coarse-Grained Filter, Fine-Grained Filter, Extract Palindromes, Iterative Doubling, and Indexing and Retrieval. The output of Module 5 is input into Module 2 for continued processing.

Sequences that are quasi-palindromic, such that the sequence and its reverse complement are imperfect but highly similar, apply enormous pressure on nearby nucleotides to increase the self-complementarity of the sequence, leading to exaggerated rates of mutations in these regions [7]. The cruciform structure itself is prone to cleavage, which can induce potentially hazardous events including deletions and translocations [8,9]. Such events are often correlated with diseases and disorders. There are over 50 genetic diseases and neurological disorders that are caused by sequence-altering events at cruciforms and similar non-canonical DNA structures [10]. Furthermore, an increased abundance of palindromic DNA is found in some cancer cell lines palindrome-containing loci are associated with cancer-related amplification of certain genes [11]. Thus, further exploration of DNA palindromes will not only contribute to our understanding of essential biological functions, but will also provide insight into health and disease research.

As the number of sequenced genomes continues to rise, identifying interesting patterns in DNA has become a big data problem. Some previous methods that locate palindromic DNA test sequence complementarity efficiently, but are designed for limited datasets [12-14]. Other tools find palindromes while performing broader or more specific search [15-17]. Therefore, we designed a new algorithm to identify and store all palindromes 6bp and larger, utilizing distributed computation and storage to maximize efficiency. We indexed the extracted palindromes into a searchable database to facilitate intra- and inter-species discoveries. We demonstrate the capability of our approach by gathering palindrome data from 42 mammalian genomes that collectively comprise over 117 billion base pairs.

This paper is organized as follows: Section II contains the methodology where we discuss the algorithm from the raw sequence processing to the indexing and search of extracted palindromes. In Section III we discuss runtime performance and the storage costs of our algorithm and present the results from the studies. In Section IV, we validate our results and show the capability of our method. The computational results and case study results are discussed in depth in Section V.

II. METHODOLOGY

Figure 1 outlines our system architecture. All components of our system are implemented in the in-memory Big Data computing engine Apache Spark [18]. All intermediate computation and filter results are efficiently stored and distributed in memory using Spark's Resilient Distributed Dataset (RDD) structure [19]. The system consist of 6 modules. In the first module, all k-mers are extracted from an input FASTA file. In the next two modules, the data is passed through two filters. The fourth module extracts palindromes and stores them. In the fifth module, the *k*-mers are doubled and sent back to module 2 for continue processing. The final output is stored in a searchable database.

A. Module 1: Raw Sequence Processing

This module gathers the raw sequence data and stores it in an efficient data structure that can be quickly accessible for future deep analyses. Because palindromes are only intrachromosomal, we are able to process each chromosome individually. We use a sliding window to collect each k-mer, or subsequence of length *k*, and its position within the chromosome and store the information in memory in a Spark RDD. This RDD becomes our initial set of "*k*-blocks", building blocks we also use to extract palindromes. We use these *k*-blocks in subsequent modules to extract palindromes and double the length of the current *k*. We use these *k*-blocks build up the length of our known palindromes. Algorithm 1 outlines the pseudocode for the Raw Sequence Processing Module.

Algorithm 1

- method RawSequenceProcessing (InputFile)
- 1 *k* = window size, c = Species+Chromosome_ID
- 2 r = RDD[]
- 3 for *i* from 1 to InputFile.length k
- 4 // gets the next k bases
- 5 *s* = InputFile.scan(k)
- 6 // *i* is position, -*i* is complement strand position
- 7 r.add((s,c), i)
- 8 r.add((complement(s),c), -(i + k)



Figure 2 Raw Sequence Processing. In the Raw Sequence Processing Module, we use a sliding window, as indicated by the boxes above. We number the positions such that index 1 is the beginning of the sequence as read 5' to 3'.

We scan the input sequence to extract all *k*-mers from the dataset using a sliding window, with an initial window size k = 6. Reading the data using such a sliding window provides the necessary information to guarantee that we find all palindromes of any size 6 or larger, eliminating the need to reference the input file again. As the input sequence is scanned, the reverse complement of the sequence is also calculated as shown on line 8 of Algorithm 1. Notice that we add the length of the sequence and flag the position of each reverse complement as negative to distinguish its location from the input strand and give us a way to map its location back to the position on the input strand. We store this data in an RDD of tuples {*key,value*} where the *key* is the input sequence and the value is the chromosomal position. Because palindromes cannot be cross-chromosomal, we are only interested in intra-chromosomal matches. We include the species name and chromosome ID (from here on abbreviated as *chr_id*) in the key, so our output data structure becomes RDD[{(sequence, *chr_id*), *position*]]. For example, the sequence AAATTT occurs in the human chromosome 17 at position 31097053, the tuple for this 6-mer will be {(AAATTT, human_17), 31097053}. This multivariate key allows us to avoid aggregating unnecessary inter-chromosomal matches when we hash the keys together in a groupByKey operation. As previously mentioned, we keep this RDD in memory for fast access in future processing. The time complexity for Module 1 is O(n) and the space complexity for this stage is O(kn) where k is the size of the sliding window and *n* is the number of base pairs in the input sequence.

B. Module 2: Coarse-Grained Filter

The Coarse-Grained Filter screens out sequences that are not subsequences of a palindrome to simplify computation in subsequent modules. Our aim for Module 2 is to maximize the performance of subsequent steps, and therefore the overall system. Recall that a palindrome is a sequence that is its own reverse complement, and therefore, a sequence cannot be a palindrome unless it occurs on both strands. We utilize this property in two ways in this module: we filter out sequences that do not occur on both strands, and we aggregate identical sequences together as read from 5' to 3' for subsequent filtering. The following algorithm shows the pseudocode for Module 2.

Algorithm 2

- **method** CoarseGrainedFilter (*r*)
- 1 // hashes identical keys together
- 2 r = r.groupByKey
- 3 *filtered*RDD = r.filter(PositiveAndNegative)
- 4 return filteredRDD

The Coarse-Grained Filter first collects tuples with identical keys and removes *k*-blocks that are not palindrome candidates. Spark's built-in *groupByKey* method hashes the keys together and aggregates the values in a list, line 2 of Algorithm 2. Recall the structure of our RDD[{(*sequence, chr_id*), *position*}]. When we perform a *groupByKey*, all identical keys (*sequence, chr_id*) will be combined and the values (*position*) will be aggregated, so the RDD becomes RDD[{(*sequence, chr_id*), List(*position*)}]. We then remove sequences that were not found on both strands of the chromosome shown on line 3 of Algorithm 2. It is important that we keep all sequences that have at least one occurrence on each strand, even non-palindromic sequences, because this data is necessary to extract larger palindromes.



Figure 3 Coarse-Grained Filter. The sequence p is a palindrome, r is identical to r', but not necessarily palindromic

Figure 3 demonstrates the reason to keep non-palindromic sequences in the Coarse-Grained Filter. If the sequences r and r' are identical sequences when read 5' to 3' on their respective strands, they may not necessarily be palindromic. However, by flanking a palindrome, they form a larger palindrome even though r is not individually palindromic. Suppose there are two inter-strand repeats separated by a significant distance, illustrated in Figure 4. Because we do not have enough information about the sequences in the space between these repeats, we cannot rule them out as potential palindrome constituents. Each inter-strand repeat is a candidate for being part of a palindrome. By storing all of these interstrand repeats, we are able to guarantee full coverage of all palindrome extraction across the genome.



Figure 4 Coarse-Grained Filter. The unknown section in this figure may or may not be palindromic, so we are unable to filter out p and p'.

C. Module 3: Fine-Grained Filter

Before we extract all palindromes from the k-blocks we perform another filter to further improve computation time. This module filters out *k*-blocks that cannot possibly compose palindromes between length k and 2k, where k is the size of a k-block output from the Coarse-Grained Filter. Note that we

need not verify palindromes of length 2k because these will be identified in the subsequent *k*-block, as detailed in Module 5. Recall that palindromic sequences must have a center around which all flanking nucleotide pairs are complementary moving outward from the center, which we call a complementary core. The complementary core of a palindrome of less than length 2*k* is included in all of the palindrome's subsequences of length k. Using this principle, we can remove sequences that do not contain any complementary core from future computation. This includes complementary cores that are not at the center of a *k*-block. For example, in Figure 5, the sequence TTTTTT does not have a complementary core, and therefore is not necessary to identify any palindrome between length 6 and 10. It may be part of a palindrome length 12 or longer, but this will be determined in future *k*-blocks. The sequence TTTTTA does contain a complementary core, TA, so we keep this sequence for the next module. Our example in Figure 5 shows that the sequence TTTTAC is filtered out. Even though it contains a complementary pair, TA, the pair TC surrounding it is not complementary, and thus we reject this sequence because it lacks a complementary core.

Algorithm 3

method FineGrainedFilter(RDD: *r*)

- 1 *passed* = RDD[] //stores tuples that pass the filter
- 2 for each tuple t in r
- 3 for each character *c* in *t.sequence*
- 4 if all flanking pairs are complementary5 *passed.*add(t)
- 6 return passed



Figure 5 Fine-Grained Filter. The left box shows example sequences that are not eligible for palindrome extraction because TT are not complementary in the upper example, and T and C are not complementary. The box on the right contains examples of valid complementary cores.

To identify sequences containing a complementary core, we inspect the self-complementarity surrounding each potential core within the sequence. We iteratively evaluate the complementarity of bases equidistant from each potential core, starting with the closest bases shown in lines 2 and 3 of Algorithm 3. If all equidistant pairs fully within the sequence are complementary, we confirm that this is a complementary core and the sequence passes the Fine Grained Filter, line 4 of Algorithm 3. Otherwise, if a non-complementary set is found, the core is proven not to be complementary and another potential core is evaluated. If none of the potential cores in a sequence are proven to be complementary cores, then the sequence fails the Fine Grained Filter and it is output to Module 4. These sequences are not forgotten altogether, as they are used in Module 5 to potentially identify larger palindromes as demonstrated in Figure 4.

D. Module 4: Palindrome identification and extraction



Figure 6 Palindrome Identification. A sequence of length 10 and the overlapping k-blocks we would use to extract all palindromes from this sequence

This module extracts all palindromes, including those whose length is between the sizes of our Coarse-Grained *k*-blocks. Figure 6 illustrates a palindrome of length 10 and the length 6 *k*-blocks our previous modules would have generated from such a sequence. Notice that the pair of *k*-blocks labelled "Overlap 1" overlaps by 2 bases and that the overlapped bases form a palindrome. "Overlap 2" also contains two k-blocks that overlap, however these *k*-blocks represent a shorter palindrome than Overlap 1. In fact, all palindromic sequences greater than or equal to length n and less than length 2ncontain two overlapping complementary sequences of length *n*. By specifically identifying those identical sequences that overlap at some point, we are able to extract all palindromes from size [n, 2n]. We can do this in a single pass over the data without iterating over each length between *n* and 2*n*, saving a significant amount of computation. The theorem and proof below formally prove that we only need to check that a given sequence and its reverse on the complementary strand overlap. Figure 7 illustrates the concept of overlaping k-blocks as palindromes.

Theorem

If a sequence of length k at position p overlaps with its duplicate on the complementary strand by o bases, then the sequence of length 2 * k - o at position p is a palindrome.

Proof

Let S be a sequence of arbitrary length and let S' be its complement. Let X be a subsequence of S of length k. Let X', a duplicate of X, be a subsequence of S' of equal length k. Let f be a function that returns the position of a given nucleotide in S. Let p be a position as read from 5' to 3' in [1,k] in X and X' such that f(X[p]) == f(X'[k]) and f(X'[p]) == f(X[k]), and thus f(X[p + i]) == f(X'[k - i]) for all $i \in [0, k - p]$.





Since X[i] = X'[i] for all $i \in [p,k]$, the interval [p,k] is a palindrome. Because these sequences occur on opposing strands, their bases must be complementary such that the complement c of X[i] is c(X[i]). Since X[i] = X'[i], c(X[i]) = c(X'[i]). From this, we can extend X such that X[k + i] = c(X'[p - i]) and extend X' such that X'[k + i] = c(X[p - i]) and extend X' such that X'[k + i] = c(X[p - i]) for $i \in [1,p)$. Since c(X[p - i]) = c(X'[p - i]), the extensions X[k + i] = X'[k + i] for $i \in [1,p)$. Since X[i] = X'[i] for all $i \in [1,k + p)$, the sequence of nucleotides given by X[i] for $i \in [1,k + p)$ is a palindrome.

The output from the previous module is RDD[{(sequence, chr_id), List(position)}]. From the proof above, we know that we can identify a palindrome based on whether or not a sequence overlaps with its reverse on the opposite strand. Notice that we have aggregated the positions where a sequence occurs together in a list in our Coarse-Grained Filter. For a set of sequences previously identified as identical, the extraction of palindromes using the above theorem is a function only of position. In this way, we can extract all palindromes of length [*n*, 2*n*) without having to iterate over every length. To extract palindromes, we look at the position lists of all tuples in the RDD output by Module 3, Alrogithm 4 lines 2-3. To find sequences that overlap, we use a simple hash function that forces collisions on positions that overlap lines 10-12 in Algorithm 4. Once we have determined the existence of a palindrome, we can extrapolate its full-length sequence by taking the reverse complement of the non-overlapping segment, line 5. We then add the results to the database on HDFS as a serialized RDD for future querying.

Algorithm 4

method PalindromeExtract(r)

- 1 Pal = RDD[]
- 2 for each tuple t in r
- 3 FindOverlap(t.value, t.seq.length)
- 4 // Extend string Based on overlap
- 5 *Pal*.add(ExtendSequence(t))
- 6 return Pal

method FindOverlap(positions, length)

- 7 //stores positions of palindromes
- 8 P = List()
- 9 for each position *i* in *positions*
- 10 *i*.hash(*length*)
- 11 for each collision *c* from hash function
- 12 P.add(*c*)
- 13 return P

E. Module 5: Iterative Double

This module doubles the length of our *k*-blocks, which allows us to extract larger palindromes and reduce our search space by quickly identifying and removing sequences that cannot be part of a palindrome. The input for this module is the RDD[{(*sequence*, *chr_id*), List(*position*)}] output by the Coarse-Grained Filter. From the Coarse-Grained Filter, we have extracted all sequences of length *k* that occur on both strands. In order to iteratively double our sequence lengths without repeatedly accessing the original input file, we combine each *k*-mer s with the *k*-mer immediately following it *s*+ for each position p and the kth position downstream, p+. By adding a tuple to the RDD for p such that we replace p with p+ and flag s as shown on lines 2-3 of Algorithm 5, we can simply hash the positions together to bring s and s+ together demonstarted in Algorithm 5 line 5. By flagging s we ensure that the order of the two k-mers is preserved when concatenating the sequences, line 7. Figure 8 demonstrates the process of iteratively doubling.



Algorithm 5

- **method** DoubleLength(RDD: r)
- 1 *doubledLength* = RDD[]
- 2 for each tuple *t* in *r*
- 3 r.add((t.key, t.value + length(t.seq)))
- 4 *onPosition*RDD = *r*.swap // swaps key and value
- 5 onPositionRDD.groupByKey //hashes on position
- 6 for each tuple *t* in *onPosition*RDD
- 7 *t*.concatenate(*sequence*[1], *sequence*[2])
- 8 *doubledLength.add(t.swap)*
- 9 return doubledLength

The output from this module is RDD[{(*sequence*, *chr_id*), *position*}], and these sequences become our new k-blocks upon which future computation is performed in Modules 2-5. *k*-blocks are iteratively doubled to size 2*k*, 4*k*, 8*k*, etc, until no sequences pass Module 4, Palindrome Extraction.

F. Module 6: Indexing and Data Retrieval

This module provides users with the capability to search for palindromic DNA patterns and to compare these patterns across chromosomes or the entire genome collection. In this section we will discuss how to quickly search the database and conduct studies after having collected all palindromic sequences and stored them on HDFS for fast analysis. We keep all palindromes length 6, our initial sliding window, and longer. This includes sub-palindromes, which are part of longer palindromes. It is important to keep all palindromes and sub-palindromes for inter-chromosomal and inter-species comparisons.

As discussed previously, the output from our algorithm is a collection of RDD[{(*seq*, *chr_id*), List(*pos*)}] that are stored on HDFS. By storing a collection of RDDs rather than a single large RDD, we are able to be selective when creating our indexes for querying. Our design allows users to index based on selected species, chromosomes, and/ or sequence lengths rather than indexing the entire dataset, which is particularly helpful to users with specific data needs or low memory systems. Users still have the option to index the entire dataset by simply combining all output RDDs. In the RDD, each position is aggregated with all other identical palindromes in the same chromosome to conserve space and improve query performance for most types of queries. Storing each position separately would dramatically increase the necessary storage space, particularly for smaller sequences, and would consequently reduce the overall performance of the system. This demonstrates the flexibility of storing the output in a serialized RDD. By storing the output data as a collection of RDD[{(*seq, chr_id*), List(*pos*)}], we have found a balance between the size of the output data and the computation cost of preprocessing and setup before queries are performed.

The number of positions that contain any given length 6 palindrome can easy reach the billions. To avoid creating static tables on disk for billions of records, we use can structure and query tables on the fly from the RDD output by Module 5. Spark SQL allows us to create an index and perform SQL queries on the RDD by converting it to a DataFrame (DF). When we create the DF, we specify a schema for the data. Suppose we are interested in finding the longest palindrome in the Human genome. When creating the DF, we can simply specify our columns as: seq, chr_id, position_list. However, because we are interested in the longest palindrome, we must also include a column for the length of seq: sequence_len. This will allow us to perform a SQL query on the sequence_len attribute. When converting the RDD to a DF, we must assign a value to each attribute. To convert our RDD[{(seq, chr_id), List(*pos*)}] to our example DF{*seq*, *chr_id*, *position_list*, *sequence_* len}, we simply need to iterate over the RDD and assign the tuple elements to an attribute in the DF.

Notice that we are able to perform operations on the data in the RDD as we insert into the DF, which allows us to perform queries on attributes that are not explicitly in the RDD, but that can be derived from values in the RDD. Once we convert our RDD to a DataFrame, we can perform any SQL queries on any combination of attributes we have declared.

III. COMPUTATIONAL EXPERIMENTS AND RESULTS

One of the major advantages to our approach is the ability to incrementally process a set of genomic data. The importance of this is that a user without access to significant computational power or memory can still use this algorithm to identify palindromes by processing their data in amounts suited for their computational infrastructure. In this section we will demonstrate the scalability of our approach by processing data input files on a various number of compute nodes. The system we used for these experiments was a set of 8 IBM Thinkservers with quad-core Intel Xeon E3-1225 processors and 32GB of RAM, and 12TB storage for each node. We will also present the statistics and findings from the entire dataset, 42 mammalian genomes that collectively comprise over 117 billion base pairs.

A. Computational Experiments

The storage requirements for our algorithm scale effectively. Since we have aggregated positions with the same sequence and chromosome, we store a separate record in the database for each chromosome, resulting in some sequence storage redundancy. Despite this, the 117GB of input data resulted in a very small 22.4GB palindrome database. Figure 9 plots

the storage required for each k-block size, which represents the storage for all palindromes of length k to 2k. We see a sort of bimodal distribution, which is a function of string size, number of positions, and number of distinct lengths (e.g. a *k*-block generates palindromes of all even lengths between *k* and 2*k*). At small *ks*, the palindrome strings and the number of distinct lengths are small, but the number of entries is massive, resulting in the peak at *k*=6. At large *ks*, only few palindromes remain, but the number of distinct lengths double along with the string size, producing the gradually rising slope that can be seen from *k*=1536 to *k*=49152. In this case, the storage requirements dip at *k*=24576, which we attribute to multiple species going from having many palindromes in the 12288-24576 range to having no palindromes larger than that.







We tested the runtime of a sample of the data as we increased the number of nodes to show the scalability. Our test data was Human Chromosome 1 with a size of 250MB. We ran the test data through our algorithm and extracted and stored all palindromes using a variable number of nodes. Figure 10 shows the results of our runtime scalability experiment. Notice that as the number of nodes doubles, the runtime approximately halves. We expect that this performance increase will plateau at a certain point, but our cluster has a total of 8 nodes, so we can only test up to that. The runtime for extracting and storing all palindromes on Human Chromosome 1 using our algorithm on 8 nodes was 11 minutes 42 seconds. The total runtime for all 42 species input was 5 days 23 hours 54 minutes on our 8 node cluster.

Runtime of Human Chromosome 1





B. Results

In this section we will be presenting the analytic results we collected from the dataset for both palindromes and subpalindromes. The data we will be presenting will include subpalindromes as well. For the results presented in this section, we filtered out di-mer palindromic tandem repeats. This is because their length and abundance dramatically skews the results data. However, these tandem repeats are retained in the palindrome database for any future exploration.

Given a chromosome of length *c*, the number of subsequences of length n we would expect to be palindromes can be calculated as $c * \frac{4^{n/2}}{4^n}$, if the sequence of base pairs was determined randomly. There are 4^n permutations of the four base pairs in a sequence of length *n*. However, when constructing a palindrome, the last n/2 bases are determined by the first n/2 bases, meaning that there are only $4^{n/2}$ permutations that construct palindromes of length *n*. In Figure 11 we present the expected and observed number of palindromes of lengths 6, 12, 24, and 48 from our 117 Gigabase dataset. As expected, the number of palindromes drops as the length increases. At length 6, we can see that the expected is higher than the observed frequency. However, as the length grows, the number of palindromes observed does not drop as slowly as the number of expected palindromes. At length 48, we expect to see less than 1 palindrome in the entire 117 Gigabase dataset, however 32,484 were identified.



Figure 11 Observed and Expected Palindromic DNA Occurrences

In the second analysis, we measured the GC content of palindromes and the abundance of each possible complementary core: AT, CG, GC and TA. The results of these calculations for palindromes of size 6, 12, 24, and 48 is presented in Figure 12, and this analysis revealed several interesting results. We found that the GC content of palindromes is lower than what we calculated to be the overall GC content of these genomes (32% in 6bp palindromes vs 35% overall). Similarly, the proportion of CG complementary cores was significantly diminished. We believe that both of these findings are consistent with previous findings that the methylated cytosine of a CpG sequence tends to mutate to a thymine [21,22]. Interestingly, the trend reverses for length 48 palindromes, where CG complementary cores are much more abundant than GC cores.

Length 6 GC Content and Center Bases Length 12 GC Content and Center Bases AT Content GC GCGC

Figure 12 GC Content and Center 2 Base Pairs.

AT CG GC TA

IV. CASE STUDIES

AT CG GC TA

As opposed to the previous section, where we outlined some global findings and calculated overarching statistics, here we chose some specific results and looked a little closer at the individual species involved. To demonstrate the cross-species search capability of our approach, we performed a study on identifying the individual chromosome with largest and smallest number of palindromes of length 12, shown in Table 1. The database can be partitioned many different ways when querying, which we show by separately examining autosomes, both sex chromosomes, and mitochondrial DNA.

The longest palindrome in the dataset was found in *Ictidomys tridecmlineatus* (ground squirrel) with a length of 101,980bp. In addition to this, extraordinarily long palindromes are abundant in the *Gorilla gorilla* genome. Over half of *Gorilla*'s chromosomes (13/24) have palindromes over 6kb long, including 8 chromosomes having at least one palindrome over 15kb long. Note that according to the calculation outline above, the number of 6kb palindromes we would expect to randomly occur in a genome the size of *Gorilla*'s is 10⁻¹⁷⁹⁷.

We assign high importance to the ability to examine palindromes affiliated with specific genes. To demonstrate this, we collected palindromes in the neurofibromatosis type 1 (NF1) gene of human, chimpanzee, gorilla, and orangutan. The NF1 gene has been studied before for its palindromic AT rich regions in Human Chromosome 17 and other primates [23]. In particular, palindromes composed of the repeating dinucleotide (AT)-n are associated with translocations that disrupt the gene. We found nine previously unmentioned palindromes in the NF1 coding sequence that are conserved across these four primate species. Some of these are AT rich palindromes that were not of the repeating dinucleotide form, which we speculate could be additional candidates for translocation or other gene-disrupting events. We also found 88 noncoding palindromes (length > 8) conserved across all four species. This capability is a major benefit of using our database for this kind of study, as the conservation of palindromes in coding and noncoding regions can be used as a metric for evolutionary divergence. Although we only examined one gene in this instance, studying many genes from many species is possible with our database, which we believe could reveal many interesting relationships between palindromes and their associated genes.

Chromosome	Mitochon	dria DNA	Autosome		
	Most	Least	Most	Least	
Species	M. domestica	P. abelii	C. familiaris Chr 32	<i>P. abelii</i> Chr 22	
Count per Kilobase	0.584351078	0.06054738	0.516892345	0.21750857	
Chromosome	>	K	Y		
	Most	Least	Most	Least	
Species	C. Familiaris	O. anatinus	P. troglodytes	H. sapiens	
Count per kilobase	0.452091905	0.281375821	0.402632522	0.174593766	

Table 1: Highest and Lowest number of palindromes length 12 per Kilo base.

V. DISCUSSION

In this paper, we present a novel in-memory and distributed computing approach to identifying and indexing palindromic DNA sequences using Spark, the in-memory computing framework. This is the first major algorithm focused on identifying genetic palindromes in a Big Data environment. The ability to utilize distributed computing and storage for identification, indexing, and search allows us to locate palindromes of every length efficiently without the use of heuristics. We processed the genomes of all 42 mammalian species, generating the most comprehensive multi-species DNA palindrome database to date.

On multiple occasions we have brought up the infinitesimally small probability that palindromes of a certain length would be produced by random chance. In reality, this was an expected outcome, as there are multiple known mechanisms for the generation, elongation, and propagation of palindromes in a genome. Furthermore, palindromes with beneficial functionality would be subject to selective pressure to develop and remain in a genome. However, it is interesting to note that small palindromes are approximately as abundant as random chance would dictate, and it is not until the palindromes grow larger than this that there is a significant discrepancy between the observed and expected abundance (see Figure 11). We tentatively speculate that this is indicative of the length at which a palindrome becomes mechanistically distinct from a non-palindromic sequence, either in its own ability to increase in abundance or as a beneficial adaptation.

Though in some respects it would be useful to refine the final results to omit all but the maximal palindrome for each complementary center, we argue that it is important to retain these smaller palindromes. By considering sequence alone, there is no way of knowing just how much of a palindrome conforms into a cruciform or other noncanonical DNA structure. Due to their unknown functional length, searching for duplicate palindromes within one or across multiple genomes would be best accomplished by comparing complementary centers of a given length, rather than restricting the search to the maximal palindrome length.

> The source code for this method and comprehensive palindrome database are available upon request. Even with our preliminary analysis, we found several interesting results that merit further investigation. The abundance and magnitude of palindromes present in the Gorilla genome is unparalleled, yet we found no previous mention of these palindromes in literature. Large palindromes are unstable and are generally purged from genomes, so it is particularly surprising to find so many palindromes of this length in Gorilla and in the other mammalian genomes [1,24]. Our future work will incorporate our method with public web-based genome databases such that palindromes are

automatically extracted from newly published and updated genomes. So far, our analysis included only true palindromes and not inverted repeats, but we intend to adapt this method to allow for the identification of inverted repeats as well. Furthermore, also plan to extend this method to allow for the detection of quasi-palindromes, as these largely complementary sequences also affect genomic dynamics.

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Muslim and American: An Inersectional Analysis of Muslim Identity Enactment in a Midwestern Town

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Abstract

The way that Muslim Americans enact their Muslim identities making it known that they are Muslim and how - is explored in this study. In-depth interviews with 10 Muslims are performed to understand how choices and actions are impacted by dominant attitudes and representations of Muslims in America, post-9/11. Four women who wear hijab, 2 women who do not, and 4 men's responses are explored within the framework of intersectionality to consider how each subject's gendered and racialized positions impact the choices they make in respect of their Muslim identities. Perceptions of threat and what I term as representational responsibility are considered causal agents that prompt Muslim Americans to make particular choices about how they act, and shapes their feelings associated with those choices. This study extracts the concept of passing and applies it beyond the black and white paradigm to reframe the way we think about race within the context of Muslim American racialization based on cultural artifacts and signifiers like the hijab, cultural garb, language, names, or beliefs.

Introduction

Representations of Muslims in the media have been overwhelmingly distorted, conceptualizing the diverse group of approximately 1.6 billion individuals (Pew Research Center, 2013) into a homogenous monolithic group. The essentialized tropes used and repeated in news and entertainment media frame Muslims as being other than American. In fact, those tropes often reinforce the idea that Muslims are anti-American and threaten the US way of life. These persistent cultural dialogues impact dominant society's feelings about Muslims and shape the way others interact with them. Similarly, these same pervasive representations and rhetoric impact the way that Muslims perceive themselves and influence how they interact with dominant society as a marginalized group.

In a previous study I conducted, Muslim American women from Columbia, Missouri were interviewed to understand how their choice to wear hijab impacts the places that they feel included or othered. In those interviews, I explored the reasons that certain places were ascribed those meanings, and in doing so, found that these women felt pressured to represent their religion as contrary to negative dominant representations. I called that pervasive feeling "representational responsibility," (Elhadi, 2015) which denotes a strategy that has been developed to cope with and counteract these representations of Muslims.

My current project aims to explore how representations of Muslims in the dominant culture impact the way that Muslim Americans choose to represent themselves. Specifically, I am interested in exploring gendered differences in the enactment of the Muslim American identity. Women who wear hijab are hypervisible and thus, make the choice to stay in the community and let everyone know that they are Muslim. Muslim Americans who are not equally hypervisible, like non-hijabis or men, have the option of making the choice to openly enact their Muslim identity or pass in greater society as a means of making things easier for the self and to distance themselves from threat.

Focusing the attention on what Muslim Americans are doing, reflecting on the familial and sociohistorical contexts of their identity development, and contemplating concepts of racial passing and threat, we can evaluate how and why Muslim Americans are enacting their Muslim identity the way they are.

Literature

Literature on Muslims in America has centrally focused on the group's negotiation of cultural and religious expectations, the racialization of Muslims and their consequent representation in the media, and Islamophobia (Mir, 2014; Selod, 2015; Alsultany, 2012; Chakraborti & Zempi, 2012). All of this literature contributes to a dynamic repertoire of research on the lived experience of Muslims in the American context, debunking the misconception that this diverse population is a homogenous group. Muslims contribute to the multicultural fabric of American life, though they are often assumed to be not American (Selod, 2015) or even anti-American. Understanding these misperceptions and unveiling the complexity of the Muslim American population's intersectional identities is important to informing the dialogue on difference in a way that aims to promote cultural competence. This project enlists literature on representation and racialization, but reframes those discussions to consider how these schemas influence the strategies Muslim Americans employ to cope with their marginalized status.

The relationship that the West has had with Islam and Muslims has roots in Orientalism, which functions to create an ideology of difference based in "the basic distinction between East and West as the starting point for elaborate theories, epics, novels, social descriptions, and political accounts concerning the Orient, its people, customs, 'mind,' destiny and so on" (Said, 1978, p. 25). Edward Said argues in Orientalism (1978) that this discourse identifies the West as it imagines itself as the contrasting image and persona of the Orient, thereby creating the othered category of the East. The risk of othering is portraying that other as essentially different and inherently inferior (Krumer-Nevo & Sidi, 2012). This process of othering has established a hegemonic ideology that strategically grants the West a "positional superiority... an uneven exchange with various kinds of power" (Said, 1978, p. 26). Said's primary focus on the Islamic world in Orientalism provides a basis for understanding how the United States currently regards and maintains "Muslim" as a marginalized status; "The Orient and Islam have a kind of extrareal, phenomenologically reduced status that puts them out of reach of everyone except the Western expert," such that "the one thing the Orient could not do was to represent itself" (Said, 1978, p. 24). This transfixed Orientalism, which exaggerates, distorts, and purports images of Muslims and Islam is the starting point for understanding the historical roots of modern-day Islamophobia.

Islamophobia holds relevance in this study on Muslim American identity enactment because of its influence on the attitudes and actions of the American public, including its Muslim subsection. The reductive concept of Islamophobia only goes so

far as to show how a religion is vilified and how negative stereotypes and representation subsequently produce a "phobia" against Muslims. This term does not encompass the discrimination that is enacted upon those who are, or who are perceived to be, Muslim, nor does it acknowledge its systemic manifestations. 'Muslim' has become a cultural race category, one that goes beyond skin color (Chakraborti & Zempi, 2012; Madood, 1997) and is a racial formation tied to the 'War on Terror,' which "targets terrorism rather than individual nations resulting in a myriad of ethnicities and nationalities being classified into a monolith category of 'Muslim'" (Rana, 2011; Selod, 2015, p. 80). The racialization of a group is the process of meaning making ascribed to physical features, as well as cultural signifiers like language, beliefs, names, and clothing. Understanding this concept beyond skin color allows for a more dynamic conversations about the fluidity of race in different cultural and sociohistorical contexts. While Muslims have been consistently racialized vis a vis Orientalism, the American post-9/11 context backed by a long history of imperialism and today's 'War on Terror' prompts a specific presentation of Muslims as the racialized other.

After September 11, American TV dramas began to articulate and incorporate public discourse on policies, and correlate actual events of racial profiling, detention of Arabs and Muslims, and the parameters of patriotism (Alsultany, 2012). The controlled images in the media that evoke sympathy for the Muslim woman and regulate it for the Muslim man (Alsultany, 2012) reinforce mainstream assumptions that conflate Arabs as Muslims, and Muslims as terrorists (McQueeney, 2014). The reductive terminology used when discussing Arab and Muslims who are framed as "terrorists" continue to create and reinforce the Muslim Other through mechanisms of discourse and interpretation that works through 1) Objectification, 2) Decontextualization, 3) Dehistorization, and 4) Deauthorization (Krumer-Nevo & Sidi, 2012). When Laura Bush carried out a radio address in November of 2001, this modality of creating the other occurred through her statements distinguishing the "civilized people throughout the world' whose hearts break for the women and children of Afghanistan and the Taliban-and-the-terrorists, the cultural monsters who want to... 'impose their world on the rest of us''' (Abu Lughod, 2002, p. 784). Within these statements, we witness the perpetuation of the notion that Muslim women lack agency and are in need of rescue.

Agency is an important component of exploring Muslim identity enactment in this study as it refers to the capacity for individuals to act independently and make choices. Reducing the intersectional identities of Muslims who hold unique racial, ethnic, and gendered positions in society reinforces an inequality regime that others Muslims through reducing their personhood and agency. This means the dominant society generates an important mechanism that makes the Muslim an "object of information, never a subject in communication" (Foucault, 1977). Such "mechanisms of Otherness produce alienation and social distance" (Krumer-Nevo & Sidi, 2012, p. 299) -- produced feelings, reflecting on this discourse and subsequent representations, that I argue prompts how a Muslim American enacts his or her identity. The agency afforded to Muslim Americans provides them with options to make their Muslim identity known or to pass in greater society; this agency also imposes barriers.

Many Muslim women who wear the hijab do so as autonomous agents, understanding the potential barriers that the practice entails. Hijab as a hypervisible symbol of Islamic practice leaves Muslim women vulnerable to potential scrutiny, discrimination, or threat. Chakraborti & Zempi (2012) have found that "by retaining the veil in a non-Muslim environment, Muslim women demonstrate that the veil is not imposed by Muslim men but chosen by them." Wearing the hijab is not a socially accepted norm in dominant Western society and the practice is looked upon with an inspecting gaze, so that wearing it in a place that presumes its oppressive nature paradoxically shows it as an autonomous practice.

Literature on passing has predominantly focused on the practice in the black community. Extending this idea to Muslims in America complicates our understanding of racial formations and begs the question of how we understand race as it applies to cultural signifiers and artifacts. Passing is "a deception that enables a person to adopt certain roles or identities from which he would be barred by prevailing social standards in the absence of his misleading conduct" (Kennedy, 2009, p. 1145); people utilize agency to practice passing or not, and within the Muslim American population, there are numerous factors that may contribute to making the choice to pass. The constructed nature of the Muslim American cultural race category explains how women that may pass as white lose that privilege after donning the hijab (Selod, 2015) and the malleability of race is exposed when one can change their racial identity with a piece of cloth. Passing is not solely dependent on appearance or skintone, but also dress, social knowledge, and outward behavior (Hobbs, 2014).

Jean Toomer suggests that "The Negro's curious position in this western civilization invariably forces him into one or the other of two extremes: either he denies Negro entirely (as much as he can) and seeks approximation to an Anglo-Saxon (white) ideal, or... he overemphasizes what is Negro" (Hobbs, 2014, p. 196). In this way, Muslim women who don the hijab choose to make their identity very apparent. And in the same way, a Muslim man or woman not equally hypervisible or outward about their Muslim identity, may deny their heritage and seek approximation to the white or Western ideal. The agency of all Muslim Americans produces choices of how they enact their identity to make it known that they are Muslim or pass in greater society.

The act of wearing the hijab is a hypervisible means of making it known that one is a practicing Muslim woman. In this way, it is similar to what Toomer said about overemphasizing one's position in society (Hobbs, 2014). The hijab attracts what Foucault details as, "An inspecting gaze, a gaze which each individual under its weight will end by interiorisation to the point that he is his own overseer, each individual thus exercising this surveillance over, and against, himself" (Foucault, 1980; Mir, 2014, p. 249). Mir (2014) further alludes to this as a system of internalized psychological self-surveillance, which causes members of the marginal group to be acutely cognizant of their distinctly different status in dominant society. W.E.B. Du Bois (1903) describes the peculiar sensation as "double consciousness," a sort of second sight possessed by African Americans that allows them to look "at one's self through the eyes of others" (p. 14). The veil he names as the distinction from whiteness prevents white America from recognizing non-whites as truly American and maintains a separation that disallows black Americans from gathering a sense of belonging in the dominant society. The literal veil, or hijab, worn by Muslim women is Du Bois's metaphor embodied.

When one is aware of the gazes, cumulative and ever-present, it creates a sense of representational responsibility (Elhadi, 2015) so that to meet the expected demands under the gaze, one engages in practices of self-surveillance. This is much like the effect of a Panopticon: the visible Muslim "must never know whether he is being looked at at any one moment; but he must be sure that he may always be so," (Foucault, 1977, p. 201) thus necessitating consistent public performance. The gaze expects Muslim women to perform within their constructed identity category and such an expectation is internalized so that these women feel responsible to represent Islam as a whole.

Hate crimes committed against Muslims and those perceived to be Muslim rose 1600% following 9/11 (Alsultany, 2012), leaving an impact on members of these groups who censored their behavior in public to avoid ethnic or religious markers out of fear (Alsultany, 2012). Such self-censorship occurs when one feels that one's safety is in danger. Perceiving threat or recognizing the reality of threat prompts people to pass to preserve safety. In A Chosen Exile (2014), Allyson Hobbs reveals passing as both an individualistic practice and social act that has functioned parallel to changing cultural and political histories in America. As racial barriers increase, so too does the incentive to pass (Hobbs, 2014).

In June 2015, Linda Sarsour wrote an opinion piece in The Washington Post called

"Why

this has been the worst year for American Muslims since 9/11." In it, the activist supports her stance by noting multiple events that occurred within days, weeks, and months of each other. These ranged from the execution-style shootings of three Muslim American students in Chapel Hill, NC, to an armed anti-Muslim rally in Arizona. The omnipresent threat of violence that such events instigate can result in the realization of the cheapness or otherness of the Muslim identity in the American context, prompting Muslims to pass. Understanding threat within the context of what makes someone feel unsafe is relative to the individual, prompted by social pressures. Within this study, the definition of threat will be evaluated on an individual basis in each interview to understand how the sensation influences Muslim identity enactment.

Methods

This study intends to explore the ways in which Muslim American young adults enact their intersectional identities. As an exploratory study, interviews were not performed to test any hypothesis but to understand how gender, race, and visibility impact the way participants feel about their personal identity and how it relates to the Muslim community, and then how that impacts the choices they make to act and represent themselves.

Prior to conducting interviews, IRB training and permission was obtained and each of the participants gave a written consent. Ten Muslim American college students were interviewed on the University of Missouri campus over a 3 month period (January-March 2016). Four participants were men, four were women who wear hijab, and two were women who do not wear the hijab. Every participant met the following qualifications: 1) personally identifies as Muslim, 2) grew up for most of their life in America, 3) has at least one Muslim parent, and 4) is a Mizzou student between the ages of 18-25. The pool of participants varied ethnically and racially with participants identifying as Nigerian, Sudanese, Indian, Pakistani, Bangali, Tunisian, Iraqi, and more. All of the names of those interviewed has been changed for this study and replaced by pseudonyms.

In-depth interviews lasted between 27 and 58 minutes. Questions were themed along three axes: 1) Islamic upbringing and values, 2) Media representation and perceived attitudes towards Muslims, and 3) understanding of personal and collective identity. Some core questions were,

1. What are the most prevalent representations that you see of Muslims in the media?

a. When you see Muslims represented that way, how do you feel?

2. Do you do anything to try to make people more comfortable with you being Muslim?

3. How do you think your race impacts the way that people see you as a Muslim?

Other questions were tailored to sub-populations according to gender and visibility. Muslims not as visible as hijabis were asked some questions like,

1. Have you ever had an interaction with someone who did not know you were Muslim?

2. Are there certain people whom you have purposefully not told that you were Muslim?

For women who did not wear the hijab, questions regarding their choice to not wear it were asked, and men were asked questions regarding how men make it known to others that they are Muslim if it is not immediately evident from appearance. As the primary research investigator, I realize my position as a visibly practicing Muslim woman as being one that can potentially bias answers, and likely do, particularly when it comes to attitudes towards hijab (which I wear). In attempt to minimize bias, I adhered to literature that finds same gender interviewing strategies as most effective for normative personal and sensitive topics (Holmgren, 2011). The gendered dimensions of the interviewer/ interviewee relationship reinforce that, "Gender permeates all aspects of social life and the qualitative interview involves processes of performance and impression management" (Broom, 2009; Oakley, 1998). Further, "When women interview men, patriarchal gender relationships are often reproduced, even reinforced" (Holmgren, 2011; Winchester, 1996). In order to eliminate the potential manipulation of data that may be produced in a mixed gender interview environment, I employed the use of a male interviewer for the male participants.

Findings

Hijab: "Hijab" literally translates to "cover" and is commonly referenced as the headscarf that some Muslim women wear. In this study, all participants – men and women alike – made statements about how wearing hijab is a choice. The women who wear the headscarf every day additionally made statements that referenced their choice to wear it as being grounded in their belief that hijab is a part of the religion and an act of submission to God. This paradoxical belief that wearing hijab is both submission and choice parallels the paradox of predestined fate and free will. A complement would be that Muslims believe they are commanded to pray five times a day but utilize free will and choose to submit or not to that command.

Through revealing the belief that "It's an act of submission to Allah and that's... the prime reason that you should wear hijab," Dunya – a 21 year old hijabi – is asserting a crucial reason that she chooses to wear hijab. In similar terms, Hayaat – an 18 year old hijabi – says that to her, wearing hijab "is an act of worship." I continue to utilize the rhetoric of choice because participants did; while these hijabis may feel it is an aspect of their religion to wear hijab, they all reported making a decision to wear it. They did not wear it because any one person told them they had to. Contrary to the contexts present in many Muslim populated countries where it is legally or socially dictated that women are required to cover, disallowing choice and acting to oppress women, these participants live in a country (America) that allows them the agency to choose to wear hijab or not.

However, the social environment in the home played a significant role in their decision to wear it. All the hijabis in this study grew up with mothers who wore hijab and the influence of growing up with the hijab as a visible sign of religiosity was evident when Dunya said, "I was really inspired to wear it by the women in my life... just the way that, just the maturity and the way that they represented themselves was really really appealing to me when I was younger." Growing up with hijab as a practice within the family seemed to place an implicit expectation on the hijabis who like Mariam – an 18 year old hijabi – did not know what hijab truly meant when she started wearing it. The meaning of wearing hijab for the four participants developed over time and continues to change according to a person's personal development and the changing political climate. Hayaat reported, "Over the years, it became something that like, really empowered me because... it made me a lot stronger in my identity as a Muslim."

For these women, hijab functioned to ground them in their Muslim identity, often calling it an anchor that reminds them of who they are and what that means. The headscarf is automatically associated with Islam and is accompanied by the tropes and representations that have been assigned to it. Because hijab renders its wearer as hypervisible, it serves as a constant reminder to its wearer and the public that she is Muslim.

The two participants – Aisha and Marwa – who did not wear hijab additionally utilized the rhetoric of choice but did not position it as a fundamental practice of the religion. Additionally, they were daughters of women who did not wear hijab. Though few in number, the distinction between the socialization of hijabis whose mothers and sisters wore hijab, and the women who did not wear hijab bears further study, and it would be interesting to note for future explorations on the development of religious identity and expression through the home.

Racialization, Threat, and Passing: 'Muslim' has become a racialized identity tied to geopolitical representations of 'the Orient' and 'the War on Terror.' The hijab as a headscarf worn by Muslim women is a highly politicized cloth that not only marks its wearer as Muslim but posits this identity within the borders of the Middle East. Hayaat said, "Most people, when they see the hijab, they know I'm Muslim and they automatically assume I'm Arab." Conversely, when she told a classroom peer that she was from India, the peer asked if she was Hindu. She used this story to reinforce that many Americans "just didn't associate anywhere other than the Middle East with being Muslim" (Hayaat). Similarly, Mariam is a black Muslim who occupies two coded racial identities at once, leaving her in a space that makes her feel excluded by both communities. On the one hand, Mariam has had people say, "you're not really black because you're Muslim," and on the other, she points towards colorism and anti-black racism within the Muslim community that makes her feel like she has to prove her "Muslimness."

Respondents frequently mentioned the overwhelming representation of all Muslims as Arab (and all Arabs as Muslim). Muslims are the most diverse religious group in the world but the constant coding of Arab people as Muslim and non-Arab Muslims as coming from the Middle East has created a conflation of race, ethnicity, geography and religion. What Hayaat called a mix-up of religion and culture has racialized 'Muslim' in a way that places traditional garb, names, and even facial hair under the predatory gaze of dominant media and society. Dunya says that people have really mixed "the idea of being Arab with the idea of being Muslim" and fail to separate the two entities: "So Arab culture may be patriarchal, maybe women are oppressed... but in Islam, Islam was brought down to combat those issues."

The racial profiling associated with the War on Terror has resulted in an increase in hate crimes against Muslims and those mistaken for Muslim (ie. Sikhs, Christian Arabs, etc.). The particular racialization of Muslim Americans produces the Other in such a way that incites threat because Muslims are represented as threatening. Malik, a 22 year old participant, responded "terrorist... terrorist again... terrorist three times," when asked what the most dominant representations of Muslims are in the media. Such a response was similar to other participants' who each said some form of 'terrorists' or 'Muslims as violent'/'Islam as a violent religion.' The 2016 election cycle, with political personalities like Donald Trump advocating anti-Muslim policies, was a source of anxiety for several of the Muslim Americans interviewed for this study, especially hijabis who felt their life may be threatened and mentioned conversations about taking off the headscarf. Aisha, one 19 year old Muslim woman who does not wear hijab, had said she had wanted to wear hijab but she and her family decided it was not a safe time to start.

Hijab is the most widely recognizable mark of Muslim identity; other Muslim women and Muslim men are not as easily identifiable. When asked if they thought people would know they were Muslim by looking at them, all six non-hijabis - female and male - said, probably not. "If I meet 10 people in the day, 7 of them don't know I'm Muslim and that's just because you know, I'm not wearing an 'I'm Muslim,' shirt," 25 year old Munir said. Hijab is that 'I'm Muslim' marker that the others do not wear on a daily basis. There is very little that Muslim men and women who do not wear hijab can do with their appearance to make it evident that they are Muslim because so much of the racialization of Muslims rests in material culture. When introducing themselves, Muslims will Anglicize their names, but even foreign sounding names do not have to be attributed to their Muslim identity. Mohamed, an 18 year old man said there is not really a way for men to show that they are Muslim unless they pray in public. Even this statement would be contingent upon the onlooker knowing and recognizing the characteristics of Muslim prayer.

With this contrasted lack of visibility, Muslim women who do not wear hijab and Muslim men have the privilege of distancing themselves from the direct threat of being identified as Muslim. Just as the hijabi makes the choice to wear hijab, which has personal and political consequences, the others can make the choice to make their Muslim identity known to their peers through social media and personal interaction. Munir says he will often tell people he is Muslim because he wants to show people what a modern Muslim looks like – that there is nothing to fear, and that Muslims are cool. He said he would often use his Muslim identity as his interesting fact about himself during introductions in groups. Malik does not feel a similar need to divulge his Muslim identity immediately, saying he feels it is weird to just bring it up. Hayaat, who wears hijab, said, "I think we should talk about Muslim male privilege because... it's so much easier for them to pass under the radar." And because they are able to pass, they are not burdened with the responsibility of constantly acting as a representation of Islam or having to think about the consequences of their actions on the representation of Muslims.

Unless they are wearing traditional garb, many Muslims move through America looking just like any other white, black, or brown person out there. When they order coffee, they will change or Anglicize their names to make them easier to say. When they encounter uncomfortable situations, they will make jokes to ease the tension. Because dominant media paints the Muslim other as just that – other – Muslims make extraordinary efforts to counter the narrative that marginalizes and stigmatizes them by showing that Muslims are just like the average American. The ways in which these Muslim Americans act to combat the negative representations are numerous. Some Muslim women have discussed changing their appearance (taking off the hijab) or maintaining their appearance (keeping the hijab off) to be less identifiable as Muslim in public.

Representational Responsibility: Representational responsibility is the sense of obligation Muslim Americans feel to act contrary to the negative representations of Muslims in dominant culture. It is a conscious effort to counter the narrative that paints Muslims as a monolithic homogenous group, with the media painting said group as violent, backwards, oppressed, anti-American, etc. Hijabis' rhetoric was laced with this sense of responsibility because they recognize themselves as the most marked. Mariam said, "I think um, a lot of Muslim girls who like, wear the hijab have to... they are so visible because they're Muslim and so they have to, like, they have to be the representative, to show people that this is what Islam is." Utilizing words like "have to" denote little choice in acting as a representative; making the choice to wear hijab puts you in a political environment that pressures its wearer to perform their Muslim identity. Little choice is granted when that same environment frequently calls on Muslims worldwide to condemn acts of violence committed by those who happen to be Muslim. Through acting with extraordinary manners and combating gendered stereotypes, hijabis work to combat the tropes the media wraps them in.

Hayaat reported that from a young age, she was confronted with the understanding that "what you said was a representation, what you did was a representation on Islam" so that she "made sure to learn my religion and then from that, it become something I did for myself." Her positioning of learning her religion first to answer people's questions and correct misinformation/misrepresentation, and then practicing for herself is one that shows the influence of the current sociohistorical context that positions religion as just as social, if not more than it is personal.

Dunya noticed that as she grew older in hijab, her behavior started changing: "I really noticed myself that day trying not to look mad, or trying not to look sad. Trying to be extra happy and extra nice to people, and extra courteous, and having like, really amazing manners and saying like, really nice things to people... even if they were being extremely annoying or extremely disrespectful or rude to me." Many male and female participants said that they felt the best way to combat the negative representations of Muslims was to be themselves, to show people how normal Muslim Americans are and how very similar they are to everyone else. With this statement however, came other statements that showed extra conscious efforts to act in particular ways. The consequence of this constant performance was reports of exhaustion and having predominantly Muslim friend groups. Other than 20 year old Ahmed, everyone interviewed had mostly Muslim friends for the following reasons: 1) they did not have to "act" or perform their identity; they could just be themselves, 2) they shared the same values and thus did not have to explain themselves or their behavior which may be viewed as deviant to those outside of the Muslim community, or 3) proximity and community; having grown up together in Columbia, Missouri and the Islamic Center of Central Missouri.

While the hijabis exhibited the highest sense of representational responsibility, others in the study also exhibited feeling obligated to represent themselves and Islam in a better light. Aisha utilizes social media or classroom discussion to combat the dominant narrative: "whenever something bad happens, personally, because so many people complain about Muslims not condemning, I personally always like, I always tweet out or say, discuss with my non-Muslim friends and stuff that this isn't representative of me, or my values, or that of my friends... I just really emphasize that I don't agree with it and then also, I've tried to like open up discussions in like classrooms and like, anywhere where the topic comes up. I always make sure to make a point about how, like, I don't agree with it." Munir similarly would engage in conversation and try to correct misinformation when it came up.

As a coping mechanism, men in particular reported using humor to make people see Muslims as normal and to make people more comfortable with their Muslim identity. Because of their ability to pass, it was through inserting themselves into these dialogues, as well as 'being themselves' that the men reported being able to combat stereotypes. The idea of making others more comfortable and easing people that they were not those Muslims they see in the media was a consistent theme.

Conclusion

The gendered position of hijabis, non-hijabis and men mean they are racialized differently, affording some people the ability to pass and others to remain hypervisible. Those who were the most marked felt most responsible to use their position of visibility to combat negative representations. These same representations directly impact choices of how to personally represent the self in private and public.

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Family and Community Influences on the Social, Emotional, and Academic Development of African American Middle School Students Living in Urban Contexts

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Brandy is the recipient Of the Moses E. Terrell Scholarship, Delta Sigma Theta Sorority, Inc., Chicago Alumnae Scholarship, and the S & H Memorial Scholarship. [After graduation, Brandy looks to pursue a doctoral degree in Counseling Psychology. Middle school entry represents a significant developmental period marked by academic and social transformations. Youth develop increasing cognitive sophistication during this period as they encounter new expectations at school (e.g., rotating class schedules) and increasing social independence and peer influences. Successful navigation of this transition is influenced both by child characteristics and also by the environmental context of school, community, and home. Identifying parent behaviors and neighborhood structure and supports that can help support youth during this transition is important for facilitating positive youth development. In particular, understanding the role of parents and community on African American youth living in urban contexts may help bolster positive outcomes for these youth.

Parental Monitoring

During the middle school years, or early adolescence, parental monitoring and parent- child relationships remain important in shaping children's lives. Parental monitoring is defined as a process in which parents are aware of their child's activities and pay close attention to their behaviors (Fosco, Stormashak, & Dishion, 2012). Parental monitoring takes on special importance during middle school aged years as children spend increasing time away from home and have opportunities to engage in risky behavior such as substance abuse and antisocial behavior (Fosco et al., 2012). Many adolescent experience an increase in substance use and delinquency, poorer school performance, and worse psychological adjustment when their parents are not involved or do not show consistent disciplinary skills (Roche et al., 2007). On the other hand, when parents actively monitor youth during this developmental period youth tend to have fewer behavior problems and better academic performance (Bogenschneifer, 1997, McCreary & Dancy, 2004; McNeal, 1999).

Parenting interacts with developmental needs and transitions. For instance, youth develop an increased sense of autonomy during adolescence. Thus parental monitoring must be balanced with this push toward independence. For instance, one study found parenting characterized by high levels of autonomy granting (e.g., making decisions, free time, and extended curfews) was strongly associated with lower depressive symptoms for African American boys (Radziszewska, Richardson, Dent & Flay, 1996). An ecological model captures these interactions between varying systems that surround youth development (Bronfenbrenner, 1992). In this model, the emerging child subsystem interacts with proximal and distal contextual systems including the family (microsystem), the community/neighborhood (exosystem), interface between the micro- and exosystems (mesosystem), and the broader cultural, government, and media influences (macrosystem).

Community and Neighborhood Influences

Youth perceptions of their neighborhood contexts begin to change during the middle school aged years. During childhood, children's beliefs are shaped predominately by the views, values, morals, and ways of thinking by their parents. During early adolescence, youth experience growing cognitive sophistication (Santrock, 2011) and interact with broader contextual systems more frequently and independently. Peers and social interactions outside the home become increasingly important during this period.

In particular, the neighborhood context that surrounds youth can have profound effects on adolescent self-perceptions, social and emotional wellness, and academic outcomes. (Boardman and Onge, 2011). Nurturing neighborhood environments can mitigate many risk factors that influence youth development. On the other hand, toxic environments can undermine youth health and well-being. For instance, exposure to violent neighborhoods not only shapes the way adolescent's view themselves and their place within the neighborhood, but it also effects the way they cope with the stressors. Previous studies have examined the coping strategies that adolescents currently use or could potentially use when dealing with exposure to violence. Research found that perceptions of safety within the neighborhood had a strong correlation with how adolescent's felt about their personal safety (Rasmussen, Aber, and Bhana, 2004). Neighborhood risk interacts with youth actions. For instance, in urban settings, African American youth who do not feel safe within their communities are at a higher likelihood of being involved in some sort of accusation or carry a weapon for protection. When youth are consistently surrounded by violent environments their perceptions of these environments start to become their way of internalizing things psychologically (Goldner et al., 2014).

Parenting and Neighborhood Context

Notably, parent monitoring interact with neighborhood risk to determine youth outcomes. In one study, Dearing (2009) found that from a sample of 668 students in early in middle adolescence, restrictive parenting values (i.e. rule setters) had a negative correlation with children's academic abilities and was positively associated with depression. On the other hand, parents that displayed more supportive practices were likely to have a positive association with children's academic performance. Results revealed that for African American children living in high risk neighborhoods, restrictive parenting served as a protective factor. This finding did not hold for White youth living in high risk neighborhoods. This study highlights the importance of examining interactions between parenting and neighborhood context within racial or ethnic groups.

Perceived Racism

Youth within disadvantaged urban communities and neighbor-

hoods are also exposed to many challenges that can effect their perceptions of the people around them and the way in which they perceive themselves as being able to control these factors. In particular, researchers have found a significant correlation between racism and mental health outcomes for African American youth. When adolescents experience racial discrimination it has detrimental affects on their mental and physical health (Broman,Mavaddat, & Hsu, 2000)

Racial discrimination is an act in which the members of the dominant group systematically disregard members of differing ethnic groups. These actions are commonly experienced by the African American community. Research has shown that 91% of African American adolescents have stated that they have experienced racial discrimination at least one time in their life (Lambert, Herman, Bynum, and Ialongo, 2009). This is problematic for adolescents because it is a time in which they are developing in so many ways: cognitively, emotionally and physically. It is also a time in which they are trying to formulate formal reasoning and also establish their racial and ethnic identities.

When dealing with discrimination and racism, children are mostly taught how to address these race related issues from racial socialization by their parents. According to a Harris and Britt (2007) study, African American parents prepared their children for coping with race related issues in two different ways: by giving messages to help instill racial pride and by preparing children for racial bias/ discrimination. Results from this study showed that adolescents who reported receiving less positive messages from their parents and family in regards to their race and culture displayed lower levels of self-esteem, while those who were exposed to more positive messages did not show negative effects from perceived discrimination (Harris- Britt et al., 2007). Thus parenting can help mitigate some of the negative outcomes experienced by youth who encounter racism.

In the current study, we examined the influence of parent monitoring, neighborhood, and perceived racism on the social, behavior, and emotional outcomes of middle school African American youth living in an urban context. In particular, we hypothesized that parental monitoring, racism, and neighborhood contexts in 7th grade would be related to the outcomes that children experienced in the 9th grade. We also hypothesized that parent monitoring and neighborhood context would interact to influence youth outcomes. Specifically, we expected that high levels of parenting monitoring would be especially important in shaping outcomes for youth living in high risk neighborhoods.

Methods

Participants

The present study is a part of a larger longitudinal study conducted by the Baltimore Prevention Research Center at John Hopkins University that has explored the relationship between family and school interventions that can help redirect or improve the academic development and behaviors of low income children. The original study included a sample of 678 children and families that were entering the first grade in nine different elementary schools around the city of Baltimore, primarily in the western region of the city. Of those children and families, 96% of them participated in an evaluation program. Of those 678 first graders 53.2% were male, 86.8% were African American, and 13.2% were white, and 63.4% were receiving free or reduced lunch when they entered the 1st grade in the fall of 1993 which was an indicator of their socioeconomic status. The original study used the Kaufman Test of Educational Achievement to measure the academic abilities of children in grade 6th-10th and 12th measuring their reading, mathematics, and spelling skills. The subsample used in the present student focused on 447 African American youth (54% males; 46% females) who completed follow-up assessments in 7th and 9th grade.

Measures

Demographics. Data on free and reduced lunch status, age, and gender was gathered from schools.

Academic Achievement. Kaufman Test of Educational Achievement-Brief and Comprehensive Forms (Kaufman & Kaufman, 1998). The K-TEA is an individually administered diagnostic battery that measures reading, mathematics, and spelling skills. The brief form of the K-TEA is designed to provide a global assessment of achievement in each of the latter areas. In the present study, we employed the Reading (reading decoding and comprehension) sub-test from the brief form in grade 6. The K-TEA Math Computation test was not administered in grade 6 in light of initial concerns over the length of the overall battery. Both forms provide age and grade-based standard scores (M = 100, SD = 15), grade equivalents, percentile ranks, normal curve equivalents, and stanines. The K-TEA norms are based on a nationally representative sampling of over 3,000 children from grades 1-12.

Parental Monitoring. Structured Interview of Parent Management Skills and Practices--Parent Version (SIPMSP, Capaldi & Patterson, 1994). The SIPMSP was designed to assess the major constructs included in Patterson et al.'s (1992) model of the development of antisocial behavior in children. The items assess (1) parental monitoring (e.g., "How often is child out after dark without an adult present?"); (2) inconsistent discipline (e.g., "How often can child talk you out of punishing him/ her?"); (3) specific praise (e.g., "How often do you praise child? How often do you explain the behavior you are praising?"); (4) parent rejection (e.g., "How difficult is it to be patient with child?"); and (5) fun time (e.g., "How often do you spend time with child in a fun activity?"). Parents are asked to respond to questions regarding their disciplinary practices in open-ended and forced choice response formats. See Capaldi and Patterson (1994) and Chilcoat (1992) for details on the psychometric characteristics of these measures.

Neighborhood Disorder. The Neighborhood Environment Scale (NES; Elliot et al. 1985) was used to assess neighborhood disorder. The NES is a measure of neighborhood disorganization, including questions about violent crime (e.g., "Every few weeks, some kid in my neighborhood gets beat up or mugged.") and drug use and sales (e.g., "I have seen people using or selling drugs in my neighborhood."). Youth rate each item on a 4-point Likert scale (1 = not at all; 4 = very much) and higher scores indicate greater neighborhood disorganization (10 items, α = .86). Studies with youth in the PIRC trials show that the NES predicts meaningful youth outcomes such as drug use in African American youth (Crum et al., 1996).

Racism. Seven items drawn from the Racism and Life Experiences Scales (RaLES; Harrell, 1997) were used to assess experiences with racism and discrimination. The RaLES assesses how often youth have experienced racism or negative events associated with his or her race (e.g., "How often have you been ignored, overlooked, or not given service in a restaurant, store, etc?"; "How often have you been treated rudely or disrespectfully because of your race?"). Youth respond to each item using a six-point frequency scale (1 = "never," 2 = "less than once a year," 3 = "a few times a year," 4 = "about once a month," 5 = "a few times a month," 6 = "once a week or more"). A summary score may be created by taking the mean of the seven items, and higher scores indicate more experiences with racism. In this sample, mean summary scores ranged from 1.00 to 5.57 (M = 1.78) in grade 7, the first year this scale was administered. Coefficient α for the 7-item scale was .88. In terms of concurrent validity, the RaLES correlates positively with conceptually similar measures including the Index of Race-Related Stress (Utsey & Ponterotto, 1996) which assesses stress experienced due to racism and discrimination. Lambert et al. (2009) reported that scores on the RaLES scores in 8th grade predicted depression in 10th grade for PIRC participants. Criterion validity was demonstrated by evidence that in each of grades 8, 9, and 10, African American participants in the PIRC study reported significantly more experiences with racism and discrimination on the RaLES than White participants (Lambert et al., 2009).

Perceived Control. Perceived control was assessed using the 18item Control-Related Beliefs (CRB) scale developed by Weisz and colleagues (Weisz, Sweeney, Proffitt, & Carr, 1993; Weisz, Southam-Gerow, & Sweeney, 1998; Weisz, Southam-Gerow, & McCarty, 2001). The CRB scale assesses beliefs about one's ability to exert control over outcomes in academic, social, and behavioral domains. It has demonstrated relationships with depressive symptoms and low perceived personal competence, another type of control related belief, and also with perceived non-contingency of outcomes (Weisz et al., 1993). Children respond to each item using a four point scale ranging from 1 ("not at all true") to 4 ("very true"). Weisz et al. (2001) reported an alpha of .88 for total CRB scores; in our sample the alpha for total scores was .76.

Social and Behavior Problems (TOCA). School Behaviors and Symptoms. Teacher Observation of Classroom Adaptation Revised (TOCA R; Werthamer Larsson, Kellam, & Wheeler, 1991). Teacher ratings of shyness, authority acceptance (defiance), and likability (peer rejection were obtained in the spring semester 7th and 9th grade using the TOCA-R (Werthamer-Larsson, Kellam, & Wheeler, 1991). The TOCA-R was developed and employed by the JHU PIRC in the evaluation of the 1st and 2nd generation JHU PIRC trials. The TOCA-R requires teachers to respond to 43-items pertaining to the child's adaptation to classroom task demands over the last three weeks. Adaptation is rated by teachers on a six-point frequency scale (1 = almost never to 6 = almost always). Each subscale is reported as a mean score of all items. Items for the sub-scales were largely drawn from the DSM-III, III-R and IV.

The Shy subscale includes four-items that measure social avoidance or low social participation ("Avoided classmates", "Stayed to him/herself"). The Authority Acceptance subscale includes 10-items that measure defiant behaviors at school (e.g., "Disobeyed teachers and other adults", "Talked back to teachers and other adults"). The Likeability (peer rejection) subscale includes 3 items (rejected by classmates, has lots of friends, and children seek him out to play); we reversed scored the positively worded items and took the mean of all items. Test-retest correlations over a four month interval with different interviewers were .60 or higher for each of these subscales, whereas the coefficient alphas ranged from .80 to .94 for all subscales.

Results

Preliminary Analysis

Preliminary correlation analyses were calculated to determine the bivariate relations among study variables (see Table 1). Several social variables had relationships with the key variables (neighborhood risk, parental monitoring, and racism) in the study. As expected, Neighborhood Risks in the 7th grade had a significant correlations with social outcomes in the 9th grade. 7th grade neighborhood risks was significant associated with 9th grade authority acceptance (r =.177, p<.05). and shyness (r= .150, p<.05), and reading (r=-.189, p<.05). Parent monitoring also had significant, albeit small, correlations with most social behavior outcomes in 9th grade. Racism in the 7th grade was negatively associated with 9th grade Math abilities (-.070, p<.05); neighborhood risk was unrelated to math achievement. In addition, racism experiences in the 7th grade had a positive association with depressive symptoms in the 9th grade (r= .235, p<.05) and anxiety symptoms (r=.234, p<.05).

Internalizing Symptoms. The Baltimore How I Feel-Young Child Version, Child Report (BHIF-YC-C; Ialongo, Kellam, & Poduska, 1999a) is a child self-report scale of depressive and anxious symptoms. Two-week test-retest reliability coefficients have ranged from .60 in first grade to .70 in middle school (Ialongo, Kellam, & Poduska, 1999a). Data from the first generation PIRC datasets revealed that child self-reports on the BHIF Depression subscale during elementary school predicted

	1	2	3	4	5	6	7	8	9	10
1. G7 Parent Monitor										
2. G7 Neighborhood	.263***									
3. G7 Racism	.075	.210**								
4. G9 Reading	100*	189**	015							
5. G9 Math	125**	197**	070	.557**						
6. G9 Depression	.098*	.218**	.235**	138**	134**					
7 G9 Anxiety	.047	.227**	.234**	156**	139**	.749**				
8. G9 Likeability	.099*	.123**	044	183**	275**	.106*	.013			
9. G9 Shyness	.088	.150	.031	148**	242**	.091*	.001	.726**		
10. G9 Authority	.123**	.177**	.101*	178**	322**	.022	.033	.277**	.242**	

to an age 19-20 report of a lifetime suicide attempt (O.R. = 2.38, C.I.= 1.30-4.25) and a diagnosis of a lifetime episode of Major Depressive Disorder (O.R. = 1.84, C.I. = 1.16-2.92).

Procedures

Data was collected annually through school record reports, teacher-ratings, parenting ratings, and youth interviews. We will be using the software SPSS to help us analyze the data used in the Baltimore Prevention Trails. The data sampled was taken from the Spring of student's 7th grade year. Most of the information came from face to face interviews that children, parents, and teachers participated in during each grade level. Mediators such as, perceived academic control and perceived social control, were assessed in grade 9. Social and behavioral problems were assessed between the grades 1-3 and later assessed again in grades 6-12. Other mediators such as parental monitoring were assessed using structure interviews and well as perceived racism being monitored using a frequency scale.

Table 1. Interrcorrelations Among African American Children in7th-9th Grade

Regression Analyses

A hierarchical linear regression analysis was conducted to test main effects and the hypotheses that the interaction between neighborhood risk and parent monitoring in the 7th grade will predict 9th grade authority problems and aggression. Following guidelines on testing moderator models outlined by Jaccard, Teitel, and Turrisi (2003), predictor variables were entered in the following order: (1) main effects for all background variables (age, sex, and SES); and (2) 2-way interaction terms.

In order to test moderation, parental monitoring and neighborhood risks were looked at as categorical variables ranging from low to high.

Table 2 provides results from the regression analyses predicting authority problems in the 9th grade when looking at whether or not the predictor is related to the criteria even after controlling for other predictors. In the table we see that in the 7th grade, authority (r=.50), racism (r=.07), and neighborhood risk (.09) were all predictors of 9th grade authority problems. However, gender (r=-.11) and intervention (r= -.03)negatively correlated with 9th grade authority problems. When adding in the interaction between monitoring and neighborhood risks, we see that there was a negative correlation (r=-.15) indicating that children who experience lower levels of parental monitoring in high risk neighborhoods are more likely to develop authority problems in the 9th grade as shown in Figure 1. Also, low levels of parental monitoring in high risk neighborhoods, was a predictor of adolescents developing high levels of aggression in the 9th grade.

Variable	β	В	SE	р	R ²
					.32*
Gender	11	15	.06	.01*	
Intervention	03	02	.04	.52	
Authority Problems (grade 7)	.50	.55	.05	.00*	
Racism (grade 7)	.07	.06	.04	.08	
Neighborhood Risk (grade 7)	.09	.10	.05	.03*	
	Mode	l 2:			
Adding Interaction Beta	ween M	onitori	ng an	d Neighb	orhood
					.33*
Parent Monitoring (grade 7)	02	01	.03	.73	
Neighborhood X Monitoring	15	.09	.03	.001*	

Table 2. Multiple Regression Predicting 9th Grade Authority

 Problems from Neighborhood Risk

Discussion

The present study investigated the effects of parental monitoring, neighborhood risk, and racism on adolescents' social and academic outcomes in 9th grade. The results from the study were consistent with our hypothesis that neighborhood risk would predict future shyness, likeability, and authority acceptance. However, racism did not predict these same outcomes. Instead, racism in the 7th grade predicted 9th grade math achievement after controlling for it in 7th grade. We also found that high levels of parent monitoring made it less likely that kids in high risks neighborhood would develop authority problems, shyness, peer rejection, or depression.

These findings suggest that neighborhood risk, racism experiences, and parental monitoring all influence youth development during the middle school years. Each contextual factor has small predictive relations with future outcomes. The small effects observed here indicate that developmental contexts are multi-faceted and no single variable trumps the others in determining youth outcomes.



Low Neighbor Risk High Neighbor Risk

Figure 1. Interaction Between Neighborhood Risk and Parent Monitoring in Predicting 9th Grade Authority Problems and Aggression

Notably, though, and consistent with ecological theory, parental monitoring and neighborhood risk interacted (e.g., the mesosystem) to determine a particular youth outcome, defiance (authority acceptance) in 9th grade. Even after controlling for 7th grade defiance and demographics, neighborhood risk predicted 9th grade defiance; meaning neighborhood context predicted the emergence of new defiance. Of most importance, though, this relationship depended on the level of parental monitoring a youth experienced. Consistent with Dearing (2004), we found that high levels of parent monitoring lowered youth risk for future defiance in high neighborhood risk context. However, parent monitoring was a less important protective factor for youth in low risk settings; in fact, excessive parent monitoring may increase defiance in low risk contexts (see Figure 1). This finding is consistent with developmental theories emphasizing the adolescent push for autonomy and independence. Balancing monitoring with contextual risk can maximize youth outcomes in combination with consideration of this developmental need.

The findings have implications for supporting parents in providing effective environments for their youth. Unlike the Dearing study which highlighted a link between a broad parent construct, and restrictive parenting beliefs, here we found evidence to support the importance of a very explicit parenting skill, monitoring, in supporting youth development. The Dearing finding was unactionable in many ways because it is difficult to change parenting values; additionally, the construct in that study was overly general to include punitive parenting practices which may lead parents to presume hostile parenting is appropriate in high risk settings. In the present study, we found evidence that a discrete and malleable parenting behavior, monitoring, could mitigate risk for adverse youth outcomes for those living in high risk contexts. For parents in lower risk settings, excessive monitoring may undermine youth autonomy. So monitoring must be balanced with autonomy support in developmentally appropriate ways to support youth outcomes.

In relation to previous literature, for African American children specifically, it is important to note that parent's who display higher levels of parental monitoring are not practicing authoritarian parenting styles, but are trying to protect their children from drugs, alcohol, or criminal activities that may be within their neighborhood. As a result, knowing where their children are, what they are involved in is best for children's development in the future. Future research should consider other malleable aspects of parenting styles that mitigate risk for negative youth outcomes.

Future research should look at strategies to provide parents with adequate ways to tailor their parenting behaviors to the neighborhood context in which they live in. Some of these things can include interventions that can target not only the student's individually, but also their families and the communities in which they belong to. One way to do this is to take into account some of the African American families who have different socioeconomic statuses. This study only focused on African American families who live in low income areas. Social contextual factors have a profound influence on youth development. Finding other ways to support parents and youth in high risk contexts and how they interact with one another can lead to improved outcomes for youth most at risk.

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Missouri: Historial and Projected Soil Moisture Modeling (1900-2099) for Soil Moisture Stress in July

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Abstract

The purpose of this project is to use historical climate data to analyze past soil moisture trends, as well as, use data from projections of future climate to analyze future soil moisture trends in Missouri. For this project over 100 years of observed temperature and precipitation data from 6 different climate stations were analyzed. The six stations include Maryville (north-west), Steffenville (north-east), Appleton City (west-central), Columbia (central), Neosho (south-west), and Marble Hill (south-east). Soil moisture stress for July was analyzed to observe how soil moisture has changed in Missouri (1900-2014). Projected temperature and precipitation data were used to analyze future changes in soil moisture (2015-2099). Projections of future climate data were obtained from the CMIP5 downscaled archives, which utilizes data from National Center for Atmospheric Research (NCAR). This project focused on two different forcing scenarios. The first is a low emission scenario (RCP26), 475ppm increase of CO2, and the other a high emission scenario (RCP85), 1300ppm increase of CO2. It was found that soil moisture trends (1900-2014) were mostly variable with periods of high stress and low stress between each station. Although, depending on the location of these stations, some experienced more or less stress on soil moisture than others. Generally (1960-2014) soil moisture stress was decreasing, indicating more precipitation in this region than seen in past. Analyzing projected soil moisture trends (2015-2099) it was found that both scenarios cause an increase in soil moisture stress for the month of July. Although, stations varied by location with some showing a greater increase or lesser increase. The high emission scenario (RCP85), displayed a greater increase in stress than low emission scenario (RCP26) for all stations in Missouri.

Introduction

Climate change has been a growing concern and much debated topic throughout the political and scientific communities. The Intergovernmental Panel on Climate Change (IPCC) synthesis report for 2014 integrates key findings from three working groups, The Physical Science Basis, Impacts Adaption, and Vulnerability and Mitigation of Climate Change, has confirmed that throughout the world, human impact has influenced many climatic systems and will continue to do so (Pachauri et al. 2014). Variance in climatic systems such as temperature and precipitation could have serious effects on the availability of soil moisture for vegetation, streamflow, farming, and human uses (Cowell and Urban 2010). Soil moisture, defined as the subsurface water stored in the upper layers of the soil (Hawkins and Ellis 2010), is an important factor in hydrological balance and is essential for land-surface interactions (Hunt et al. 2009). Soil moisture can effect surface albedo and heat fluxes (Black 2007), as well as, be affected by changing climate patterns (Cowell and Urban 2010). All over the world studies are being conducted to better understand the effects of shifting climate patterns on soil moisture. Many different techniques have been applied including historical observations and modeling (Hollinger and Isard 1994, Famiglietti et al. 2008, Svoma et al. 2010, Gallant et al. 2013, Nandintsetseg and Shinoda 2014, Trnka et al. 2015), remote sensing (Jacobs et al. 2003, Cosh et al. 2004), and projected modeling (Miller et al. 2007, Cowell and Urban 2010, Destouni and Verrot 2014, Mishra et al. 2014, Leng et al. 2015).

Historical Soil Moisture Trends

To understand the ways in which climate change affects natural resources, it is important to assess both regional and localized patterns (Kintisch 2008). Studies agree that drying is occurring in the soil profile, thus perpetuating decreased soil moisture availability. For instance, over the extent of Oklahoma and Iowa, 36,000 ground-based soil moisture measurements documented soil moisture variability and found soil moisture followed predictable patterns over the extent of the climatological region (Famiglietti et al. 2008). Thus, depending on the location being assessed patterns should be clear and comparative to temperature and precipitation patterns for that region.

Research conducted in Mongolia discovered decreasing trends in soil moisture from 1961-2006, due to decreased precipitation and increased potential evaporation (Nandintsetseg and Shinoda 2014). This same trend was seen in Czech from 1961-2012 which supported the concern of increasing drought events in that region (Trnka et al. 2015). Similar trends were noticed in Arizona, although soil moisture trends from 1895-2007 showed no significant changes, when assessing the years 1980-2007 soil moisture levels had decreased significantly (Svoma et al. 2010). Although many studies about soil moisture have been conducted, little research has been done in Mid-West and even less in Missouri when assessing soil trends relative to changing climate.

The scientific community will benefit from more studies being conducted in these areas because of the agricultural implications. Soil moisture data in Illinois suggested seasonal differences depending on drought years or wet years (Hollinger and Isard 1994). Global and regional trends in soil moisture from 1950-2000 indicated that soil moisture is driven by precipitation (Sheffield and Wood 2008). This is in agreement with a similar research that found frequency of precipitation controls much of the soil moisture dynamics (Porporato et al. 2004). Research in Australia from 1911-2009 differed from the collective studies above and found soil moisture trends had a tendency towards less frequent, shorter, and less severe droughts (Gallant et al. 2013).

These findings all support the importance of research within this field, as others have found temperature and precipitation driven soil models are a good tool for identifying soil moisture trends. This study will provide valuable data for the Mid-West, particularly in Missouri, where little research has been conducted in order to better understanding soil moisture trends. This project utilizes a large historical record (1900-2014) and this is generally a longer time series than many observational studies.

Projected Soil Moisture

Anthropogenic climate change is thought to be related to greenhouse gas emissions, which have been steadily increasing since the pre-industrial era, due to the growth in population and industry (Pachauri et al. 2014). The implications of these impacts depend on how humankind responds to these changes as society continues to advance (Moss et al. 2010). From 1880-2012 the temperature has risen nearly .850C with each three decades being warmer than the last. (Pachauri et al. 2014). The ability of coupled GCMs to simulate a reasonable seasonal cycle is a necessary condition for confidence in their prediction of long-term climatic changes (Covey et al. 2000). These archives focus on the rapid climate change happening on earth and opened access to climate simulation data for students and scientist (Meehl et al. 2007). These archives have provided valuable data for an array of projects all over the world.

The scientific community has studied the effects changing climate may have on a variety of climactic systems including soil moisture. Most of the research agrees that a drying pattern will continue, thus decreasing the amount of soil moisture available as climate continues to change. One study used data obtained from four AmeriFlux sites in the United States and found that projected soil moisture will become severely stressed at two of the sights as climate continues to change (Miller et al. 2007). Research in China used GCM climate projections under the high emission scenario (RCP85) and found a similar trend that future climate could exacerbate water related risk including a decrease in soil moisture (Leng et al. 2015). When studying a Swedish drainage basin a major increase in the frequency of drying events was found from beginning to the end of the twenty- first century (Destouni and Verrot 2014). These studies all agree that increasing temperatures throughout the twenty-first century will produce higher PET across the United States, decreasing availability of soil moisture (Cowell and Urban 2010). A study conducted in India differed from others research projecting a period of severe drought (2010-2040), that then lead into increases in precipitation from 2070-2099, increasing future soil moisture availability (Mishra et al. 2014). There are many different projected models that can be used to obtain future temperature and precipitation data. This project will be using downscaled versions of CMIP5 archives from National Center for Atmospheric Research (NCAR) in the United States. This project utilizes data from two different forcing scenarios. The first is a low emission scenario (RCP26), 475ppm increase of CO2, and the other a high emission scenario (RCP85), 1300ppm increase of CO2. The research will analyze how different scenarios could affect future soil moisture availability. This has not yet been done in Missouri and will help to fill a gap in research within this region.

Data and Methods Historical Data Sets

To obtain historical data sets of temperature and precipitation the website http://mrcc.isws.illinois.edu/ was used. This site supplies data back to 1895 from both COOP and GHCN stations. COOP (Cooperative Observer Network) stations are supplied through the (NWS) National Weather Service. There are over 10,000 volunteers that obtain daily maximum and minimum temperatures, 24 hour precipitation values, snow fall, and occasionally hydrological or meteorological data such as evaporation or soil temperatures (US Department of Commerce n.d.). GHCN (Global Historical Climatology Network) is an integrated data set that is obtained from 20 different sources (including the COOP network) and over 40,000 stations across all continents. GHCN is currently the largest data set within the world. It utilizes multiple land surface observations over the globe (Menne et al. 2012). These historical data sets provide temperature and precipitation values needed to run the soil moisture model.

Downscaled Climate Model Output

The CMIP5 archive is a collection from 20 different model groups using 50 different model types to project climate change, driven by different emission scenarios (Taylor et al.2012). The need for downscaling was presented after the release of CMIP3, the global climate modeling was too coarse of a resolution for localized systems and needed to be refined. Thus the BCCA (Bias-Correction Constructed Analogues) have been used for downscaling, primarily for CMIP3 but is also used for CMIP5. CMIP5 application differed in that it featured three variables rather than two; daily precipitation, daily maximum temperature, and daily minimum. BCCA is a statistical downscaling method that uses historical data sets and is best suited to project daily climate patterns (Maurer and Hidalgo 2008). Request for projected temperature and precipitation data up to the year 2099 is done using the website http:// gdo-dcp.ucllnl.org/downscaled cmip projections/dcpInterface.html#Projections:%20Subset%20Request can. This website offers a variety of emission scenarios, locations, and archives for projected data. This project, as mentioned earlier, will use two forcing scenarios. A high emissions scenario (RCP85) and a low emission scenario (RCP26). The projected daily temperature and precipitation can then be used in the soil moisture modeling equations.

Soil Moisture Calculations

The soil moisture modeling equations originate from Thornthwaite's Climatic Water Budget Method. For the soil moisture model (AE) actual evaporation and (ST) soil moisture storage must be calculated. By applying (P) precipitation and (PE) potential evaporation values to monitor ST, AE can be found. To achieve this both daily (P) precipitation and (T) temperature data are used to drive the model. ST is calculated based on the previous time step. (ST_{max}) water storage of soil at field capacity is found based on soil type and bed rock within a region. ST can change in two ways; Recharge, an increase to ST, and Utilization, a decrease in ST. There are three different scenarios that can affect the value of ST and AE and they are dependent on supply P and demand PE. PE is found from the equation below and is driven by daily mean temperature (T) in °C and the day length (D) in units of 12 hours (Hawkins and Ellis 2010).

PE=12.97 D²
$$\left(\frac{4.95e^{0.62T}}{100} \right)$$

When P=PE then all the precipitation is lost to evapotranspiration, soil moisture (ST) does not change, and AE=PE. When P>PE there is excess water available to recharge the soil if below field capacity. When P<PE an initial AE is calculated as (Hawkins and Ellis 2010):

$$AE = PE\left(\frac{ST}{ST_{max}}\right)$$

If this value of AE > P, then utilization equals AE-P the value of ST decreases. If this value of AE < P, which may occur with dry soils and light rain events, AE=P and utilization is zero. Soil moisture stress is finally calculated for July in each year using the equation:

$$Stress = 1 - \left(\frac{AE}{PE}\right)$$

July tends to be the driest month and can give a good look at the stress for Missouri soils. When the value for Stress= 0 this represents no stress or wet soil. When the value for Stress=1 this represents the highest level of stress or dry soil.

Historical/Observational Results

This section refers to (Figures 1-6), these figures represent the observational and historical soil moisture data that have been modeled. The graphs display average soil moisture stress for the month of July for the years 1900-2014, for six climate stations in Missouri. The fluctuation of soil moisture stress was variable, with periods of alternating high stress and low stress, Maryville (Figure 1), Steffenville (Figure 2), Appleton City (Figure 3), and Columbia (Figure 4). Two stations were exceptions and showing lower stress events, Neosho (Figure 5) and Marble Hill (Figure 6). Columbia (Figure 4) had the highest stress on average than the other stations, with many of the data points between stress levels of (.10-.40). Marble Hill (Figure 6) had the lowest stress levels on average, with many of the data points between (0-.20). Columbia (Figure 4) and Stephenville (Figure 2) had more frequent and higher stress events than other stations. High stress events indicating years of severe drought include: 1901 (Figures 2-6), 1934 (Figures 1-2, 4-5), 1936 (Figures 1-6), 2012 (Figures 1, 3-5). All of the figures display a similar wetting trend from (1960-2014), indicating an increase in soil moisture over last 30 years. This wetting trend is in disagreement with previous research conducted in the United States and around the world.







Figure 6: As explained in (Figure 1) for Marble Hill, Missouri.

Projected Results

This section refers to (Figures 7-12) and displays modeled future soil moisture trends from years 2015-2099 from projected climate data. Two different climate forcing scenarios were used for the projected results, the first being a low emission scenario, RCP26 (black), the other being a high emission scenario, RPC 85 (grey). Maryville (Figure 7), the low emission scenario (RCP26), many of the data points are between (.10-.30) indicating an increase in soil moisture stress when compared to observed data. For the high emission scenario (RCP85), many of the data points are between (.10-.40), also indicating an increase is soil moisture stress. Steffenville (Figure 8), the low emission scenario (RCP26), many of the data points are between (.10-.20) similar to the observed data. However, there are few data points below (.10) indicating an increase in soil moisture stress. The high emission scenario (RCP85), the data are between (.10-.40), indicating an increase in soil moisture stress. Appleton City (Figure 9), the low emission scenario (RCP26), the data looks very similar to the observed data (Figure 3), with variable high and low stress. This scenario differs from Steffinville (Figure 8) and Maryville (Figure 7) in that less high stress events occur in the future than observed in the past. For the high emission scenario, RCP85, the data again looks very similar to the observed data (Figure 3). When comparing years 2049-2099 there are almost no events below (.10), thus indicating an overall increase in soil moisture stress into the future. When comparing the two emission scenarios for Maryville (Figure 7), Steffenville (Figure 8), and Appleton City (Figure 9) we can observe that the higher emission

causes greater stress on soil moisture than the lower emission scenario. Columbia (Figure 10), the low emission scenario (RCP26), is similar to Appleton City (Figure 9) in that the data looks very similar to the observed data (Figure 4). The data points for this station differ from other stations in that the points are between (.0-.30) indicating fewer stress events in the future than had been seen in the past. This indicates a wetting trend or an increase in precipitation during this time for Columbia (Figure 10). For the high emission scenario (RCP85), the results closely reflect the observed data (Figure 4), again with fewer stress events in the future. Columbia (Figure 10) differs from other satiations in that comparing the two forcing scenarios there seems to be little difference between them. Neosho (Figure 11), the low emission scenario (RCP26), the data is similar to the observed data (Figure 5). The data points are between (0-.20) with no high stress events indicating wetter soils and increasing precipitation. For the high emission scenario (RCP 85), many of the data are between (.10-.40), with two stress events above (.40), indicating an increase stress events for this station. Marble Hill (Figure 12), the low emission scenario (RCP26), the data falls between (.10-.30), indicating a large increase in stress as compared to the observational data (Figure 6). For the high emissions scenario (RCP85), the data also show an increase in stress falling between (.10-.50). A single stress event for the high emission scenario in Marble Hill is (.48), which is double the highest event seen in the observed data (Figure 6). When comparing the two scenarios the higher emissions causes greater stress on soil moisture than the lower emission scenario. Although,

both generally show an increase in soil moisture stress as compared to the observed data sets (Figure 1-6). This indicates as climate continues to change soil moisture availability will decrease and soil moisture stress will increase.



Figure 7: Graph of projected, modeled soil moisture stress for the month of July (2015-2099) in Maryville. Two emission scenarios; low emissions, RCP26 (black) and high emissions, RCP85 (grey).



Figure 8: As explained in (Figure 7) for Steffenville, Missouri.



Figure 9: As explained in (Figure 7) for Appleton City, Missouri.





Figure 11: As explained in (Figure 7) for Neosho, Missouri.



Figure 12: As explained in (Figure 7) for Marble Hill, Missouri.

Summary and Conclusions

When analyzing the historical data in Missouri we observe location plays a large role on how soil moisture is affected. Many of the stations had variable results, periods of high stress and low stress, but some apparent trends could be observed at different locations. Columbia (Figure 4) had more frequent and higher stress events than other stations, whereas Marble Hill (Figure 6), had very few stress events. Several drought years that affecting soil moisture at all stations can be observed, this leads one to believe that severe and prolong drought events can have serious effects on Missouri soils. A clear pattern from 1960-2014 indicates more precipitation than seen in the past 40 years for Missouri. This would indicate more precipitation in the future unlike other studies suggest. The projected climate change had clear and recognizable patterns with soil moisture stress generally increasing into the future. However, when comparing the two different climate scenarios the high emission (RCP85) indicates a larger increase in soil moisture stress than the low emission scenario (RCP26). These trends to agree with other studies that project increased soil moisture drying to continue into the future.

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Relational Schemas and Romantic Relationships Among African Americans

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Abstract

Historically, a majority of African Americans were married, with approximately 95% of black women marrying (Tucker & Mitchell-Kernan, 1995). Over the years this trend has drastically changed with nearly 30% of black women being projected to remain single (Tucker & Mitchell-Kernan, 1995). Today, African Americans marry later than any other racial and ethnic groups, are less likely to stay married, are more likely to divorce and cohabit, and are less likely to remarry after divorce. While many studies address these issues by examining the causes and consequences of this dramatic evolution, very few studies are conducted to address how early experiences and relational schemas-insecure attachment impact romantic relationships. Utilizing data from the Family and Community Health Study (FACHS), we assessed whether early experiences such as discrimination, financial hardship, and relational schemas-insecure attachment negatively impact later romantic relationship functioning. Findings show a significant link between the main effects of earlier experiences and romantic relationship functioning. For example, the link between discrimination and relationship quality indicate that higher levels of discriminatory experiences lowers relationship quality. The link between financial hardship and relationship happiness show that higher levels of financial hardship contribute to lower levels of relationship happiness. The link between relational schemasinsecure attachment and romantic relationship functioning suggests that heighten levels of negative relational schemasinsecure attachment lowers relationship quality, happiness, and satisfaction. Lastly, discrimination and relational schemas-insecure attachment on relationship quality was found to be the only significant interaction effect. In summary, results strongly suggest that early experiences negatively impact later romantic relationships of African Americans.

Introduction

During the 1970s, a majority of black families were married but over time, this trend changed (Marks et al., 2008). There has been a steady decline in marriages and an increase in divorce within the African American community. Research also shows that African Americans are more likely to cohabit and are less likely to marry as compared to their white counterparts (Cherlin, 1998). This decline in marriage rates shows a shift from earlier beliefs and provides evidence about the relationship challenges that African Americans face.

African Americans who do marry experience high divorce rates and lower relationship functioning, which makes it important to research these factors in order to identify the difficulties that are experienced within African American relationships. Not only that, there has been an increase in reluctance to marry among the African American population due to the change in attitudes and negative schemes or experiences with racial discrimination and financial hardship (Simons, Simons, Lei, & Landor, 2012). This in turn, has greatly affected couples relationship quality, happiness, and satisfaction. Due to these factors, a significant amount of evidence indicates that it is a challenging task for African Americans to maintain enduring relationships because of their lower romantic relationship functioning. There have been several studies that highlight the importance of early childhood and adolescent experiences which contributes to the development of negative schemas at an early age (Simons, Simons, Landor, Bryant, & Beach, 2014). For example, there have been many studies that examine the effects that parent-child relationships have on later marital and relationship guality (Nicholson, 2006). There has also been research linking financial strain and socioeconomic status with marriage and divorce rates as well as cohabitation among African American couples (Lincoln & Chae, 2010). Racial discrimination experiences during ones childhood has also been a major factor that reduces relationship quality (Allen, 2015). While decades of research examines the causes and consequences of this epidemic suggesting that factors such as financial hardship and discrimination contributes to relationship instability in African American romantic relationships, very little research investigates the links between earlier experiences and romantic relationship functioning and how relational schemas-insecure attachment might impact these associations.

Early Experiences Experiences of Racial Discrimination

Multiple studies have accumulated a significant amount of research on the impact racial discrimination experiences may have on the psychological well-being of African Americans. Being that African Americans are more likely to experience higher levels of discrimination, this plays a key role in the daily experiences of African American youth, with their psychological well-being oftentimes being put at stake (Sellers, Caldwell, Schmeelk-Cone, & Zimmerman, 2003). Experiencing verbal and physical harassment and discrimination at jobs and school, contributes to adolescents having lower expectations for themselves and the creation of negative schemas that can later impact their romantic relationship functioning. Members of minority groups are often thought to be devalued groups which contributes to an individual internalizing these negative views and perceptions of themselves or their racial group. Due to these early experiences of prejudice and discrimination, negative schemas of one's self is created which, in turn, have mediating effects on relationship quality (Kogan et al., 2013). Prejudice and discrimination is a stressor that spills over and contaminates romantic relationship quality with mechanisms such as self-image and relational schemas-insecure attachment serving as driving factors (Doyle & Molix, 2014). Research reveals that negative effects and threats to social identity such as, prejudice and discrimination, have detrimental effects on one's health, well-being, and relationship quality for members of stigmatized groups

such as African Americans (Doyle & Molix, 2014). Having negative relational schemas-insecure attachments resulting from perceived discrimination mediates negative effects of perceived discrimination on romantic relationship quality through negative self-image (Doyle & Molix, 2014). Individuals are greatly influence by their perceptions of how others view them which can result in internalizing negative attitudes towards one's self and their ethnic group which affects their romantic relationship functioning since positive self-image is important in the maintenance of relationship quality. Research has found that having a less positive self-image, low self-esteem, and negative schemas due to discrimination are all factors that contribute to individuals being distrustful in relationships because of their own insecurities (Simons, Simons, Lei, & Landor, 2012). As a result, the negative effects of discriminatory experiences influence one's schemas and self-image which contributes to lower relationship quality and functioning.

Financial Hardship

Numerous studies over the past several decades have addressed the continuous issues of poverty and financial hardship within the African American community. According to research, African Americans are more likely to experience financial instability as compared to other racial/ethnic groups (Simons, Simons, Lei, & Landor, 2012). Studies suggest that these social factors (financial strain) that occur within the home as well as those occurring outside of the home (racial discrimination/unfair treatment) of many African American families have contributed to negative effects on one's marital quality, satisfaction, happiness, and psychological distress (Lincoln & Chae, 2010). While chronic stress is a major concern within the African American community, economic hardship, socioeconomic status, and financial stress are classified as the most pivotal factors (Hughes, Kiecolt, & Keith, 2014). These limitations of economic resources for this particular racial/ethnic group can be a result of many circumstances such as racial discrimination and unfair treatment which can structure one's economic and life circumstances. This increased stress as a result, negatively impacts the marriages of African Americans through increased tension and mental distress. This in turn, contributes to late and early adolescence developing less positive relational schemas and a reluctance to marriage (Simons, Simons, Lei, & Landor, 2012). Findings show that financial difficulties negatively impact the health and behaviors of individuals in a romantic relationship which diminishes perceptions of marital happiness by the increased negativity that is projected on one's spouse at the expense of expressions of warmth and support (Conger & Elder, 1990). There is a significant link between chronic economic hardship (unemployment, public assistance, and low income level), economic strain (feeling that resources are inadequate to meet one's needs) and martial tension and happiness. Due to marital tension and conflict over finances, the quality of spousal interactions diminishes into negative content (criticism) and negative emotional affect (angry or threatening gestures) which results in lower martial happiness and increased distress (Conger & Elder, 1990). This economic strain and lack

of adequate resources results in negative marital interactions such as increased hostility, withdrawal, and irritable behavior with a decrease in warmth/supportiveness. This ultimately affects perceptions of relationship functioning which results in lower reports of marital happiness. The experience of financial hardships often promotes withdrawn and brittle spousal relationships which can result in low marital happiness and dissolution.

Relational Schemas-Insecure Attachment

Earlier experiences with attachment figures influence relationships that individuals develop with others later in life, while especially setting the stage for later interpersonal relationships. The attainment of a secure attachment figure earlier in life is essential to the formation of a satisfying romantic relationship but due to various adverse experiences, Africans Americans are more likely to possess an insecure attachment style when compared to their white counterparts (Simons, Simons, Lei, & Landor, 2012).

Insecure attachment interferes with an individual's ability to reshape negative relational schemas into pro-relationship perceptions because of its impact on interpersonal trust, which is essential in maintaining relationship quality, happiness, and satisfaction for a well-functioning relationship. Insecurely attached individuals create negative schemas or mental representations of one's self and others due to prior interdependent experiences. These in turn, shape the expectations and beliefs of later romantic relationships. Insecurely attached individuals become accustomed to a history of unreliable, unavailable, inconsistent, and rejecting attachment figures early in life which makes it difficult to establish trust and positive relational schemas in later romantic relationships. This makes it difficult for insecure individuals to establish trustworthiness and achieve the quality of close relationships. As a result, this corrupts the interpersonal relationship processes that are vital to maintaining relationship quality (Givertz, Woszidlo, Segrin, & Knutson, 2013). This lack of interpersonal trust, as a result, contributes to spouse's report of lower relationship quality.

Research states that African Americans are less satisfied with their romantic relationships due to negative relational schemas-insecure attachment experiences during late childhood and early adolescence (Simons, Simons, Lei, & Landor, 2012). Relational schemas-insecure attachment behavior patterns are associated with reduced relationship happiness, satisfaction, and positive emotions due to negative affect and insecure behaviors towards one's partner (Meyer, Jones, Rorer, & Maxwell, 2015). This can be due to persistent exposure to adverse earlier experiences which includes race-related disadvantages and stressful events such as racial discrimination and financial hardship during late childhood and early adolescence. This contributes to cynical views of romantic relationships and ultimately develops distrustful relational schemas. Chronic exposure to adverse conditions increases the chances that African American youth will develop negative relational schemas and insecure attachment that promote conflict and hostility with romantic partners, while creating a reluctance to marry. As a result, African Americans disproportionate exposure to poverty and discrimination lead individuals to expect poor treatment from others in their romantic relationships and contribute to negative relationship views and interactions (Kogan et al., 2013). Therefore, as negative relationship schemas-insecure attachment behaviors increase, romantic relationship quality and positive affect decrease which contributes to lower romantic relationship quality, happiness, and satisfaction (Simons, Simons, Lei, & Landor, 2012).

The Present Study

In this study, we will investigate how the impact of early experiences in childhood and adolescence such as racial discrimination and financial instability contribute to the development of negative relational schemas-insecure attachment. Developing research in this particular area is important given that these factors have a negative influence on African American romantic relationship functioning. We explore how discrimination and financial hardship could possibly lead to adolescents developing distrustful relational schemas, which in turn may impact their romantic relationship functioning. The factors that we will explore in romantic relationship functioning include relationship quality, happiness, and satisfaction. By examining these issues, it is important to consider the consequences for African American couples and significant implications for intervention and education programs.

Hypothesis

As African American youth continue to experience adverse early experiences such as discrimination, financial hardship, and negative relational schemas-insecure attachment there will be a significant decline in their later romantic relationship functioning. Our hypotheses are summarized in the Theoretical Model (see Figure 1).



Figure 1. Theoretical Model. Linking Early Experiences And Romantic Relationship Functioning

Method

Sample

The Family and Community Health Study (FACHS) is a multisite study of neighborhood and family effects on the health and development of African American families. The 867 African American children and their primary caregivers were recruited from small towns and cities in Iowa and Geor-

gia. Block groups, taken from 1990 census data, identified neighborhoods in Iowa and Georgia where the percentage of African American families was high enough for economically practical recruitment and in which at least 10% of families with children live below the poverty line. Two hundred fiftynine blocks (115 in Georgia and 144 in Iowa) were identified and the families were recruited from them. Families with at least one fifth grade child were randomly selected from rosters. There were no significant gender differences among the adolescents in the socioeconomic status of the primary caregivers, parental religiosity, and per capita income of the families. This project includes two waves of data. Waves 3 and

4 were selected for the present study because the variables needed to address the research questions were not all included in previous waves. Wave 3, in which the target adolescents were between 15 and 16 years old, was used to predict adolescent romantic relationship functioning in Wave 4, in which target adolescents were between 18 and 19 years old. Data were collected 2 years apart, which allows for testing of the lasting effects of various influences on romantic relationship functioning.

The analysis focuses upon the respondents who reported at wave 4 that they were involved in a romantic relationship. These were individuals who checked one of the following categories: I see one person on a regular basis; I am in a committed relationship but not engaged; I am engaged to be married (but don't cohabit); I live with my romantic partner but we have no plans to marry; I live with my romantic partner and we are engaged to marry. This consisted of 357 respondents (138 males and 219 females). The remaining sample (i.e., those classified as not having a romantic partner) checked one of the following two categories: I am not dating or seeing anyone right now; I date but do not have a romantic relationship with anyone.

Procedures

Two home visits were completed with each family. The first home visit focused on the informed consent for both the primary caregiver and the target child. Each home visit contained a self-report questionnaire administered in an interview format using a computer-assisted personal interview (CAPI) for the primary caregiver, child, siblings, and a secondary caregiver if applicable. The CAPI procedure provides an element of privacy that increases the likelihood that respondents will be honest when answering sensitive questions. The CAPI procedure was also used as an attempt to eliminate concerns about underreporting and respondent literacy. The interviews were conducted privately between one participant and one researcher, with no other family members present. Laptop computers were used and the questions appeared in sequence on the screen, which both the interviewer and participant could see. Responses were entered on a keypad operated solely by the respondent and those answers did not appear on the shared screen. Caregivers received \$100 and

the target child received \$70 for participating in the study.

Measures

Experiences of Discrimination. The adolescents completed 13 items from the Schedule of Racist Events (Landrine & Klonoff, 1996). This instrument has strong psychometric properties and has been used extensively in studies of African Americans. The items assess the frequency (1 never to 4 several times) with which various discriminatory events (e.g., racial slurs, hassled by police) were experienced during the preceding year. These items form a measure of experiences of discrimination.

Financial Hardship. The adolescents' primary caregiver reported the extent to which they had experienced financial stressors (e.g., couldn't pay bills). These items form a measure of exposure to family financial hardship.

Relational Schemas-Insecure Attachment. Relational Schemas, by proxy insecure attachment, was assessed using the Experiences in Close Relationships-Revised (ECR-R) (Fraley, Waller, & Brennan, 2000) which improves the measurement precision and construct validity of the original ECR scale (Brennan, Clark, & Shaver, 1998). Adolescents reported on the extent to which they agree with statements such as "I don't like people getting too close to me", "I'm nervous whenever anyone gets too close to me", and "I often worry that my partner(s) doesn't really love me."

Relationship Quality. Relationship quality was assessed by asking the adolescent "how well do you and your romantic partner get along compared to most couples?" Responses ranged from 1 (a lot worse) to 5 (a lot better). Relationship Happiness. Adolescents were asked "how happy are you, all things considered, with your relationship?" Responses ranged from 1 (extremely unhappy) to 6 (extremely happy).

Relationship Satisfaction. Relationship satisfaction was assessed by asking the adolescent "all in all, how satisfied are you with your relationship?" Responses ranged from 1 (not at all satisfied) to 5 (completely satisfied).

Analytic Strategy

Hierarchical regression analyses were conducted to test for the main and interaction effects of early experience (discrimination, financial hardship, relational schemas-insecure attachment) on adolescents' relationship functioning (relationship quality, relationship happiness, relationship satisfaction). For each regression analysis, the main effect variables (e.g., discrimination, financial hardship, relational schemas-insecure attachment) were entered at Model 1, two-way interaction terms (discrimination × insecure attachment, discrimination × financial hardship, insecure attachment × financial hardship) were entered at Model 2 (Aiken & West, 1991). Analyses were performed using SPSS Version 17 software package (SPSS, 2008). Post hoc analyses were conducted on all the significant interaction effects using the Aiken and West (1991) approach to probing interactions.

Results

Table 1 shows the main effects of discrimination and insecure attachment on relationship quality was found to be significant. Results indicate that respondents who reported higher levels of discrimination and insecure attachment tended to report lower relationship quality (-.18, p<.05 and -.11, p<.05). The main effects financial hardship and insecure attachment on relationship happiness was also found to be significant. These findings suggest that respondents who reported higher levels of financial hardship and insecure attachment tended to report lower relationship happiness (-.11, p<.05 and -.15, p<.05). In addition, the main effect of insecure attachment on relationship satisfaction was found to be significant. Higher levels of insecure attachment predict lower levels of relationship satisfaction (-.16, p<.01). Only the interaction variable, discrimination × insecure attachment, emerged as statistically significant. Figure 2 depicts the post hoc analyses of the interaction between discrimination × insecure attachment suggesting that the effect of discrimination on relationship quality is heightened when it occurs in combination with insecure attachment.



Figure 2. Interaction Between Discrimination Relationship Quality, and Relational Schema

Discussion and Conclusion

Numerous studies have reported that African Americans are less satisfied with their romantic relationship and are less likely to marry than their white counterparts. As for those who do marry, they tend to report lower romantic relationship functioning (Simons, Simons, Lei, & Landor, 2012). Previous research has focused primarily on the causes and consequences of African Americans reports of lower romantic

Table 1. Multiple Regression Models Assessing the Influences of Early Experiences on Rom	iantic
Relationship Functioning	

Variable	Relati Qua	onship ality	Relati Hap	ionship piness	Relati Satisf	onship action
Main Effects						
Discrimination	18*	89*	03	78	10	10
	(.09)	(.41)	(.12)	(.55)	(.09)	(.38)
Financial Hardship	.01	.20	11*	58*	06	.08
	(.04)	(.19)	(.04)	(.26)	(.04)	(.18)
Relational Schemas-Insecure Attachment	11*	-21	15*	67*	16**	13
	(.05)	(.23)	(.07)	(.31)	(.05)	(.22)
Interaction Effects						
Discrimination*Relational Schemas- Insecure Attachment		.19*		.13		.03
		(.10)		(.13)		(.09)
Discrimination*Financial Hardship		.02		.09		.03
		(.09)		(.12)		(.08)
Relational Schemas-Insecure Attachment*Financial Hardship		07		.09		03
		(.05)		(.06)		(.04)
R ²	0.17	0.22	0.17	0.21	0.22	0.22
+ n < 10, * n < 05, ** n < 01						

† p<.10; * p<.05; ** p<.01

relationship functioning. Although important, this research does not include considerations of how early experiences and relational schemas-insecure attachment impact romantic relationship functioning. The present study extended this research by investigating the links between earlier experiences and romantic relationship functioning and how relational schemas-insecure attachment impacts those associations.

We hypothesized that as African American youth continue to experience adverse early experiences such as discrimination, financial hardship, and negative relational schemas-insecure attachment there will be a significant decline in their later romantic relationship functioning. Hypothesis were tested with a sample that included two waves of data, Wave 3 and 4, which consisted of 767 target African American adolescents. Our study results provided strong support and were consistent with our hypothesis. Findings show a link between the main effects of earlier experiences (racial discrimination and financial hardship) and romantic relationship functioning (relationship quality, happiness, and satisfaction). High levels of racial discrimination predicted lower levels of relationship quality. Research shows that racial discrimination experiences negatively impacts the psychological well-being of African American youth (Sellers, Caldwell, Schmeelk-Cone, & Zimmerman, 2003). This contributes to the creation of negative schemas of their experiences and one's self which creates distrustful views in adolescent's romantic relationships. As a result, this impacts relationship quality.

High levels of financial hardship also contributed to lower levels of relationship happiness. Being that African Americans are more likely to experience financial instability when compared to other racial/ethnic groups, they are more likely to experience stressors from financial strain and marital tension (Simons, Simons, Lei, & Landor, 2012). This in turn, creates negative marital interaction styles which negatively impacts perceptions of relationship happiness. Heightened levels of negative relational schemas-insecure attachment predicted lower levels of relationship quality, happiness, and satisfaction. Negative relational schemas-insecure attachment orientations corrupts interpersonal relationship processes such as trust and connectedness that are essential in maintaining positive romantic relationships (Givertz, Woszidlo, Segrin, & Knutson, 2013). This contributes to lower relationship quality. Due to negative relational schemas-insecure attachment, adolescence develop negative self-images and low self-esteem which give rise to distrust and negative relational emotions. This results in negative affectivity which, in turn, is deflected onto one's romantic partner and contributes to lower relationship happiness within romantic relationships. All of these factors may be a result of adverse/negative experiences during childhood and early adolescence which gives rise to negative relational schemas-insecure attachment. This creates negative and distrustful relationship views which causes low relationship satisfaction.

Our findings also show a link between the effects of discrimination and relational schemas-insecure attachment on relationship quality. This was the only significant interaction effect. Reports show that high levels of negative relational schemas-insecure attachment heightens the impact discrimination has on romantic relationship quality. In summary, results strongly suggest that early experiences negatively impact later romantic relationships of African Americans. By examining these issues, findings yielded from this study will provide information about African Americans attitudes and experiences in romantic relationships. Consideration of relational schemasinsecure attachment can foster intervention programs that identify and respond to relationship problems with the use of cognitive process to help promote healthier relationships among African Americans. This can also lead to the development of educational programs that focuses on positive relationship attributes, specifically for African Americans, which

can help alter negative relational schemas-insecure attachments experienced during childhood and adolescence. Moreover, future research should also explore the influence of other culturally-relevant factors such as skin tone (e.g., lightness or darkness of one's skin color) on the formation of African Americans attitudes and experiences in romantic relationships (Landor & Halpern, 2016; Landor et al., 2013).

Limitations

Despite its strengths, our study has a few limitations. First, our sample focuses only African Americans. As a result, we were unable to examine the extent to which differences between African Americans and other racial/ethnic groups with regard to the early experiences in our model explain the gap between the two groups in relational schemas and relationship functioning. In addition, given the sensitive nature of several of the self-reported discrimination questions, these events may be underreported.

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Featured Scholar



Stanley A. Ikpe, PhD Electronic/Reliability Engineer, AST NASA Langley Research Center Hampton, Virginia

In a fast-paced, rapidly evolving society, often times it can be challenging and even somewhat intimidating for a young adult attempting to find value in their work and get the most out of their college education. This was precisely the predicament that I faced as I was entering into my junior year in the Department of Electrical and Computer Engineering at the University of Missouri-Columbia some ten years ago (2006). To further complicate the situation, the economic climate at the time was such that I was not entirely sure that I would be equipped with the skills and experiences necessary to compete in a global technical arena directly after completing my bachelor's in engineering. It was in that realization that I realistically began to consider continuing my education. The McNair Scholars Post-Baccalaureate Achievement Program was suggested to me as a great opportunity to participate in research opportunities and extracurricular learning. Little did I know that it would become so instrumental in providing me with the insight and skills necessary to be successful in graduate school.

The McNair Scholars Program afforded me with a great opportunity to get involved in a multidisciplinary undergraduate engineering research project. I investigated nondestructive methods to evaluate the strength and integrity of steel rebars commonly found embedded in various concrete structures. Under the tutelage of Dr. Gregory Triplett and Dr. Glenn Washer I learned how to develop relevant research questions and research methods that eventually helped me in pursuing and completing my PhD in Electrical and Computer Engineering just a few years later (2013). Through the program, I became familiarized with the expectations of graduate school and developed the fundamental skills required to be successful in not only academic endeavors, but in my professional career as well.

Not only was the McNair Scholars Program effective in introducing me to the vast world that is independent research, but it also provided access to ample skill workshops and mentoring in which I learned the importance of time management, technical writing and public speaking to name a few. These workshops were invaluable in helping me further develop these fundamental tools of success. Furthermore, the exposure to the various research projects and innovative ideas of my peers helped scope my own research pursuits in both a Master's and later in a PhD. The devotion to the success of each scholar and the unlimited support and encouragement displayed by Dr. NatTashua Davis and Dr. Vicki Curby (as well as the entire McNair Staff at the University of Missouri-Columbia) played a vital role in helping me forge the confidence and determination to succeed in my academic career and now in my professional role. Even now, as I am currently working as an Electronics Engineer/Aerospace Technologist at NASA Langley Research Center, I still draw upon the valuable lessons that I learned in the McNair Scholars Program as well as from my graduate education. I am very grateful for the opportunity to have participated in the McNair Scholars Program. The skills that I developed and the relationships that I formed during my time in the McNair Scholars program at MU were invaluable and I consider it a true honor to be among the select few. I undoubtedly do recommend and encourage every student looking for an opportunity to participate in independent research or looking for guidance and preparation for the rigorous road that is graduate school to take advantage of this terrific program and all the resources it provides.

2015- 2016 Research Topics							
Scholar	Major	Title	Mentor				
Tyler Adelstein	Geological Sciences	Zinc-rich ores of West Fork Mine: Multiple-fluid involvement in the southeast Missouri mining district	Kevin Shelton				
Ian Boese	History & Geography	Stadiums, Cities, and the NFL: A Content Analysis of the St. Louis Post-Dispatch	Douglas Hurt				
Denisha Campbell	Communication Science & Disorders	Dual Tasking While Speaking: To Do or Not To Do	Mili Kuruvilla- Dugdale				
Cassandra Casteel	Archaeology & Anthropology	The Development of Morphologies of the Feather Serpent in Mesoamerica	Christine VanPoo				
Belquis Elhadi	Sociology	Muslim and American: An Intersectional Analysis of Muslim Identity Enactment in a Midwestern Town	Ibitola Pearce				
Delan Ellington	Anthropology & History	Singing from the Choir: Exploration Analysis of the Cultural Effects of the Black Church has on LGBTQT African Americans	Mary Shenk				
Nicole Franklin- Jordan	Psychology	Effects of Diet Stress Interaction in Alzheimer's Disease	David Beversdor: & Brianne Kille				
Samantha Fullington	Special Education	Supporting Kindergarten Readiness for Children at Risk	Melissa Stormont				
Lydia Singh Ghuman	English	Speech Variation and Gender Expression	Matthew Gordon				
Lauren Godsy	Human Development and Family Science	Divorce Education and Coparenting Styles: An Examination of the Focus on Kids Program	David Schramm				
Andrew Hutchinson	Sociology & History	Order Up: Documenting Restaurant Culture	Wayne Brekhus				
Amber Kellum	Human Development and Family Science	Relational Schemas and Romantic Relationships Among African Americans	Antoinette Lando				
Trevion McGhaw	Industrial Engineering	The Environmental Impacts of Reducing Food Waste	Ron McGarvey				
Brian Moreno	History	Descendants of the Seven Caves: The Origins of the Tlaxcalan-Mexica Rivalry	Robert Smale				
Devin Petersohn	Computer Science	Multi-Species Study on Palindromic DNA	Chi-Ren Shyu				
Brandy Pugh	Psychology	Family and Neighborhood Influences on Self-Perceptions and Academic Achievements of African American Middle School Students Living in Urban Contexts	Keith Herman				
Da'Vonya Wilson	Nursing	"Peers Keep It Real" HIV Peer Educator Medication Adherence Intervention	Maithe Enriquez				
Victoria Young	Psychology	Mindfulness Focused on Interpersonal Interactions Predicts Friendship Quality	Ann Bettencourt				

2015-2016 McNair Scholars



Back Row: Jeremy Bloss (Sr. Student Services Specialist), Devin Petersohn, Andrew Hutchinson, Victoria Young, Samantha Fullington, Brandy Pugh, Tyler Adelstein, Delan Ellington, Brian Moreno

Front Row: Amber Kellum, Lyndia Singh Ghuman, Nicole Franklin-Jordan, Da'Vonya Wilson, Belquis Elhadhi, Lauren Godsy, Cassandra Casteel, Walta Abraham, Trevion McGhaw, Dr. NaTashua Davis (Director)

Not Pictured: Ian Boese, Denisha Campbell, Darlene Dixon (Administrative Assistant), Tiffanesha Williams (Graduate Assistant)





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