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TRiO
RONALD E. McNAIR
POST-BACCALAUREATE
ACHIEVEMENT PROGRAM

BIOGRAPHY OF DR. RONALD E. MCNAIR

HE OVERCAME OBSTACLES.

Dr. Ronald Erwin McNair, Physicist & Astronaut, dared to dream. As an African-American growing up in a poor community in the South, he encountered discrimination early in his youth. Yet this did not stop him from pursuing his dream of becoming a scientist.

HE ACHIEVED ACADEMIC EXCELLENCE.

In 1971, he graduated magna cum laude from North Carolina AT&T State University with a B.S. degree in physics. Ronald McNair then enrolled in the Massachusetts Institute of Technology. In 1976, at the age of 26, he earned his Ph.D. degree in laser physics.

HE BECAME A LEADER IN HIS FIELD.

Dr. McNair soon became a recognized expert in laser physics while working as a staff physicist with Hughes Research Laboratory. He was selected by NASA for the space shuttle program in 1978 and was a mission specialist aboard the 1984 flight of the shuttle Challenger.

HE WAS RESPECTED AND COMMENDED.

For his achievements, Ronald McNair received three honorary doctorate degrees and many fellowships and commendations. These distinctions include: Presidential Scholar, 1967-71; Ford Foundation Fellow, 1971-74; National Fellowship Fund Fellow, 1974-75, Omega Psi Phi Scholar of the Year, 1975; Distinguished National Scientist, National Society of Black Professional Engineers, 1979; and the Friend of Freedom Award, 1981.

HE EXCELLED IN MANY ASPECTS OF LIFE.

Ronald McNair also held a fifth degree black belt in karate and was an accomplished jazz saxophonist. He was married and was the dedicated father of a daughter and a son.

After his death in the Challenger explosion in January 1986, members of Congress provided funding for the Ronald E. McNair Post-Baccalaureate Achievement Program to encourage college students with similar backgrounds to Dr. McNair to enroll in graduate studies. Thus, the program targets students of color and low income, first-generation college students. This program is dedicated to the high standards of achievement inspired by Dr. McNair's life.

Biography courtesy of the University of Nevada, Las Vegas

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2017 McNAIR RESEARCH ARTICLES

CHILDREN'S PERCEPTIONS OF LIE-TELLING IN MODESTY CONTEXTS: A QUALITATIVE STUDY

by AMBER N. BACHNER

INTRODUCTION

Developmental research has found that children perceive lying as black and white until approximately age eight (Bussey, 1999). A lie is considered "bad" and a truth is "good" according to their early socialization (Heyman et al., 2008). In his book, *The Moral Judgment of the Child*, Piaget (1932) describes that around age 10, children shift away from viewing rules as moral absolutes, and into an autonomous stage of morality in which it is permissible to violate or challenge rules in order to benefit other people. It is also the case that judgments by the child of right and wrong focuses less on objective outcomes and more on intent (Heyman et al., 2008).

However, recent research asserts that development of a sense of morality, especially with regard to lie-telling, is firmly in place before the age of seven (Heyman et al., 2008). Talwar, Murphy, and Lee, (2008), found that children as young as three-years-old were able to tell white-lies when receiving undesired gifts out of consideration for the gift-giver (Talwar et al., 2007), suggesting that very young children recognize politeness contexts, and have the ability to respond accordingly. Furthermore, Bussey, (1999), Peterson et al., (1983), and Walper & Valtin, (1992), found that elementary school-aged children evaluate truth-telling as less acceptable and lie-telling as more acceptable in politeness contexts, compared to transgression contexts (Heyman et al., 2008), even though children are keen to evaluate these transgressions as morally wrong the majority of the time (Shweder et al., 1987; Turiel, 1983).

Research by Walper and Valtin (1992) examined children's understanding of white-lies and lying behaviors in politeness situations. The results revealed that as children get older, they begin evaluating others' lie-telling behaviors in politeness contexts as less negative, and are more inclined to tell situational lies themselves (Walper and Valtin, 1992). Children's socio-moral knowledge about lying was significantly related to their judgments (e.g., lying to avoid hurting another's feelings), especially when their moral judgments were consistent with their motives for truth or lie-telling in the politeness situation. As such, what may account

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for this is, "the development of role-taking skills which allow one to infer and take into account the wants and needs of individuals, and to coordinate different perspectives" (Walper and Valtin, 1992, p. 249).

The question remains whether the development of role-taking skills correlates with moral evaluation among children. It appears to be the case in the aforementioned study, and early research by Piaget suggests the same. This is because between the ages of six and ten-years-old, children increase in their understanding of socially desirable motives. "This greater understanding of mental life may facilitate children's ability to reason about the relation between motives and verbal behavior" (Heyman et al., 2008). The research by Heyman and Walper and Valtin seems to indicate that older children (between the ages of 8 to 11 years-old) would be more aware of the impact of lie-telling and truth-telling behaviors than younger children.

The study by Heyman et al. (2008), revealed more about the subject of children's moral evaluations in politeness contexts. The study was designed with a particular emphasis on children's moral evaluations of being honest, social awareness, and protecting the feelings of others. In this study children (ages 7 to 11) were read stories that described politeness situations in which the protagonist received an unwanted gift. In each story, the character reported what he or she thought of the gift in one of two variations of the story. In variation one, the character honestly reported not liking the gift, whereas in variation two, the character lied, claiming to like the gift. Across all ages, children assessed lie-telling as unfavorable and truth-telling more favorably in transgression contexts, demonstrating context sensitivity in their evaluative judgments (Heyman et al., 2008). When children focused on emotional impact of a statement, they evaluated lie-telling more favorably (Heyman et al., 2008).

Focusing on the social impact of lie-telling and truth-telling in modesty contexts has also been researched from a cultural perspective. Cultural experiences and socialization are crucial to the development of children's evaluations of truth telling, lie-telling, and moral consequences (Banerjee, 2000; Cameron, 2012; Lee, 2017). From a cross-cultural perspective, it is interesting to note the philosophical differences between cultures, especially in the literature comparing Chinese and Western cultures (Lee et al., 1997). These differences include that Chinese philosophy is rooted in collectivism and the greater good for the society, whereas Westerners value individualism, self-confidence, and self-esteem (Lee et al., 1997; Sweetser, 1987).

It was hypothesized that this prosocial behavior rooted in Chinese culture was the result of the Chinese culture as being more collectivistic than individualistic (Fu et al., 2008). However, surprising findings by Banerjee (2000) found that British children (aged 8 and 10) showed a preference for modest lie-telling in a pro-social way, and 75% of the children who preferred modesty were able to give socially evaluative justifications for their choices (e.g. being boastful causes others to dislike you). As children gradually gain awareness of their cultures and contexts, these values become more evident, especially with regard to modest lie-telling (Cameron et al., 2012). For example, it has been found that Chinese-Canadian children (Cameron et al., 2012) prefer modest lie-telling to immodest truth-telling in social modesty contexts, but were more likely to rate modest-lie telling positively than Euro-Canadian children (Cameron et al., 2012).

Based on these findings, our study further investigates how American children evaluate the morality of both lies and truths told in different social contexts (collaborative versus non-collaborative) and with different social pragmatic outcomes (pro-social vs. self-serving). Our specific hypotheses are:

1. Are there developmental differences in children's reasons for moral evaluations of truth-telling and lie-telling?
2. Is there a difference in children's reasoning strategies for determining whether a lie is good or bad?

METHODS

Participants

A total of 24 children, 12 boys and 12 girls, participated in this study. The children were recruited from a dual-language (Spanish and English) university lab school in South Texas whose student body represents the district's socioeconomic and linguistic demographics. Seventeen of the 24 children were 7 to 8 years old, (constituting the younger age group), and seven children were 10 to 11 years old (comprising the older age group).

Procedure

Before data collection began, the children were given written information and an informed consent form to take home to their parents. Once the informed consent form was returned, signed by the parent, children were invited to participate in the study. A quiet room near the classroom was provided by the school staff for the study. Once children had given their assent to participate in the study procedure (all agreed to participate), demographic data including name, age, grade, and primary language, were collected on university iPads.

The children were then read a series of 10 short vignettes, including 2 practice stories and 8 study stories (see *Appendix*). Four of the eight study stories contained a character that told a lie, and four of the stories contained a character telling the truth. Of the four involving telling a lie, two of the stories depicted the telling of a lie in a pro-social situation, while the other two stories depicted the telling of a lie in a non-prosocial situation. One of the two stories involving telling a lie in a pro-social situation had two characters that collaborated to do a single task, whereas the other story depicted only one character in a non-collaboration situation.

After each story, children were asked three questions about each story: 1) Was the character's response a truth or a lie? 2) Was the character's response very good, good, neither, bad, or very bad? 3) Why was it very good, good, neither, bad, or very bad? The children's answers to the first two questions were recorded on an iPad, using Qualtrics software, and the open-ended question was recorded on audio tape recorders for later transcription and coding.

Transcription and Coding

The audio recordings of the third, open-ended questions were transcribed word for word as Microsoft Word documents. The transcriptions were used to inductively develop codes which captured the differences in reasoning and moral evaluations children gave about the character's actions and reports in the stories. These were then entered into SPSS, along with the children's demographic data. . The following codes represent three different kinds of justifications given by the children:

1. *Restatement* was when a child restated what the story character said was good or bad: "because he/she lied."
2. Focus on the *Truth Value* of a statement. For example, if in the vignette, a character cleaned their room, and reported that they cleaned their room, then the character's report was not only considered "true" but also "good." Or, if the story character did not clean their room, but reported that they did, this was considered a lie and therefore "bad." In this case, the report and action do not match.
3. The third category, *Social/Pragmatic Reasoning*, includes responses that reflect the child's social awareness of consequences. For example, if one character blamed another character for a wrongdoing, even if the child was "telling the truth," the children often identified the report as bad, stating that the other (blamed) character "could get in trouble" as a result. Similarly, responses in which a child reasoned that it was "good" when one character gave credit to the other and didn't take credit for themselves in a collaborative setting, also falls into this category.

ANALYSIS

Three chi-square analyses were run to determine whether there were significant differences in the kinds of justifications used by children according to age and two social context variables. First, a 2(Age) X 3(Justification) analysis was run to determine whether younger vs. older children used different kinds of justifications. Second, a 2(Modesty) X 3(Justification) analysis was run to determine whether children used different kinds of justifications depending on the modesty context. Finally, a third, 2(Collaboration) X 3(Justification) analysis was used to determine whether collaborative context affected children's use of different kinds of justifications.

RESULTS

First, no significant difference was found between reasons used across age groups to justify evaluations of all reports ($F(2, 190) = 5.671$, $p = .059$). Second, there was a significant difference between reasons used to justify evaluations of modest and immodest reports

($F(2, 92) = 7.019$, $p = .03$) when children perceived the character in the vignette was telling the truth. Children used social/pragmatic reasoning strategies to explain behavior, in modesty contexts more often than in immodest contexts. Third, there was a significant difference between reasons used to justify evaluations of reports with collaboration and without collaboration ($F(2, 98) = 16.644$, $p < .001$) when children perceived the character in the vignette was telling a lie.

DISCUSSION

The present study investigated American children's reasons for their moral evaluations of lie-telling and truth-telling in modest and immodest social contexts, with and without collaboration. In terms of age, all children use all categories of reasoning: Restatement, Truth Value, and Social/Pragmatic Reasoning. Truth Value was the greatest concern for children across all ages, accounting for at least half of all evaluations. Social/Pragmatic Reasoning, or the concern for social impact of the report, was more of a concern for children when they perceived the report to be a lie than when it was a truth. Negative social impact also affected all but one child's perception of how severe a lie was, even for children as young as seven.

In terms of moral evaluations of lie-telling and truth-telling, we were able to capture a glimpse of the kinds of reasoning strategies children might employ. We know they are aware of social impact (suggesting a kind of perspective-taking that contributes to the development of Theory of Mind), and that the consistency of the report and action (Truth Value) is important in the determination. This is especially true with regard to modesty and collaboration.

In the case of modesty, children considered modest truths that are socially positive to be important, but these truths are especially "good" when the truth value matches. If the character actually did bring his sick friend his homework assignment so he could complete it on time, and reported that he did so, then children consider this to be a complete truth without ambiguity, *and* socially good.

Collaboration plays a big role in children's justification strategies, as previous literature has found, particularly when social consequence and truth value is concerned with regard to telling lies (Fu, G. et al., Heyman, G.D. et al., & Lee, K. et al.). Children will use social/pragmatic reasoning to justify lies that are told in collaboration, which suggests awareness of social impact. When lies are told without collaboration, children use the truth value strategy to evaluate the lie instead, suggesting that the lie is of low social impact and of higher personal consequence.

Limitations

One main limitation of this study is that there was a small sample size. In addition to the small sample size, there was a smaller number of children in the older group than the younger group. This makes it difficult to meaningfully compare the reasoning strategies and moral evaluations utilized by the older group of children than the younger group of children.

Another limitation is that we only captured specific circumstances in which the children employed their reasoning strategies. There could be other life situations that affect children's evaluations of truths and lies that we could not capture in our vignettes. An example of an uncaptured circumstance could be how a child evaluates lie-telling behaviors if the lie is meant to protect the feelings of another person.

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TABLE 1.
Age X Justification Type

		Social/ Pragmatic	Truth Value	Restatement	Total
Age	Younger (7-8 Year olds)	41	68	32	141
	Older (10-11 Year olds)	20	25	4	49
	Total	61	93	36	190

NOTE: There was not a significant difference between justification type used by younger vs. older children ($F(2, 190) = 5.671$, $p = .059$).

TABLE 2.
Truth: Modesty X Justification Type

		Social/ Pragmatic	Truth Value	Restatement	Total
Modesty	Modest	20	24	13	57
	Immodest	4	23	8	35
	Total	24	47	21	92

NOTE: There was a significant difference between reasons used to justify evaluations of modest and immodest reports ($F(2, 92) = 7.019$, $p = .03$) when children perceived the report to be true.

TABLE 3.
Lies: Collaboration X Justification Type

		Social/ Pragmatic	Truth Value	Restatement	Total
Collaboration	With	29	16	6	51
	Without	8	30	9	47
	Total	37	46	15	98

NOTE: There was a significant difference between reasons used to justify evaluations of reports with collaboration and without collaboration ($F(2, 98) = 16.644$, $p < .001$) when children perceived the report to be a lie.

APPENDIX

Practice Stories

One night Emma made brownies for the whole class. The next morning, Emma took the brownies to school, and passed them out to the class. When Emma handed her teacher a brownie, her teacher said, "How nice of you to bring brownies for everyone. Did you make them yourself?" Emma said, "Yes, I made them."

Danny and Paul were told by their father that they could not have any snacks before lunch, but they wanted some animal crackers. Danny and Paul decided to go into the kitchen when their dad was not looking, and grabbed the animal crackers. They ate the whole bag of crackers together, and then went back to their own rooms. Danny and Paul's Dad then noticed that all of the crackers were gone. He went into Danny's room and asked him, "Do you know who ate the animal crackers?" Danny responded, "It was Paul who ate the animal crackers."

Lying About a Prosocial Act (Modest Lie): Without Collaboration

Ricardo and Juan were putting a puzzle together. Once they finished, Ricardo and Juan helped each other put the puzzle pieces back into the box. After they cleaned up, Ricardo went to use the restroom. The teacher approached Juan and asked if he was the one who cleaned up the puzzle. Juan said, "No, I did not do that, Ricardo did."

Lying About a Prosocial Act (Modest Lie): Without Collaboration

Selena knew that her friend Mary had lost her lunch money on the way to school, and had no money to buy her lunch. When Mary left her desk, Selena secretly put some of her own money on Mary's desk so she could buy lunch. When Mary found the money and told her teacher, the teacher told the class, "Mary just told me that someone has given her money so she can buy lunch." The teacher asked Selena, "Do you know who left the money for Mary?" Selena said to her teacher, "No, I don't know who left the money for Mary."

Telling the Truth about a Pro-Social Act (Immodest Truth): With Collaboration

Jennifer and her sister Lucy were playing with toys and got their room very messy while their mom was cooking dinner. They decided to clean the room together after they finished playing. Lucy left the room to go watch her favorite cartoon. Their mother then came into the room and found that the room was very clean, and asked, "Did you clean the room?" Jennifer said, "Yes, I did clean the room."

Telling the Truth about a Pro-Social Act (Immodest Truth): Without Collaboration

Timothy and Mark are best friends at school. One day Mark was sick and had to stay home and Timothy knew Mark would not be able to complete his part of the group assignment due the next day unless Timothy took him the assignment. So, Timothy decided to take Mark the assignment to his house after school, so that Mark could work on it. The next day Mark came to school and turned in his part of the group project on time, and the teacher asked the whole class, "Who was so nice to take Mark his homework assignment yesterday so he could turn it in today?" Timothy replied, "It was me, I took him his assignment."

Lying About a Misdeed: With Collaboration

Pam and Lisa were playing with a soccer ball outside when their mom came out and said, "It's about to rain, do not bring the ball when you come inside." When it started raining, the girls brought the ball inside and played in their room. Pam went to the kitchen and while she was gone, their mom saw the ball on the floor and asked, "Who was playing with the ball inside?" Lisa told her mom, "I wasn't, Pam was playing with it."

Lying About a Misdeed: Without Collaboration

Michael and Derek were reading books in the school library. Derek excused himself to go to the bathroom, and while he was gone Michael decided to make paper airplanes. To do this, he tore some pages out of a storybook from the library. The librarian noticed that pages were missing from the storybook, and asked Michael, "Do you know who tore out the pages?" Michael said to the librarian, "No, I don't know who tore them out."

Telling the Truth about a Misdeed: With Collaboration

Ben and Carlos' mom made cookies for dessert. She told them not to eat any because they were for after dinner. They did not want to wait, so while their mother wasn't paying attention, they each took a cookie back to their bedroom and ate it. Once they were done eating, Carlos went outside to play. When their mom noticed the cookies were missing, she went to their bedroom and asked Ben, "Did you eat the cookies before dinnertime?" Ben replied, "Yes, I did eat a cookie."

Telling the Truth about a Misdeed: Without Collaboration

Anne wanted to play with a jump rope during gym class but found that one of her classmates, Sherry, was already playing with it. Anne told Sherry that she wanted the jump rope, and when Sherry said no, Anne grabbed it out of her hands which made Sherry cry. The teacher came over to see if Sherry was alright, and asked Anne, "Do you know who made Sherry upset?" Anne replied, "I did."

STUDENTS' BOOK CHOICES DURING THE TEXAS BLUEBONNET AWARD VOTING

by KATRINA CANTU

ABSTRACT

The purpose of this study is to determine children's reading interests by analyzing two sets of data: students' explanations in focus groups of their voting processes in the Texas Bluebonnet Award Program and the researcher's reading of several past winning books in this same program. Participants in this study included seven fifth grade students and the librarian at one South Texas elementary school. After conducting a content analysis of the books and analyzing focus group transcripts and librarian interview transcripts, several themes emerged. It seems students are interested in graphic novels, stories with human characters around the same age of the readers, and lively book covers and interior illustrations. Teachers can use this information to better assist students as they choose books to read since they will be armed with information about student interests. By providing students with a choice of books, teachers can begin to motivate their young readers.

MENTOR

Dr. Bethanie Pletcher

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INTRODUCTION

"I couldn't stop reading [the book] because it was so good." So, what is it about a book that makes a child interested in reading it? In order for teachers to assist elementary-aged children in selecting books, they need to know why children choose certain books over others. Do children study the picture on the front cover, the title, the synopsis on the back cover, or the genre of the book? In order to gain insight as to the reading interests of third, fourth, fifth, and sixth grade students in Texas over the years, this study began with a content analysis of the Texas Bluebonnet Award (TBA) Program. The TBA program began in 1979, and students in grades three through six have the opportunity to exercise their vote on a favorite book from a master list of 20 books. Originally, this research began with reviewing all winning books since 1981 in order to observe the similarities and differences between them and to learn about the reading interests of students. This study evolved to include focus interviews with students from a school that participates in the TBA program each year with the goal of hearing the children's perspectives of the Texas Bluebonnet Award Program. "…Books that children find "most interesting" are those they have selected for their own reasons and purposes" (as cited in Gambrell, 1996, p. 21).

LITERATURE REVIEW

Children Have the Choice

In order to get children to want to read, we must first give them the option of what to read. "Children's choice award programs have proven to be effective weapons in the battle to get and keep children reading" (Crow, 2010, p. 12). Research says children's choice book award programs are founded upon positivity; it is that positivity that allows children to "develop a bond with reading" (Crow, 2010, p. 12). The goal of children's choice book award programs is for students to continue to read into their adult lives for pleasure. Before students possess the desire to read on their own, they must first discover the way real reading happens. The main factor that contributes to this discovery is the power of choice. "Choice is a proven positive motivator for individuals, because choice provides autonomy in decision making" (Crow, 2010, p. 12). To help students take up texts for their own purposes, the success is higher if we provide them a choice and the knowledge that reading takes many forms (Mackey, 2014). In an adult-driven world, children do not always have a choice and it is not always taught; in fact, "No matter what a person's reading preferences, selection proficiency matters. It is a significant life skill" (Mackey, 2014, p. 526). Like most individuals, when given the power of choice, the want to do something is more likely to happen. In order for children to benefit from literature, they must first understand "literature on [their] own terms" (Aerila & Ronkko, 2015, p. 355).

The Texas Bluebonnet Award Program

Founded by Dr. Janelle Paris, a former school librarian and a professor of children's literature courses at Sam Houston State University, the Texas Bluebonnet Award Program was launched as a dream and turned into a reality (Lesesne, 2007, p. 47). The goal of the Bluebonnet program is "to encourage Texas children to read more, explore a variety of current books, develop powers of discrimination and identify their favorite books" (Texas Library Association, 2010). Every year in October at the Texas Book Festival, a master list of 20 books, determined by the TBA selection committee, is released. This committee is comprised of librarians who work directly with children (Lesesne, 2007, p. 47). As Johnson and Blair add, some may see [master lists] as an "alternative approach to total student self-selection" and suggest that teachers can provide students with a set of quality books (as cited in Bang-Jenson, 2010, p. 171). The committee selects a variety of books including both fiction and nonfiction in order to address the diverse interests of students. For a book to be considered for the Texas Bluebonnet Award and to be included on the master list, the book must have been published within three years of the current date in the United States and must have been written by a United States citizen. Every book to be considered must have credentials and a positive review within the literature community from journals like *School Library Journal, Horn Book,* or *Publisher's Weekly.* Each of the books must also demonstrate appropriate content and reading level for students in third through sixth grade (Lesesne, 2007). For students to be involved in the Texas Bluebonnet Award Program, their school or library must be registered with the TBA program each year. Students in grades three through six are allowed to begin reading texts off the master list in the fall, and to be eligible to cast their vote in January for their favorite book, they must have read or heard read aloud at least five of the books from the master list (Texas Library Association, 2010). The author of the winning book is presented the award at the annual conference in April by the Texas Library Association.

The Ingredients of Children's Literature

Children's literature is composed of many different elements and the reason we know these elements work in these types of books is because the children are honest with what they have to say about the things they read. "Children…are the best critics of all. They read carefully and passionately…" (Slater, 2016, p. 7). The authors of children's books strategically implement features into their work, such as a well thought-out orientation, cover design, fonts and their sizes, word choice and their syntax, and illustrations. Each of these elements are meant to offer further meaning for the reader to construct (Layne & Serafini, 2013). The decisions made by authors and illustrators of children's books are strategic and purposeful and exist for readers so they may delve further into the reading experience for their own personal benefit. The visual elements included in a story give the reader more clues as to the meaning behind the content of the story. "Calling

students' attention to the way font adds to the story, how color and borders can change the way we react to an illustration…the shape of the book itself, and the relationship between words and images expands the meaning potential of the readers' experiences" (Serafini, 2012, p. 458). Visual elements should not only be looked at in aesthetic terms, but also how they were designed and created (Serafini, 2012). Every detail included in the pages of children's literature matters. With the goal of the content solely at focus, the input of authors' syntax and sentence structure is worthwhile because the words used and the way they are used have a purpose. All of these features create a complex work of children's literature in which the focus on detail amplifies the story for the better (Louie et al., 2014).

Fain, Hasty, and Schrodt (2015) discuss how diversity and the representation of students' cultures, as well as the cultures of others in children's literature, contributes to the idealistic approach of providing students with the various books available on the market today. It is also useful to note the content of children's literature. Many children's books are adventurous, sad, loving, joyful, and funny; however, there is often much more involved in the story than what we see on the surface. Regarding humor in children's literature, "What may first look like a simple, funny book may in fact require readers to think in more complex and sophisticated ways" (Coles & Serafini, 2015, p. 636). All the ingredients added to children's books are mixed in for a reason, but the main purpose is to offer students high-quality books so their reading experiences are memorable.

Establishing Motivation to Read

Reading is not simply a way to pass the time; it is also a way of learning about the world and the changes it goes through. Consider a book from the 1970s and a book from the 21st century; study the way words are used, the pictures on the page, the elements added that move the reader from the words to the pictures, and the overall message in focus. One can notice the extreme difference. Miller (2009) suggests, "If we want our students to read and enjoy it for the rest of their lives, then we must show them what a reading life looks like" (p.110). After modeling for students what reading means, we must provide them with a choice of books "for their own reasons and purposes" (Gambrell, 1996, p. 21). Research provides strong support and evidence on the value of choice and how it provides an intrinsic motivation to read, rather than a goal to reach. When individuals take on reading from an aesthetic point of view, the long-term effect is more meaningful. This can begin with teachers who introduce reading as a gift rather than a goal to achieve (Miller, 2009). As Bang-Jensen (2010) adds, "When readers have their say in selecting books, they exercise agency in the development of their own reader identities and create a rich relationship with books" (p. 175). Using the analysis from the Young Adults' Choices Program (Samuels, 1989), the votes of the students indicate they value the opportunity to be able to choose their own books to read (Samuels, 1989). Gambrell (1996) suggests, "[motivation] often makes the difference between learning that is superficial and shallow and learning that is deep and internalized" (p. 15). Motivation begins by giving children a choice, and that is part of what shapes students in becoming independent thinkers and learners of our society. As Miller (2009) suggests, people must find their own "joy in reading," as that is going to provide each and every person a reason to read (p. 113). Miller also proclaims, "it is not too late to develop a love of reading… craft your own reading plan" (p. 112). This is something we could all add to our teaching repertoire in hopes of inspiring each and every child each and every day.

METHODS

This study consists of two parts: a content analysis of the winning Texas Bluebonnet Award Program (TBA) books since the program's inception in 1981 and interviews of students and a librarian involved in the program at one elementary school. The content analysis, both qualitative and quantitative in nature, provided a framework for the possibilities of what children in grades three through six might be interested in reading based on the types of books that won the award across the years. The researcher also used feedback from two focus group interviews of children from one fifth grade class in a South Texas elementary school in order to gain insight into the reading interests of children. In addition, the researcher interviewed the librarian at the same school to learn more about the TBA program.

Participants and Setting

Focus group participants. One elementary school in a large South Texas district was chosen based on

convenience due to the researcher's previous work there as an American Reads tutor and the fact the school participated each year in the TBA program. The elementary school campus resides on a university campus where the researcher attends classes. 679 with a Hispanic ethnicity majority. There were also 11full-time employed at this school The focus group was comprised of seven fifth grade students, one of who was male and six of who were female. Of this fifth grade class, there were 12 females and 8 males. These seven focus group students were purposefully chosen based on their willingness to participate, along with parental/guardian consent.

School librarian. The librarian was chosen due to her position at the same school as the focus interview students, as well as for her experience with the Texas Bluebonnet Award Program. The librarian had worked at the school for 10 years and had organized the TBA program on the campus for several of those years.

Data Collection

Focus group interviews. In order to add authenticity to this research, the researcher asked fifth-grade students questions about their reading interests and the TBA Program, hoping to gain insight as to what children are interested in reading and how adults can better assist them when selecting books to read. The researcher split the group into two groups of four and three students to allow for conversation. Each focus group lasted approximately 25 minutes and followed a whole-group discussion format using a pre-determined list of questions (see Appendix A). Using a university-owned iPad, the researcher recorded each focus group interview using a program called AudioNote. After recording these discussions, the researcher transcribed them onto a word document and color-coded each response of each child in order to determine which child spoke and when.

Librarian interview. This interview lasted about 35 minutes and the researcher used a pre-determined list of questions in order to facilitate the discussion (see Appendix B). This conversation was recorded using the same program as above and the researcher also transcribed the questions and comments onto a word document. The information gained from this interview allowed the researcher to learn about the TBA program as well as the librarian's perceptions of students' reading interests in this school. The researcher also visited the librarian on separate occasions to learn more about the TBA Program; however, these discussions were not recorded.

Content of Texas Bluebonnet Award Program winning books. By reading and carefully analyzing 28 of the winning books of the TBA Program since 1981, the researcher was able to determine the similarities, differences, and common themes between them. Books not read were researched by the researcher. Noticing the elements of these books, the researcher was able to note the kinds of things children in grades three through six might be interested in reading. In order to evaluate these elements, the researcher read 28 of the winning books since 1981 and used a checklist to record what each book contained (see Table 2).

Data Analysis

The researcher first gathered notes taken about the content of each award-winning book and created a checklist to determine the similarities, differences, and common themes found in them. The researcher first open-coded the student focus group transcripts and the librarian interview transcript. Next, these themes were placed alongside the researcher-created checklist information from the TBA winning books to compare the two. After, the researcher grouped themes together into categories to represent the data collected.

Ethical Considerations

Student participation in the focus groups and librarian participation in the interview was voluntary. Students provided assent to participate and their guardians provided consent for them to participate. The librarian also completed a consent form. All information presented from the focus group and interview transcripts is confidential and pseudonyms are used.

Trustworthiness

Three types of data were used to establish triangulation within this study. The researcher's mentor reviewed the book checklist (Table 2), as well as the focus group interview questions. The responses from both focus groups were compared to each other in order to create overlapping responses and themes from all participants. Focus group transcripts and librarian interview transcripts were shared with the students and the librarian, respectively, as a form of member checking.

RESULTS

Which Books Are Students Most Interested in Reading?

"These are stories with a beginning, a middle, and an end." With *Roller Girl* by Victoria Jamieson as the 2017 Texas Bluebonnet Award recipient, it is apparent children enjoy reading graphic novels. In the researcher's focus groups, several participants responded they like to read graphic novels, and the story, *Diary of a Wimpy Kid* by Jeff Kinney, was one of the first they had read. Many of the focus group participants claimed graphic novels are funny and they are easier and different from a regular book "because those are like in lines." The librarian also revealed details about graphic novels when she indicated, "[Graphic novels are] stories with a beginning, a middle, and an end and you're bringing in a lot more…illustrations with the text so [the children] are getting a little better understanding of it and they're comprehending graphic novels better than a regular novel…" In 2006, another graphic novel, *Seadogs: An Epic Ocean Operetta* by Lisa Wheeler and Mark Siegel, received the Texas Bluebonnet Award. David L. Russell (2015), in *Literature for Children: A Short Introduction,* says, "proponents of the graphic novel argue it creates a bridge between the visual media and the written media…" one of which makes a lot of sense considering young people of the 21st century are more visually savvy with the rise of technology having been at their fingertips each and every day. As the librarian said, "graphic novels are the key to getting kids to become readers…[because after], they naturally move on to other books themselves."

"I'm more of like a people person." Many might assume animal characters would spark an interest in younger readers more than human characters, but according to the Texas Bluebonnet Award Program winning books, students enjoy reading about human characters just as much. In the researcher's focus groups, conversations arose about animals versus human subjects and participants agreed human characters were more relatable to them. One participant explained they did not enjoy reading about books with animals because they are sad, that they are "more of…a people" person. When animal books come to mind, it is safe to say some may start off rather sad or end sadly and according to one participant, this is what draws them away from these types of texts. On the other hand, voters for the Texas Bluebonnet Award Program have chosen books such as *Snot Stew* by Bill Wallace in 1992 and *Because of Winn-Dixie* by Kate DiCamillo in 2002 as their winners, which are animal books filled with more humor, friendship, and less sadness. On a similar note, one participant's feedback on animal books being too sad to read, *Shiloh* by Phyllis Reynolds Naylor won the Texas Bluebonnet Award in 1994 and this one could be considered as particularly sad at times. Some animal books are sad and some readers read one or two sad animal books and are driven away from other animal books, preferring to read about other people instead.

First impressions do matter. We have been told numerous times to never judge a book by its cover and, while that is true, first impressions are rather important. Many of the winning TBA Program books have front covers that are full of color, creatively designed, or carefully constructed to convey the story's overall theme and the pages contain a "juxtaposition" of images that pave the way for a successful book design (Russell, 2015). Readers in the focus groups explained when they look at the front cover, it gets them thinking "like what, what is that?" As the participants discussed the 2017 winner, *Roller Girl,* they commented on how they noticed someone roller-skating on the front cover and how that sparked their interest in the book's overall focus. Many participants in the focus groups agreed the illustrations play a big role in whether or not they will choose a particular book. In addition, one participant mentioned how one of the books from the master list, *Crenshaw* by Katherine Applegate, "really grabbed them." This particular book's front cover displayed the perspective of the reader behind the bench on which the two main characters are sitting, as well as the size difference between the boy and the cat (Russell). Also, the title, according to one focus group participant, was printed on the front cover in a way that caught their attention. These noticings provide evidence on why the front cover of a book matters to the reader in whether or not they choose to select the book in the first place.

The favorite gets the vote. As determined by the TBA Program, in order for children to vote on their favorite book, they must have read five or have heard read aloud five of the books from the master list. This could be noted as the most "exciting" part of the Texas Bluebonnet Award Program, as one participant from the

focus groups mentioned, because it allows children to showcase their favorite book in the program from that current year's master list. Many times though, children will have more than one favorite book they read from the master list. In regards to which book to vote for if the reader had many favorites, one response was, "the one I read the fastest because [I must have been] more interested…[as in] I couldn't stop reading it because it was so good." This may be a useful tactic for children in deciding which book gets their vote.

What Are the Similarities of the Texas Bluebonnet Award Winning Books?

Ten-year-olds want to read about other ten-year-olds. After carefully reading many of the winning books from 1981 to 2017 of the Texas Bluebonnet Award Program, the researcher found most of these books contained a character between the ages of eight and 12, which falls under the age group of the TBA Program audience. Books like *Nothing's Fair in Fifth Grade* by Barthe DeClements, *Skinnybones* by Barbara Park, *The Ghost of Fossil Glen* by Cynthia DeFelice, and *The Strange Case of the Origami Yoda* by Tom Angleberger are only a few of the titles from the winning list of TBA books that present characters of this age, as shown in Table 1. It seems children enjoy reading books about other children and their lives, whether they are humorous, scary, or adventurous pieces of literature.

Illustrations tell the story too. As previously mentioned, participants in the focus groups mostly agreed illustrations play a starring role in what they decide to read. Many of the winning books contained colorful illustrations on the front cover of the book and/or within each page of the book. One student participant mentioned how, when they are looking for a book to read, they tend to "flip through the pages" before removing it from the bookshelf. It may be perhaps students are not only skimming through the words on each page, but through the illustrations as well. Many of these illustrations contain realistic images engaged in unrealistic behaviors, as is the case in the winning book of 2001, *Cook-A-Doodle-Doo!* by Janet Stevens and Susan Stevens Crummel. Some of these winning books are chapter books, which also contain illustrations; although the chapter books' illustrations are usually black and white and more of a sketch. Such is the case in the 1991 winning book, *Aliens for Breakfast:* by Jonathan Etra and Stephanie Spinner. This short chapter book that contains about 150 pages included several black and white illustrations to go along with the text. Many of these findings are depicted in Table 2. Illustrations, as Serafini (2012) states, adds to the "relationship between words and images [which] expands the meaning potential of the readers' experience" (p. 458). The pictures within a book, whether a chapter or picture book, are not there to make the page(s) simply look pretty; rather, they help to tell the story and sometimes they may tell their own story too.

TABLE 1.
Ten-year-olds want to read about other ten-year-olds

Book Title	8-12 Year Old Character	Human Character	Gender role: girl	Gender role: boy
1984, Nothings Fair In Fifth Grade	X	X	X	
1985, Skinnybones	X	X		X
2000, The Ghost of Fossil Glen	X	X	X	
2012, The Strange Case of the Origami Yoda	X	X		X

Immerse us in another world. In addition to the many similarities found within the winning Texas Bluebonnet Award Program books, it was determined the audience of these books also prefer to read fiction books over nonfiction books. One participant from the focus groups mentioned nonfiction books "put you into [the] real world again." Another participant mentioned how they prefer fiction books such as realistic fiction "because it could really happen [and] it does happen." Many of the winning TBA books are fictional, including subgenres such as realistic fiction, historical fiction, and science fiction, whereas only two of the TBA winning books are nonfiction works, namely biographies. Participants claimed to enjoy reading about "things that are based on real people." Comments like these indicate perhaps some children enjoy reading about real people who are immersed in a world other than their own.

DISCUSSION

Research Purposes and Results

After determining which books children in grades three through six are most interested in reading and in observing what the winning books of the TBA Program have in common, the researcher was able to gain insight as to the types of books children are reading in 2017 and how this has changed since 1981. Based on the focus group transcripts and the book checklist (Table 2) that compared the winning TBA books since 1981, children are interested in reading about other people, more specifically people within their age group of eight to 12 years. Children in grades three through six also choose books to read based on the front cover and the illustrations within the book. Similarly, as Louie, Pughe, and Sierschynski (2014) discovered, visual elements included in a story provide the reader with more clues as to the meaning of the story, which may be another reason children choose books based on the illustrations. After reviewing the checklist, it seems children are interested in reading about books that contain humor and friendship elements and they prefer books with a realistic storyline but in a fictional matter. Graphic novels are also popular.

TABLE 2.
Texas Bluebonnet Award Program
Winning Books (1981-2017) Checklist

Elements contained within	Total %
8-12 year old character	50%
Animal characters	35%
Human characters	70%
Gender focus: girl	27%
Gender focus: boy	38%
Family focus	35%
Simple storyline: problem/solution	48%
Realistic storyline	43%
Humor	54%
Love/Romance	5%
Friendship	65%
Mysterious	22%
Scary (ghost stories)	16%
Sad (death, loneliness, fear)	32%
Adventurous	27%
Biography	5%
Fictional (all types)	95%
Picture book	38%
Graphic novel	5%
Interactive (throughout story, activities at the end)	16%
Repetitive phrases throughout story	30%
Black and white color usage in illustrations	22%
Various color usage in illustrations	43%
Detailed illustrations	51%
Realistic illustrations engaged in real behaviors	27%
Realistic illustrations engaged in unreal behaviors	19%
Chapter book	62%
Shorter chapter book, less than 150 pgs	32%

Implications

Children need to make their own book selections, and teachers need to be mindful of these choices in order to stock their classroom libraries with selections children will want to read. Many focus group participants agreed being able to choose their own books was something they enjoyed. For children participating in the Texas Bluebonnet Award Program, pleasure reading grows from having access to books they are actually interested in reading. One student participant said, "[our librarian tells us] to have fun with it…to enjoy it…" and when there are certain restrictions, to "pick one book that is within your level and then another book that you want." The school librarian explained how the older children in this particular school sometimes read to kindergarten students and "…now they're getting a chance to read the picture books they still want to read." Allowing children choices puts pleasure, rather than pressure, back into reading. In order for our students to hold onto that intrinsic motivation to read they start out with when they are younger, we must allow them to decide which books most interest them. This information coincides with what Crow (2010) says about children's choice award programs in that they "have proven to be effective weapons in the battle to get and keep children reading" (p. 12). The Texas Bluebonnet Award Program is a prime example of how we can provide our students with choices within a restriction of 20 books as determined by the selection committee of the TBA Program.

An exciting part of this program is that students can vote on their favorite book that may end up being the

overall winner. Focus group participants commented about how they enjoyed being able to "make a choice" on their favorite book and possibly "[change] an author's life." The school librarian explained "[the children] have the power to change things [and this is why the] award is so important." Being able to vote makes them "feel special," as one focus group participant explained because "kids usually don't get to make the big decisions, it's all the grown-ups." As Crow (2010) stated, "Choice is a proven positive motivator for individuals, because choice provides autonomy in decision making" (p. 12). And with the children being able to cast their vote, this is clearly represented.

Focus group participants also explained how they believe the people who choose the books on the TBA master list provide a wide range of books and they must be "the best books" out there since "professionals" are choosing them. As Lesesne (2007) commented, "…the TBA selection committee…is comprised of librarians who work directly with children" (p. 47) and these must be the "professionals" to which our students are referring. Students said some of the best parts of participating in the Texas Bluebonnet Award Program are "the new books" and that "that's more to read" for them. Another focus group participant said the TBA Program helped them "want to read thicker books because they're more interesting…"

Another positive benefit of the TBA Program, and perhaps the most conclusive and much talked about part of why the Texas Bluebonnet Award Program is "fun" for the students at this elementary school, is the promotion and encouragement of it by the librarian and teachers. This librarian motivates students to participate in the program by offering students a celebration for having read at least eight of the books and having completed five projects related to the books read. Students agreed it is "fun" to make projects out of [the books] and, according to the school librarian, a project for a book helps students remain engaged with that book. To name a few, students have created a blacked-out solar system for the text *Lowriders in Space* by Cathy Camper with a lowrider hanging from it, and another student mimed something from one of the books for the librarian. Some students created different crafts based on the books they read, such as bottle-cap necklaces, bookmarks, and journals. Similarly, as Layne and Serafini (2013) wrote, "[books' additions] are meant to be seen in order to offer further meaning for the reader to construct." By the librarian encouraging students to interact with these texts at this elementary school, the students are getting that exact experience. Students participating in this program explained these activities motivated them to read and interact with the books. The librarian also reads many of the TBA books aloud to children in the primary grades in order to encourage wider reading. The librarian commented how "the second graders were always seeing what I'm doing with the third-sixth graders and they wanted to be a part of it so on their own, [and] without me doing anything…they started creating book projects themselves and bringing them to show me during library time…they didn't have to do that…it was strictly voluntary."

The librarian also conducted "book talks" with students to motivate children to participate in the TBA program. Book talks "…help prepare children as readers…[listen] to other readers' points of view to explore themes and big ideas, and [create] a community of learners where everyone can share ideas…[and] make meaning of their reading" (Bixler, Henderson & Smith, 2013). Students involved in the focus groups explained they were motivated to read these books because the book talks inspired them. One student said, after hearing the librarian share something about a new book, "you're like wow." The librarian commented how she reads aloud at least three TBA books to each grade level. The librarian explained how "the biggest thing you can do to motivate a reader is to do a book talk…whether it's a kid doing a book talk or a teacher doing a book talk… whatever it is, kids [gain interest in that book because of it]." One year, she also created a life-sized game board in the library for the book *Giants Beware!* by Jorge Aguirre.

With all of this information in focus, it is apparent the Texas Bluebonnet Award Program can do wonderful things for students and schools. Children are able to choose their own books for pleasure reading from a list of high quality children's literature and they feel powerful in the sense they have the chance to change an author's future with their vote. Much of the excitement and anticipation of this program comes from how the school promotes and encourages the award process with the students. Through the two focus groups and

librarian interviews, the researcher has learned the many things one children's choice program has to offer. Programs such as this bring life and joy to reading, as they make books real and memorable for students. This is especially true if the librarian and teachers promote the books with intriguing book talks and projects which allow students to connect with the books. If the adults pave the way for what reading can do for students and the world in which it can immerse them in, children may be intrinsically motivated to continue reading. This is what the Texas Bluebonnet Award Program is all about. Learning about the reading interests of our students, as well as studying the content of the winning TBA books since 1981 might allow teachers to assist students in choosing a book to read. Knowing why students choose certain books over others can also help teachers expose students to rich, quality literature that may help bring life and joy back into reading.

Limitations

The limitations of this study were the use of a small sample of seven fifth grade students from one South Texas elementary school and one librarian from the same school. In addition, focus group interviews were under time constraints due to the nature of the school calendar and state testing.

Future Directions for Research

After conducting this research, several questions emerged. What might students in the primary grades have to say about books included in the Texas Bluebonnet Award Program? In what ways do the reading interests of students change as they enter the upper elementary grade levels? How does the use of the TBA program's books' read alouds affect students' participation in the program when they move into third grade? It will also be helpful to consider other children's choice book award programs and determine how they align with the TBA program.

CONCLUSION

After conducting this research, insightful information was discovered in regards to the types of books children in grades three through six are interested in reading. Analyzing the TBA Program's winning books, as well as the responses from fifth grade student participants, helped to put in perspective the reading interests of upper elementary students. Armed with this data, teachers may not only give students opportunities to choose their own books, but also develop ways to assist children in making book selections. I have gained much insight as to how and why a children's choice program can promote reading and offer the intrinsic value of reading for students. Furthermore, the evidence gathered from this study may provide teachers with a road map of the reading interests of elementary-aged students, as well as why and how the TBA program works so well.

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APPENDIX A:

Focus Groups Interview Protocol

- Do you like to read? Why or why not?
- What kinds of things do you look for when you choose a book to read?
- What kinds of books do you like to read?
- Is this your first time participating in the Texas Bluebonnet Award Program? What was it like for you?
- Did you vote? Why or why not?
- How did you make a decision on which book to vote for?
- How many of all the TBA books that you read did you:
  * Read by yourself?
  * Read with a family member/friend?
  * Have a teacher read aloud to you/the class?
  * Did you read any of them to other students of your age or younger?
- Out of this year's 20 books:
  * Which one did you like the best and why?
  * Which one did you like the least and why?
- Have you learned anything by participating in this program?
- Did you enjoy being able to choose a winner out of all 20 books?
- How does it feel to participate in a children's choice book award program?
- Would you participate in a program like this or this one in particular again?
- Did this program help with motivating you to read?
- How did it feel to be able to choose your own book to read?
- What do you think the TBA Program does for you and your classmates?
- What was the best part of participating in the TBA Program for you?

APPENDIX B:

Librarian Interview Protocol

- Voter Qualifications:
  * Students in grades 3-6
  * Have read or have heard read-aloud of at least 5 books from the master list
  * Enrolled at a TBA-registered school
  * Last day of voting is January 31st
  * Voting required or on a volunteer basis?
- How long have you been a school librarian? What about at this school?
- What is the Texas Bluebonnet Award?
- What is the history of the award?
- How long have you been involved with the award as a librarian?
- All the reading of the books and voting on the books is entirely on a volunteer-base?

- In what ways do you promote the award with students? With teachers?
- About how many children participate in the voting each year?
- What do you notice about how the children vote each year? (Excited, prefer one method over another, etc.)
- What was your voting process this year?
- What was the general procedure the kids had to do in order to vote?
- Have you ever predicted which book would win and why?
- How do you feel the award and voting process affects students' reading?
- What were some things you overheard about the books this year?
- Can you identify the ones you felt were popular this year and why?
- Did you read any of them? What did you think? Any in specific you want to mention?
- Could other students read books from the master list that were not in grades 3-6?

EVIDENCE OF A COUPLE-SERVING BIAS IN INTIMATE RELATIONSHIPS

by JESSA RUBIE G. CASTRO

ABSTRACT

The present project explored the possibility of the existence of the couple-serving bias and the impact of attribution styles within close relationships. Using a modified version of the Attributional Style Questionnaire (Peterson et al., 1982) developed for this study, a sample of 122 undergraduate students currently in a romantic relationships displayed evidence of a couple-serving bias in which they made internal, stable, and global attributional ratings for their partner's successes and made more external, unstable, and specific attributional ratings for the partner's failures. The size of these couple-serving biases were found to be positively related to participants' scores on the relational assessment scale (Hendrick, 1988).

Keywords: *Self-Serving Bias, Attribution, Attribution Style, Romantic Relationships, Attributional Style Questionnaire*

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INTRODUCTION

Successful relationships likely have unique ways of maintaining fulfillment and enjoyment throughout their duration, may it be five months or five decades. Couple use a multitude of relationship maintenance techniques and strategies in an attempt to sustain satisfying relationships (Canary, Stafford, & Semic, 2002). The present project attempts to explore whether the use of a couple-serving bias, in which couples make internal, stable, and global attributions for partner successes and external, unstable, and specific attributions for partner failures may serve as one such relationship maintenance mechanism.

Attribution Theory hypothesizes that people generally try to understand events as well as their own emotions, and behaviors through certain causal sources (Wachowiak, 1975). These sources may vary from things completely internal to the one making the attributions, such as their personality, to external factors, such as the circumstances or environment of the event, emotion, or behavior. As the literature on Attribution theory accumulates, many researchers have come to the conclusion that people's attributional tendencies are quite self-serving. When facing success and failures, people assume more personal responsibility for success compared to failure (Arkin & Kolditz, 1980). In creating situational attributions, people tend to disperse the

amount of personal responsibility they assume when facing failures (Larson, 1977). Furthermore, individuals usually attribute positive outcomes and/or evaluations to dispositional or intrinsic factors while when facing negative outcomes and/or evaluations, attribution is directed at specific situational circumstances (van der Pligt & Eiser, 1983). This pattern of making attributions, a self-based positivity bias, has been more popularly referred to as the self-serving bias (Heider, 1958).

The self-serving bias is regarded as the inclination to claim more responsibility for success while simultaneously denying any fault for any failures (Heider, 1958). This bias can be viewed as something that is motivated by the desire to enhance/protect self-esteem by making internal attributions for positive outcomes and external attributions for negative outcomes (Coleman, 2011; Sedikides & Strube, 1995). The self-serving bias is typically viewed as the inclination to rationalize positive outcomes or events as being caused by factors that come from within (internal), that will continue in the future (stable), and that will arise in different areas (global), while negative outcomes or events will be perceived as being due to factors that are extrinsic, completely circumstantial (unstable), and easily identifiable (specific) (Mezulis, Abramson, Hyde, & Hankin, 2004). Furthermore, the self-serving bias is suggested to play an important role in mental health (Taylor & Brown, 1988/1994). The self-serving bias is considered to serve an adaptive function in maintaining psychological well-being and a defensive function when it comes to facing stressful situations and emotional distress. As such, the self-serving bias serves the purpose of an effective protective strategy (Alicke & Sedikides, 2009; Sanjuán, & Magallares, 2014).

As the term implies, the self-serving bias is focused on serving the needs of the individual who uses it. The influence of self-serving bias, however, is apparently not only limited to its owner; rather, it extends towards other persons that are allied with the individual forming the attributions. In a study by Taylor and Doria (1981), evidence for the parallel operations of both self and group-serving biases emerged when both attributional tendencies were set against each other. Indicating that along with securing one's own self-identity, the protection of the group's image is an important, pervasive norm. While this pattern of attributional tendency to protect the image of one's own group is observable, the extent to which an individual is willing to justify the actions of others is very dependent on the closeness of existing relationships (Sedikides, Campbell, & Reeder, 1998). Once a romantic relationship ends, for example, ex-partners are typically devalued, and given more fault for the relationship ending (Verrastro et al., 2016; Gray & Silver. 1990). Even during marriage, the lack of a self-serving bias, specifically external attributions for marital problems can lead to verbal criticisms during problem solving discussions (Dorothy, 1982).

Given the literature surrounding the self-serving bias, it is reasonable to suggest that couples in successful relationships may make use of a self-serving bias in which people make internal, stable, and global attributions for their partner's successes and make external, unstable, and specific attributions for their partner's failures. This "couple-serving bias" would likely serve as an excellent relationship maintenance strategy the couples could employ to help sustain relationship satisfaction and perhaps function to improve their relationships.

The current project was designed to investigate whether couples make use of a couple-serving bias and whether such a bias is related to the health of the relationship. To do this, an assessment was made of people's (who are in a relationship) pattern of attributions for good and bad events that happened to their partner. These attributional assessments were then explored to see if attributional patterns resembling the couple-serving bias were associated with measures of relationship satisfaction. Two major predictions were tested. First, it is predicted that people in close relationships will make use of internal, stable, and global attributions when explaining their partner's successes and use more external, unstable, and specific attributions when explaining their partner's failures. Second, it is predicted that measures of relationship satisfaction would be positively related to the degree to which participants engaged in the couple-serving bias.

METHODS

Participants

Undergraduate Students enrolled in Texas A&M University-Corpus Christi (N=122) who were over the

age of 18 and who identified themselves as being in a relationship participated in the experiment. The sample consisted of 99 females and 22 males ranging in age from 18 – 37 years (median = 19 years).

Measures and Procedure

Participants were asked to complete an online survey containing the Rosenberg Self-Esteem Scale (Rosenberg, 1965), the Relational Assessment Survey (Hendrick, 1988) and a modified version of the Attributional Style Questionnaire (Peterson et al., 1982) along with relevant demographic items (gender, age, and relationship status).

The Rosenberg Self-Esteem Scale (Rosenberg, 1965) is a commonly used measure of global self-esteem. It is a ten item, four point Likert scale consisting of five positively phrased sentences, and five negatively phrased sentences relating to the person's feelings about the self. Self-esteem is then measured based on responses which should theoretically reflect the participants' emotional state and self-perception. The scale is believed to be uni-dimensional.

The Relational Assessment Survey (Hendrick, 1988) is a seven item generic measure of relational satisfaction that is commonly used in relationship research. Participants use a five point Likert scale to respond each item with "5" representing high satisfaction and "1" representing low satisfaction.

The Attributional Style Questionnaire (Peterson et al., 1982) is a self-report questionnaire comprising of twelve scenarios that describe events that survey takers imagine happened to them. Half of the scenarios described good events and the other half described bad events. For each event, participants are asked to identify the reason why they think the event occurred and then rate their causal explanation along three dimensions (internality of the cause, stability of the cause, and globality of the cause) using a one to seven Likert scale. For the purpose of this study the Attributional Style Questionnaire was modified so that the scenarios used in the new measure represented events that happened to the participant's relationship partner rather than to themselves. Participants were thus asked to generate and rate causes for good and bad events that happened to their partners. See of the modified questions of the attributional style questionnaire in appendix A.

RESULTS

A reliability analysis was conducted on both the self-esteem scale (alpha = .87) and the relationship assessment survey (alpha = .85) and found both scales to be highly reliable. An independent samples t-test did not find significant differences for gender of the participant for scores on self-esteem, $t(123) = .813$, $p = .418$. Relationship assessments scores, however, did differ with female participants (M = 4.26) showing greater satisfaction than male participants (M = 3.78), $t(123) = 2.779$, $p = .006$. The index scores from the attribution style questionnaire (stability, globality, and internality for good and bad events) did not differ as a function of gender.

Correlations between self-esteem, relational assessment scores, and the six index scores from the attributional style questionnaire were calculated (see Table 1). As expected, self-esteem and relational assessment scores were positively related, $r(N = 122) = .249$, $p = .003$. Relational assessment scores were positively related to making stable judgments for good events ($r(N = 122) = .231$, $p = .005$) and negatively related to making internal ($r(N = 122) = -.333$, $p < .001$), stable ($r(N = 122) = -.182$, $p = .031$), and global ($r(N = 122) = -.311$, $p < .001$) judgements for bad events. Self-esteem failed to correlate with any of the attributional style questionnaire items.

A series of dependent samples t-tests were used to test whether participants were more likely to make internal, stable, and global explanations for good events that happened to their partner. The means for participants' attributional ratings by event valence (good vs. bad) and type (internality, stability, and globality) are presented in Figure 1. Consistent with a couple-serving bias, participants consistently made higher internal, $t(121) = 13.25$, $p < .001$, stable, $t(121) = 13.83$, $p < .001$, and global, $t(121) = 10.86$, $p < .001$, ratings for good events as compared to bad events. To explore whether the extent of a couple-serving bias was associated with greater relationship satisfaction and self-esteem, internality, stability, and globality ratings for bad events were subtracted from those of their corresponding good events. Greater difference scores would be indicative of

participants' tendency to generate internal, stable, and global explanations for their partners' good events and more external, unstable, and specific explanations for partners' bad events. These difference scores along with a composite measure represented the sum of all three difference scores (internality + stability + globality) were then examined in a correlational analysis along with relationship assessment scores and self-esteem. As can be seen in table 2 relationship assessment scores were found to be positively correlated with internal attribution, $r(n = 122) = .368$, $p < .001$, stable attribution, $r(n = 122) = .416$, $p < .001$, and global attribution scores, $r(n = 122) = .330$, $p < .001$. The composite difference scores were also found to be positively related to relationship assessment scores, $r(n = 122) = .428$, $p < .001$. The correlations between these difference measures and self-esteem scores, however, failed to reach significance.

DISCUSSION

Consistent with Leary and Baumeister's (2000) assertion that self-esteem serves as a "sociometer" for relationships, self-esteem scores and scores on the relational assessment scale were found to be positively correlated. Meaning that self-esteem along with scores on the relational assessment scales appear to represent two assessments of relationship satisfaction.

It was predicted that people in close relationships would make use of internal, stable, and global attributions when explaining their partner's successes and use more external, unstable, and specific attributions when explaining their partner's failures. The results of the present study present strong evidence for participants' use of the couple-serving bias. Participants in this study were found to make more internal, stable, and global attributions for their partner's successes (good events) than for their partner's failures (bad events). These results are consistent with previous work suggesting that people extend their self-serving biases to cover close acquaintances (Sedikide et al., 1998; Verrastro et al, 2016; Gray & Silver. 1990).

It was also predicted that measures of relationship satisfaction would be positively related to the degree to which participants engaged in the couple-serving bias. Only partial support was gained by looking directly at participant's ratings of internality, stability, and globality for good and bad events. Relational assessment scores increased along with the tendency for participants to attribute good scenarios internally to their partners. The participants appraised the positive outcomes as being due to factors that are intrinsic to their partners. Stable and global attributions were not found to be related to relational satisfaction. When presented with negative situations affecting their partner, however, relational satisfaction increased to the degree that partners used external, unstable and global explanations.

Stronger evidence for the impact of couple-serving biases on relational satisfaction was gained by computing difference scores for each participant to focus on the difference in their attributional ratings for good and bad events. Difference scores for internality, stability, and globality (where higher scores indicated stronger couple-serving bias) were all found to be positively related to relational assessment scores. Thus, the present study offers strong support for the couple-serving bias functioning as a successful relationship maintenance mechanism.

While correlations were found between all dimensions of attributions and relational assessment scores, no significant correlations were found between these dimensions and self-esteem scores. Given Leary and Baumeister's (2000) assertion that self-esteem serves as a "sociometer" of close relationships, this was puzzling. This finding suggests that couple-serving biases, while assisting with relational satisfaction, may not always serve the self to the same degree. Future research should address this apparent contradiction in our findings.

A large and important portion of the data on present research was based on a modified version of the attributional styles questionnaire that has not been previously tested before this study. Additionally, it has been suggested that questionnaires describing written situations cannot truly reflect an individual's response and creation of causal attributions in real life (Olsson, 2002). Future studies might take this into account and perhaps have participants take both versions of the attributional styles questionnaire to compare the difference between the type of attribution they give themselves and their partners.

While the present study made use of college students who were currently in a relationship, only a small

portion of the sample indicated that they were married. It may be interesting to use an exclusively married participants sample and include a duration of relationship measure to add to the current findings. It may also be interesting to conduct some retrospective research using divorced participants to examine the possibility of couple defeating biases that may exist in relationships headed for disaster.

Despite some limitations, the present study offers strong support for the use of couple-serving biases in the maintenance of ongoing close relationships. Making internal, stable, and global attributions for our partner's successes and external, unstable, and specific attributions for our partner's failures appears to be an attributional strategy related to relationship health. Such results add to the knowledge base of relationship research and may provide suggestions for improving relationship therapy.

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APPENDIX A.
Modified ASQ Hypothetical Scenarios

Good	Bad
(3) Your partner becomes very rich.	(2) Your partner has been looking for a job unsuccessfully for some time.
(10) Your partner applies for a position that they want very badly (e.g., important job, graduate school admission) and they got it.	(5) Your partner gives an important talk in front of a group and the audience reacts negatively.
(12) Your partner gets a raise.	(8) Your partner can't get all the work done that others expects of them.
(1) Your partner meets a friend who compliments them on their appearance.	(4) A friend comes to your partner with a problem and they don't try to help.
(6) Your partner does a project that is highly praised.	(7) Your partner meets a friend who acts hostilely towards them.
(9) You have been treating your partner more lovingly.	(11) Your partner invites you on a date and it goes badly.

TABLE 1.
Intercorrelation Among All Variables

	Age (in years)	RAS	SE	GI	GS	GG	BI	BS
Relationship Assessment Scale (RAS)	-.327**							
Self-Esteem (SE)	.094	.249**						
Good Internality (GI)	.093	.148	.003					
Good Stability (GS)	-.019	.231**	-.110	.668**				
Good Globality (GG)	.122	-.014	.-.043	.466**	.621**			
Bad Internality (BI)	.173*	-.333**	.070	.029	.020	.211**		
Bad Stability (BS)	.304**	-.182*	.064	.115	.157*	.218**	.550**	
Bad Globality	.197*	-.311**	-.033	-.032	.062	.326**	.501**	.502**

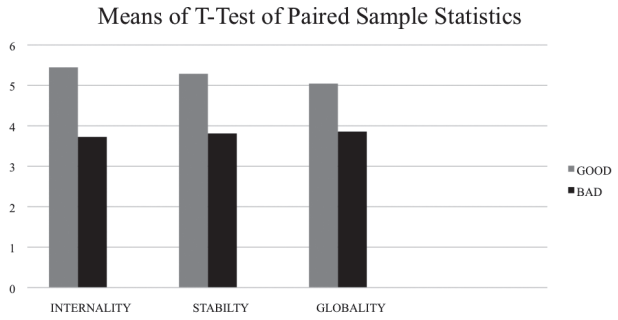
**Correlation is significant at the 0.01 level (1-tailed)
*Correlation is significant at the 0.05 level (1-tailed)

TABLE 2.
Correlations Between Attributional Differences Between Good and Bad Events and Relationship Satisfaction Measures

	Relationship Assessment Scale	SE	SSB Diff.	Int. Diff.	Sta. Diff.
Self-Esteem (SE)	.249**				
Self-Serving Bias Difference (SSB Diff.)	.428**	.084			
Internality Difference (Int. Diff.)	.368**	.054	.919**		
Stability Difference (Sta. Diff.)	.416**	.123	.927**	.855**	
Globality Difference	.330**	.037	.749**	.496**	.522**

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

FIGURE 1.
Mean partner attributional ratings as a function of event type (good vs. bad)



HARM REDUCTION WITH SYRINGE EXCHANGE PROGRAMS: A REVIEW OF LITERATURE

by ANNA M. HAGA BSN, SN

ABSTRACT:

Objective: *To examine whether intravenous drug users who participate in syringe exchange programs (SEPs) had lower rates of infections than those who did not participate in exchange programs. Injection drug use contributes to the transmission of Human Immunodeficiency Virus (HIV), Hepatitis B and C (HBV, HCV) and soft tissue infections. Results: Harm reduction, through the use of (SEPs), is effective at reducing the rate of infections among persons who inject drugs (PWIDs).*

Background: *Intravenous drug use provides routes of transmission for Human Immunodeficiency Virus, the virus that causes AIDS. Injection drug use is a known route of transmission of hepatitis C and B. Also, 50-80% intravenous drug users test positive for the hepatitis C antibody (CDC, 2014). Injection drug use leads to skin abscesses and infections of the heart. The reuse of syringes, and sharing syringes contributes to the spread of diseases.*

Methods: *A systematic review of literature comprising a search of Pub Med, Medline, CINAHL, and Cochrane Library was conducted. Included were articles reporting on Needle Exchange Programs, and the impacts that these programs have on infection rates among intravenous drug users. Eighteen articles were identified that met the selection criteria and related to in impact of needle exchange programs on rates of infection.*

Selection Criteria: *The review follows PRISMA reporting guidelines. Studies were eligible for incorporation into the review if they: (1) presented the results of peer-reviewed research based on either randomized control trial, single non-randomized control trial; case-control study; case series analysis; or experimental study with measures for the outcomes of interest; (2) studies conducted within the United States of America. Studies were excluded if they: (1) were not published within the last ten years; (2) were non-peer-reviewed publication; or (3) not published in the English language.*

Search Strategy: *A systematic review of literature comprising a search of Pub Med, CINAHL, and Cochrane Review was conducted. Included in the study were peer-reviewed papers reporting on infection rates among people who inject drugs and participation in sterile syringe exchange programs.*

MENTOR

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Keywords used were needle exchange program, syringe exchange program, infection, and the United States. The search identified 18 articles that related to infection rates among persons who inject drugs and participate in SEPs. The CDC statistics on common infectious diseases among people who inject drugs were also included.

Keywords: *Needle exchange programs, Syringe Exchange programs, infection, and United States*

INTRODUCTION:

Syringe exchange programs (SEPs) have been in use for a few decades in many countries across the world; however, they have faced resistance in the United States of America. In 2014, the Centers for Disease Control (CDC) reported that the percent of persons twelve years and older with any illicit drug use in the past month was 10.2% in the United States (CDC, 2014). According to the CDC, there has been a four-fold increase in the number of deaths involving heroin to 2.7 per 100,000 people in 2013 (CDC, 2013). With increasing drug use, the rate of infection transmission will likely correlate.

To counter the transmission of infections, a person who injects drugs (PWID) should ideally use a clean and sterile syringe each time they inject. SEPs provide free sterile syringes, usually in trade for the used syringes to lessen the rate of transmission of blood-borne bacteria, viruses, or other microorganisms that cause disease. All persons who inject illicit drugs are at risk for exposure to blood-borne diseases, such as Human Immunodeficiency Virus (HIV), Hepatitis B virus (HBV), and Hepatitis C virus (HCV), subcutaneous skin and soft tissue infections. In 2015, the Centers for Disease Control (CDC), recorded that 6% (2,392) of the 39,513 diagnosed with HIV in the United States were attributed to intravenous drug use (CDC, 2015). In 2014, of 2,194 cases of acute hepatitis C were reported to CDC from 40 states, which is an increase of antecedent years. Of the 2,194 acute HCV cases, 1,252 of the cases responded to questions about their risk behaviors. Out of the 1,252 cases that responded 836 of them (66.8%) indicated at least one risk exposure in the prior six months leading up to the illness (CDC, 2014).

RESULTS

The study selection process is presented in Figure 1. The literature search returned 75 non-duplicate records, of which 31 articles were eliminated following a title and abstract screening. The 44 remaining items that potentially met the inclusion criteria were retrieved. After thoroughly reading the remaining papers, 15 of the articles were selected for inclusion.

FIGURE 1.

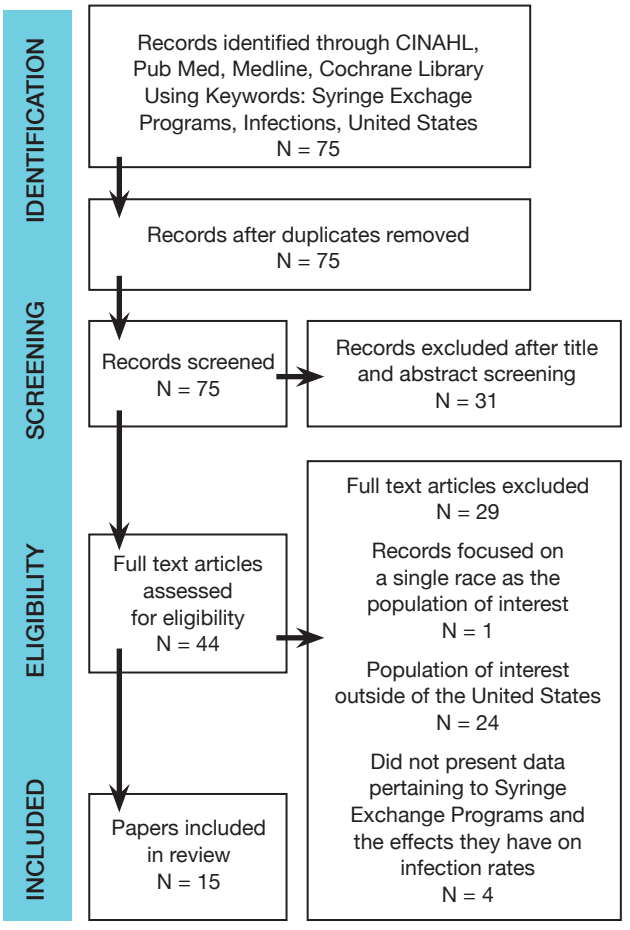


TABLE 1.
Key Features of Included Papers

Author and Year	Study Design	Sample	Outcome of Interest	Country
Bluthenthal (2008)	Cross-sectional longitudinal	N=24 program directors were interviewed for three consecutive years	Total syringe exchange increased by more than one million per year. Closure of some programs resulted in a dramatic and sudden increase in HIV risk among injection drug users.	USA
Clarke (2016)	Cross-sectional	N=106 participants	48% of participants reported sharing syringes before beginning the NEP program but stopped.	USA
Cohen (2007)	Case Control	N=119 case patients with skin infections	MRSA was identified in 68.1% of the patients (n=81)	
Des Jarlais (2007)	Randomized control trial	N=15 Syringe exchange programs	The aim of the study was to identify specific factors that may be related to sharing behaviors.	USA
Des Jarlais (2009)	Cross-sectional	N=186 Syringe exchange programs	99.2% of SEPs provide condoms 100% give alcohol pads 88% offer HIV counseling and testing 55% offer HCV testing 95% HIV/AIDS prevention education 92% offer referrals to substance abuse treatment.	USA
DesJarlais (2015)	Cross-sectional	153 locations surveyed, a total of 45,868,960 syringes given out.	Recent skin abscess was reported by 37% (n=120). Prior lifetime abscess (n=457) of these 252 (55% had treatment from a provider, 14f3 (31%) reported self-lancing	USA
Fink (2013)	Cross-sectional analysis longitudinal study	N= 858 participants	457 participants reported a prior skin abscess, 252 (55%) had been treated by a healthcare professional, 143 (31%) reported self-lancing, and 22 (5%) reported self-medicating with illegally purchased antibiotics. Self-treatment of a recent abscess was reported by 45% of injection drug users with a prior skin abscess.	USA
Kidorf (2009)	Randomized Control Study	N=281 participants	40% of participants enrolled in drug treatment, suggesting that SEPs can serve as conduits to substance abuse treatment	USA
Latkin (2006)	Cohort Study	N= 440 participants	HIV-positive women were more likely to enter long-term detoxification programs.	USA
Mark (2006)	Cross-Sectional Correlational	N=446 intravenous drug users	No difference in syringe sharing habits of SEP participants, detox participants, and methadone maintenance treatment participants	USA
(2015)	Expert Opinion	n/a	Not only do needle exchange programs reduce disease transmission, but they are conduits to treatment.	USA
Nguyen (2014)	Hypothetical model	n/a	SEPs, with higher coverage, can reduce the costs of treatment of infections among PWIDs.	USA

TABLE 1. (continued)

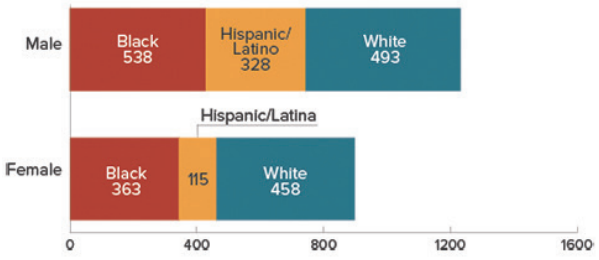
Author and Year	Study Design	Sample	Outcome of Interest	Country
Raynald (2014)	Cross – sectional longitudinal	N= 2,525 (1994-2011) N= 596 (2012-2013)	Both groups 1 in 5 reported sharing needles to inject drugs. 44% of clients in 2012-2013 were HCV infected, and 10% reported HIV positive serostatus.	USA
Rich (2015)	Expert Opinion on a case study	N=153 cases of confirmed HIV	In two months, 153 confirmed cases of HIV-associated with intravenous use of oxymorphone, methamphetamine, and heroin. By implementing a syringe exchange program, Indiana was able to avert the spread of HIV.	USA
Robinowitz (2014)	Case-control qualitative	N=78 wound care participants	Number of wound care patients from May 2012 to August 2013. Seventy-eight unique patients were seen across 172 visits to the wound care clinic at Baltimore Needle Exchange Program. Of the 172 visits, 116 were chronic wound visits, and 52 addressed acute wounds and abscesses.	USA
Steffanie (2015)	Cohort Study	N=169	169 new cases of HIV in Southeast Indiana, 80% coinfected with HCV.	USA

Table 1 summarizes the essential characteristics of the fifteen included papers. The articles are in alphabetical order by author's last names. Of the fifteen studies, eight of the studies were conducted with persons who inject drugs (PWID). Another four studies were performed on syringe exchange programs (SEPs). Many of the articles discussed more than one outcome of interest. Three studies included an expert opinion on the efficacy of SEPs on the rate of infection among PWID.

Syringe Exchange Programs and Blood-borne Pathogens

According to the Centers for Disease Control (CDC), sharing needles, syringes, and other injection equipment is a direct route of transmission of human immunodeficiency virus (HIV). The risk of getting or transmitting HIV is high if an HIV-negative person uses drug injection equipment that someone with HIV has used. At the end of 2013 the CDC reported, an estimated 103,100 men were living with HIV, and an estimated 68,200 women were living with HIV as a result of intravenous drug use. HIV infections cause suffering, hundreds of thousands of dollars in treatment costs, and loss of years of life (Nguyen, T., Weir, B., Des Jarlais, D., Pinkerton, S., & Holtgrave, D., 2014).

FIGURE 2.
HIV Diagnoses Attributed to Injection Drug Use by Race/Ethnicity and Sex, 2015 United States



NOTE: Subpopulations representing 2% or less of the overall US epidemic are not represented in this chart (CDC, 2015).

In 2014 the CDC estimates that there are almost 2.7 – 3.9 million people living with chronic hepatitis C virus (HCV). Injection drug use remains the most common way of transmitting hepatitis C. The CDCs most recent survey of active PWIDs indicates that 30% of PWIDs ages 18-30 are infected with HCV, and 70-90 % older than 30, are HCV positive. At a Rhode Island SEP

half of all participants reported prior HCV exposure or infection (Raynald, J., Koffman, A., Larney, S., & Fitzgerald, P., 2014).

Syringe exchange programs are one of the primary methods of harm reduction from illegal drugs that are injected. The objective of SEPs is to reduce the harm associated with sharing or using blunt or contaminated syringes that can contribute to the transmission of blood-borne pathogens, such as HIV and HCV.

Clarke, K., Harris, D., Zweifler, J. A., Lasher, M., Mortimer, R. B., & Hughes, S. (2016) conducted a study of 106 participants of a SEP. Individuals were surveyed about their syringe exchange practices before and while attending the SEP. "Forty-three percent denied sharing needles before or after beginning the SEP. Forty-eight percent (95% Confidence Interval) reported sharing syringes before visiting the SEP but discontinued this practice after starting the SEP" (Clark, et. al., 2016, p. 403). Nearly half of participants reported that they no longer shared syringes after involvement with an SEP, this demonstrates a substantial decrease. Respondents were also asked about reusing their syringes, and "eighteen percent (95% confidence interval) reported that they did reuse syringes before attending the SEP, but have stopped reusing syringes since attending the SEP" (Clark, et. al., 2016, p.404).

Respondents reported less risky behavior once beginning the SEP program. "Close to 50% no longer shared syringes, 70 % reported obtaining new syringes every two weeks and most reported using clean equipment or paraphernalia" (Clark, et. al., 2016, p. 404). The SEP did not have as dramatic an impact on the reuse of syringes as it did with sharing the syringes, with eighteen percent no longer reusing needles after attending the SEP (Clark, et. al., 2016).

Within a study Des Jarlais, D., McKnight, C., Goldblatt, C., & Purchase, D. (2009), examined 186 SEPs across the United States. All 186 of the SEPs studied provided alcohol pads, for skin cleansing. Ninety-nine and two tenths percent of the SEPs studied offered free condoms, 88% offered HIV counseling and testing. Ninety-two percent provide referrals for substance abuse treatment and detoxification. Ninety-five percent provide HIV and AIDS prevention education (Des Jarlais et. al., 2009).

A study conducted by Bluthenthal, R., Heinzerling, K., Anderson, R., Flynn, N., & Kral, A. (2008), an annual analysis was performed for three years with 24 SEP program directors. Total syringe exchange among the 24 programs had increased by more than one million syringes per year (Bluthenthal et. al., 2008). This data suggests that there is a growing need for SEPs throughout the United States.

Another study by Des Jarlais, D. C., Nugent, A., Solberg, A., Feelemyer, J., Mermin, J., & Holtzman, D., (2015) examined 153 locations of operating SEPs. These programs distributed a total of 45,868,960 sterile syringes throughout the United States in 2013 (Des Jarlais et. al., 2015). Over the course of the last decade there has been an increase in injection drug use in rural areas; often these areas are lacking in harm reduction and prevention programs. Unmet needs for SEPs were recently documented in Kentucky, Tennessee, West Virginia, and Virginia (Des Jarlais et. al., 2015). The CDC reported substantial increases in HCV infection, that was associated with injection drug use in these four states from 2006-2012. There was only one SEP operating in the four states combined. Kentucky and Indiana recently authorized SEPs, after the Indiana HIV outbreak in 2015 (Des Jarlais et. al., 2015).

The most recent outbreak of HIV occurred in rural Indiana. Rich, J.D., & Adashi, E.Y.,(2015) discusses this epidemic, where 153 cases of HIV were reported within a two month period. These cases were attributed to intravenous drug use (Rich et. al., 2015) . Governor Mike Pence responded to the outbreak by temporarily overriding a few laws that criminalized the possession and distribution of syringes, and championed a law that prevents authorities from using public health emergency funds to distribute sterile syringes for illegal drug use. It is important to note that SEPs are not limited to just providing sterile syringes, but also offer counseling and testing services for HIV, hepatitis B and C, tuberculosis, and sexually transmitted infections. By providing these services, SEPs reduce the spread of infectious diseases. Additionally, SEPs "facilitate referral and entry of injection drug users into substance abuse treatment programs" (Rich et. al, 2015).

SEPs trade previously used syringes on a one to one basis for sterile syringes. Because syringes are difficult

to obtain outside of SEPs, this reduces the number of syringes that are not disposed of properly thus lessening the risk of infection to the community. PWID are less likely to throw the syringes away or dispose of them in an unsafe manner because they cannot be exchanged via the SEP. This exchange practice also assists in removing contaminated syringes out of circulation among PWIDs.

Mark, H., Nanda, J., Davis-Vogel, A., Navaline, H., Scotti, R., Wickrema, R., & ... Sochalski, J., (2006) conducted study of 446 participants, who were intravenous drug users, recruited from detox (35%), SEPs (38%), and methadone maintenance (27%) in Philadelphia (Mark, et. al., 2006). This study was a comparative analysis, trying to decipher the sharing habits of users from different harm reduction programs. There was no difference among the three recruitment sites in the frequency of sharing syringes (Mark, et. al., 2006).

In a randomized control trial, Kidorf, et. al., (2009) followed 281 participants from the Baltimore Needle Exchange Program for four months. Participants were randomly assigned to three interventions: (1) eight individual motivational enhancement sessions and sixteen treatment readiness group sessions (2) first intervention with monetary incentives for attending sessions and enrolling in treatment or (3) a standard referral condition which directed participants back to the SEP for (Kidorf, et. al., 2009). Overall, 40% of the participants enrolled in treatment from the SEPs, with the majority being methadone maintenance at 64%, while others enrolled in outpatient detox, inpatient detoxification or drug-free settings. Eighteen percent registered in more than one treatment method during this time. Meanwhile, in another study Latkin, C.A., Davey, M.A., & Hua, W., (2006) showed that women, who had a positive HIV serostatus, were more likely to enter treatment compared to men and persons who tested negative for HIV.

Syringe Exchange Program Attitudes Towards Participants

A common theme in the studies was the providers of SEPs offer PWID a place to seek services free from judgment or bias. Drug use has long been looked down upon and labeled a taboo practice, a choice that a person has made to use drugs. Furthermore, choosing the risky route of intravenous drug use is looked upon condescendingly and oftentimes provokes judgement from non-users. The nonjudgmental attitudes of SEP service providers play a vital role in maintaining attendance and compliance among participants at SEPs. SEP providers have the ability to connect PWIDs to services of all types, including rehabilitation. They can also make referrals for health care providers that are familiar with the population, offering non-judgmental treatment for a variety of health ailments.

Many times health care services are sought only as a last resort. Emergency rooms are usually the place of treatment, as many PWIDs are without stable employment and insurance. As Mark, et. al., (2006) study summarized the demographic characteristics of 446 participants. Eighty-three percent (n=368) had an annual income of less than $10,000 (Mark, et. al., 2006). By offering screenings, sterile syringes, and equipment, and even wound care clinics, SEPs reduce the costs associated with emergency room visits. In addition, when PWID have a place to get screenings, they are more likely to participate.

Skin Infections

Soft tissue infections such as cellulitis and abscesses are the leading cause of emergency room visits and hospital admissions among PWIDs. Repetitive skin punctures facilitate bacterial colonization, particularly *Staphylococcus aureus* (Cohen, A. L., Shuler, C., McAllister, S., Fosheim, G. E., Brown, M. G., Abercrombie, D., Gorwitz, R., 2007).

In addition to *Staphylococcus aureus* infections, other characteristics or habits of PWIDs are associated with bacterial infections in general. Drugs leaking from the vein into surrounding tissues, known as extravasation, can cause the tissues to become susceptible to disease and infection (Fink, D. S., Lindsay, S. P., Slymen, D. J., Kral, A. H., & Bluthenthal, R. N). "Skin-popping" is a process where drugs are injected into the tissue instead of a vein (Fink, et. al., 2013). Subcutaneous injections can cause irritation, blistering, skin and tissue breakdown, and even tissue death or necrosis due to the toxic chemicals in illegal drugs (Fink, et. al., 2013). Long-term intravenous drug use can damage veins, cause collapsed veins, increase the odds of extravasation, and could motivate the user to resort to subcutaneous injections when veins can no longer be

accessed (Fink, et. al., 2013). A used syringe can be contaminated with bacteria from the skin and blood in and on it. Reusing a syringe can introduce these bacteria into the body, thus increasing risks of infection.

Women are at greater risk for skin abscesses, presumably because female PWIDs have fewer visible veins than men do and may have greater difficulty in accessing their veins (Fink, et. al., 2013). Similarly, infections may be spread among PWIDs in shooting galleries, or other places where drugs are consumed, and hygiene practices are less than adequate. PWIDs use unsterile water, and even saliva to clean the skin before injecting (Fink, et. al., 2013). Simple skin cleaning with alcohol decreases the risk of soft tissue infections.

As many PWIDs know not to share syringes, they may not are not educated on ways that infections can be spread with other equipment like spoons, utensils used to cook the drug for breakdown, and cotton balls. Hepatitis C virus can remain infective in dry blood for several weeks at room temperature. According to the CDC, bleach does not provide adequate sterilizing of equipment used for injection. Cotton balls are used as filters to prevent particles from entering the syringe and being injected into the blood stream. Recurrent use of cotton balls, accompanied by the repetitive use of syringes, can lead to skin infections, as well as the spread of blood-borne pathogens.

Many SEPs have education programs that can provide directions on the importance of not sharing any utensils used for self-injection. Education on how to cleanse the skin before injections can be given along with alcohol swabs for best practice. The nurse or SEP provider can instruct PWIDs not to reuse utensils that are used for injection. Further, SEPs can offer lessons in basic anatomy to tell if they are hitting a nerve, a vein, or artery. By offering education and sterile equipment, SEPs can reduce the rate of infections of severely addicted PWIDs (Fink, et. al., 2013).

Some SEPs, such as the Baltimore Needle Exchange Program, have wound care clinics to help with the treatment of soft tissue infections. Robinowitz, et. al., (2014) comprised a study of the Wound on Wheels specialized wound clinic that was started in partnership with John Hopkins Wound Healing Center within an established SEP. Estimates of wound prevalence in among PWIDs is between 55-68% (Robinowitz, et. al., 2014). Untreated, injection-related wounds may lead to further complications such as sepsis, gangrene, and endocarditis. Over the course of sixteen months, the clinic treated 78 patients during 172 visits (Robinowitz, et. al., 2014). Fifty-two visits were for acute wounds and abscesses, while 116 visits were for chronic wounds, and 38 of the visits required antibiotic prescriptions (Robinowitz, et. al., 2014). By providing the wound care in conjunction with current Baltimore Needle Exchange Program operations, overhead costs were minimized (Robinowitz, et. al., 2014). The average cost of each visit was $146.45, opposed to costs for emergency care or initial visits in wound care specialty clinics (Robinowitz, et. al., 2014). This method of delivery demonstrates ways that SEPs can implement other services within their establishment, at a low cost, and improve the health of PWIDs. A need exists for normalized wound care among this population.

Reducing barriers to care and implementing wound care in SEPs seems warranted. It is estimated that nearly half of all hospitalizations of PWIDs are due to soft tissue infections and abscesses. Wound care treatment within SEPs offers PWIDs interaction with providers trained in the prevention of intravenous drug use related health concerns.

DISCUSSION

Syringe exchange programs are moving towards becoming a surrogate health-care platform for injecting drug users, with many services provided on site. The advantages of being a surrogate health-care platform include impartiality to the needs of the participants, comparatively lower cost, and most importantly, providing services using a harm reduction framework – treating PWIDs with dignity and respect (Des Jarlais, et. al., 2009). Throughout the articles, studies showed that SEPs were effective at reducing harms associated with intravenous drug use. Studies demonstrated that use of these programs has steadily increased, showing that the need for more SEPs and expanded funding for SEPs is on the rise (Bluthenthal, et. al., 2008).

Studies showed that participation is SEPs by PWIDs had a positive effect on their risk-taking behaviors. As Clark, et. al., (2016), explained in their study of 106 participants, that almost half of them reported sharing

syringes before attending the SEP, but stopped. After learning of the dangers associated with wounds 83% of 106 participants reported using alcohol swabs before self-injecting. Eighteen percent reported no reuse of syringes (Clark, et.al., 2016).

Moreover, SEPs have the opportunity to provide education about the risks associated with intravenous drug use. SEPs can serve as a way to not only provide sterile supplies but can teach PWIDs methods of reducing infections. They can provide testing for diseases that otherwise may go undiagnosed, further preventing the possibility of being transmitted. They can provide condoms, and birth control so that risky sexual behavior does not add to the overall risk, and reduce the chances of a woman getting pregnant while using substances. SEPs can provide information about detoxification availability.

SEP providers are on the front line, providing respect, nonjudgmental care for this PWIDs. This may be the only point of care accepted by PWIDs, because of the fear of being judged. By reducing the harm associated with intravenous drug use, PWIDs can better reintegrate into society, once sober, if they do not have a chronic illness. Although no single intervention would be sufficient for eliminating infections among PWIDs, SEPs may be a necessary intervention.

Limitations of the Review

This systematic review excluded non-peer reviewed literature. Articles were only included if they were written in English, and available through electronic databases. Articles were included if they were published from 2006-2016 and performed in the United States. Most of the respondents were from convenience sampling, the majority of studies relied on self-reported information, which could affect the generalizability of the study.

CONCLUSIONS

Harm reduction, through the use of syringe exchange programs (SEPs), is effective at reducing the rate of infections among persons who inject drugs (PWIDs) when they have access to such programs. There is a limited amount of research available on SEPs in the United States because not all states permit SEPs. In addition to the reduction of infections, SEPs are cost effective. The cost of harm reduction is greatly reduced compared to the cost of treating infections among PWIDs. Outcomes could be better studied if a standardized program was offered nationwide.

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IT'S OKAY IF I DO IT: SELF-SERVING BIAS IN PERCEPTIONS OF SEXUAL MORALITY

by AUSTIN R. HEILMAN

ABSTRACT

The present project explored possible evolutionary underpinnings of the self-serving bias involved in judgments of sexual morality. Asao and Buss (2016) have recently suggested that exploring the topic of morality from an evolutionary perspective may encourage new questions and new lines of research previously unexplored. In the present study, 66 male and 128 female participants rated the morality of 60 sexual behaviors designed to range from highly moral to highly immoral actions. In addition, participants completed the Rosenberg Self-esteem scale (Rosenberg, 1965) and the Personal Attitudes toward Sexuality scale (Rempel & Baumgartner, 2003). Participants were asked to make their judgments based on 2 perspectives. Half of the participants judged the sexual acts from the perspective of themselves while the others made judgments from the perspective of an average person their age. In line with evolutionary psychology, it was predicted that males would be more accepting of sexual acts than females. It was also predicted that acts leading to sexual reproduction would be rated as more moral in males. In line with the self-serving bias, it was predicted that participants in the self-perspective would rate items as more moral than those taking the other-perspective. Results suggest males were more accepting of sexual acts than females. Additionally, males rated sexual acts leading to reproduction as more moral. Participants rating items under the "self" perspective rated high-morality items as more moral, and low-morality items as less moral than the "other" perspective participants.

Keywords: *self-serving bias, sexual morality, evolutionary psychology, sex-differences*

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INTRODUCTION

Sex differences are a useful tool when investigating topics in evolutionary psychology, and understandably so. Differences between the sexes offer key information on the evolutionary trajectories of the sexes in both the realms of psychology and biology, and offers a perspective in the divergence of behaviors between males and females of humans as well as various other organisms. When studying human behavior, an interesting topic which arises is that of sexual morality. It introduces various questions, such as whether or not males and females behave differently in regards to their sexual

proclivities, whether or not males and females judge acts differently, or if one sex is more likely to engage in sexual behaviors despite these moral perceptions. From this, further questions arise, such as whether or not acts that lead to procreation are considered more moral. The importance of the evolutionary psychology perspective cannot be understated when examining the phenomenon of sexual morality, and it serves a powerful purpose in the examination of the topic, and in sex differences in general. However, a topic which has gone relatively undiscussed in the realm of sexual morality is self-serving bias and its potential role. The examination of self-serving bias, and the inclusion of social psychology within the evolutionary framework offers a unique perspective into the factors involved in the perception of sexual morality. For instance, what is unacceptable for another may be more acceptable when regarding oneself. The present study seeks to integrate self-serving bias, and the traditional view of evolutionary sex differences in the examination of sexual morality. Other factors, such as self-esteem, age, and comfort with sexuality are also examined.

Sex differences have historically been a common tool in measuring behavior within species, from the study of animal and human behavior in both the realms of biology and psychology. The scientific study of behavioral differences between sexes can be dated back as far as Bateman, and his seminal work on the study of the evolution of mate selection (Bateman 1948). Bateman's work focused on drosophila, in which he identified males as being encouraged to mate with as many females as possible to compete for sexual reproduction, with females being more selective in mates as a result of the higher investment into the production of offspring. While Bateman's principle has been heavily debated, is unlikely to apply to humans, and has even been criticized within its original purview of other organisms this emphasizes the rich history in the study of evolutionary differences (Brown, Laland, & Mulder 2009; Collet, Dean, Worley, Richardson & Pizzari 2014). Since this time, the evolutionary study of sex differences has continued to proliferate and has since found footing in the examination of human behavior in mate selection, as well as in the examination of human behavior in regards to morality.

These sex differences in behavior and mate selection have been well researched and established. For instance, Townsend (1995) suggests feelings regarding investment and vulnerability in low-involvement sex differ between males and females, with females reporting greater difficulties with feelings of security in such scenarios. Such finds follow the lens of Triver's variant of the parental investment theory (1972), a theory within evolutionary psychology and biology which asserts that parental investment affects the behavior, mate preferences, and mate selection of humans along with other organisms. Another example of mate preference and selection is the schism in how preferences change, over short term vs. long term contexts. Confer, Perilloux, and Buss (2010) suggest a shift in men's priorities from facial features to bodily attractiveness when transitioning into a long-term mating context, whereas women do not display such a behavior. Consider also the suggestion that a tendency for arousal to reduce sexual disgust and promote reproductive behaviors is present in women, whereas arousal has no effect on sexual disgust in men (Lee, Ambler, & Sagarin 2014). Such research highlights the use of sex differences in determining human behavior and mating strategies, establishing a firm foundation of acknowledged differences in sexual behavior.

While these differences in mate selection and behavior have been well established, it was only recently that evolutionary differences in perceptions of sexual morality have found themselves under the scientific lens. Despite this being a relatively new area of research, several interesting finds have been suggested. It is relatively known that sexual permissiveness and moral perceptions vary between the genders. For example, consider a study by Lance (2007) comparing moral perceptions of extramarital sex, and childlessness from the 1940s, to 2000-2005. While Lance's study indicated an increase in acceptance of extramarital sex from the 1940s, to 2000-2005, the findings still consistently indicated a higher rate in acceptance of extramarital sex in men, than in women. While the differences have narrowed as societal barriers and institutions have shifted, this tendency cannot be ignored. This tendency towards sexual permissiveness in males is further seen in Galperin et. al.'s studies on sexual regret. Within these three studies, males and females were measured

on their level of regret through various sampling measures such as free response, written scenarios, checklists, and internet surveys (Galperin, Haselton, Frederick, Poor, von Hippel, Buss, & Gonzaga 2012). Across all available data sources from within these studies, men displayed less sexual regret than women (2012). Galperin et. al. perceive this as strong evidence for evolved sex differences, and rightly so. A woman's higher reproductive costs would penalize reproductive mistakes, whereas in male reproductive strategies, failing to take a sexual opportunity carries a cost for reproductive fitness (2012). Another such example of these sex differences is the schism in condemnation of sexual acts between men and women. Buss (2009) notes that men and women may have differing judgements of different acts, in terms of moral wrongness and deserved punishment. Supporting this argument is sexual jealousy: males tend to report higher measures of jealousy than females when discussing sexual infidelity, whereas females report higher measures of jealousy when discussing emotional infidelity (Bendixen, Kennair & Buss 2015). This falls perfectly in line with the traditional view of men and women having different consequences and needs in achieving and maintaining reproductive fitness.

Beyond evolved sex differences, two other factors in sexual morality have recently been posited: various "moral tools" or adaptations which lead others and the self to be judged differently, and self-serving bias. While the former is grounded in evolutionary psychology, the latter sits within the realm of social psychology. Together, they further expound upon the mechanisms behind sexual behavior and moral judgements, and integrate social and evolutionary perspectives.

Most relevant to the discussion on evolved morality as a factor in sexual moral judgements is the prospect of different moral tools for judging morality of oneself, versus judging the morality of another. Asao and Buss (2016) argue that morality exists as three separate and distinct adaptations: judgement, influence, and conscience. Moral judgement seeks to determine whether another individual is self-serving or prosocial in nature, and serves to identify relationships which may be beneficial or harmful. Further, moral judgement imposes traits upon others, influencing perceptions of their morality. Moral influence is an adaptation serving to identify the most effective and efficient ways of altering the future behavior of another, be it through ingratiation, ostracism, physical harm, or other prosocial or harmful behaviors. Lastly, Asao and Buss discuss moral conscience, which serves to direct behavior to avoid negative consequences. In this way, moral conscience drives prosocial behavior and judgements of what is "right," in order to avoid harm. However, it also drives negative behaviors when the benefits are greater than the risk.

This concept of morality provides some explanation for possible behaviors in sexual morality. Sexual behaviors, and their consequences, have an enormous impact on reproductive fitness. Moralization of sexual behaviors then becomes key to preserving and reconciling one's own mental and reproductive fitness. This moralization also helps establish positive, rewarding behaviors – and negative behaviors with result in a fitness cost. When considering sexual morality, the distinction between moral judgment and conscience becomes particularly important. Take sexual infidelity, for example. If the benefits of sexual infidelity outweigh consequences, the adaptation of moral conscience may drive the action (Asao & Buss 2016). Moral judgment however may drive an individual to judge their own actions as wrong – but more importantly, the actions of others. In this way, the high-benefit, low-risk in a potential situation in which the infidelity is unlikely to be found out may incite moral conscience to produce mechanisms to moralize and justify the behavior, while at the same time moral judgment lays out just why this behavior is wrong – and in doing so, a sexual double standard is born. Conscience, which drives one's own actions, and judgment, which examines the actions of others both act to preserve one's own fitness – however, being separate and distinct adaptations, moral conscience could promote and moralize infidelity while moral judgment simultaneously condemns another (especially a partner) for these same actions.

Recently, Buss & Asao (2013) asserted the possibility of self-serving bias as another example for sexual double standards. Self-serving bias and attribution work to preserve one's emotional, mental, and reputational fitness in multiple realms and situations – why not within the domain of sexual morality, as well? Self-serving bias may serve to explain one of the factors

involved in judgements of others, and ourselves. Within a phenomenon known as the fundamental attribution error, individuals tend to judge others more harshly than themselves – where they take a more moderate and forgiving view (Andrews 2001; Shepperd, Malone & Sweeny, 2008). Self-serving bias leads individuals to look inwards towards themselves, and take into account both internal and external factors to explain the result of a situation, or the legitimacy of an action (Shepperd et. al., 2008). The fundamental attribution error is the lack of attribution of external factors, relying solely – or at least mostly – on internal states when judging the actions or events surrounding another individual. Andrews (2001) suggests several possible evolutionary causes for the emergence of the fundamental attribution error. Firstly, individuals may have adapted to be most concerned with mental states which have consequences to the self. As a result of this, individuals would be more likely to make negative attributions in the name of self-preservation, such as identifying laziness, or deception. Second, individuals may have adapted to reduce the incidence of potentially damaging errors in inference (2001). Rather than risk coming to harm, being more critical of others, and more willing to make negative attributions reduces the chances of incorrectly assuming benevolent behavior and intention. Finally, Andrews suggests that attribution serves to ensure and promote reputational benefits. Positive, and more thought-out attributions to the self then serve to enhance and maintain self-esteem, rather than risk damage to one's regard of themselves.

Within the context of sexual morality, this builds upon the notion of sexual double standards. For the sake of example, consider once again sexual infidelity – the hallmark and go-to of sexually immoral behavior. One may make several attributions for one's own reasons for taking part in sexual infidelity: failure to receive sufficient emotional or financial support, cruel or unfair treatment, or lack of sexual satisfaction – plenty of reasons may be offered, and under this paradigm, would be utilized to justify and mediate an individual's perceptions of their own level of wrongdoing. Further, the nature of self-serving bias and its role in promoting one's own fitness and preserving one's own esteem and sense of reputation would further mediate an individual's judgement of themselves. However, given this same need to preserve one's own fitness and personal regard, coupled with the fundamental attribution error (Andrews, 2001), an individual could easily be led to judge another as wrong for the very actions they take part in. In this way, a couple may both be engaging in sexual infidelity, while both thinking they're morally justified, and that the other is wrong.

It is important to note the role of self-esteem in self-serving bias, which in turn may impact perceptions of sexual morality. Individuals with high self-esteem have a tendency to display a consistent self-serving attributional bias, whereas in those suffering from depression, or having low self-esteem display less self-serving bias (Cohen, van den Bout, van Viliet, & Kramer 1989). In No, Lee, Son, & Lee's study on self-serving memory bias in depressed individuals, both self-esteem and depression were examined to determine their effects on internal states, and whether or not self-serving bias occurs consistently within individuals suffering from these conditions (2016). Continuing to support the role of self-esteem in self-serving bias, mildly depressed individuals as well as those with low self-esteem displayed low levels of self-serving bias (2016). This may lead to a mitigation of the disparity between perceptions of sexual morality when comparing oneself to another as a result in a reduction in self-serving bias.

In conjunction with the evolutionary perspective of sex differences, and the evolutionary perspective of morality, self-serving bias and related factors make for an interesting and multifaceted account. Together, the possibility of a refreshed and deepened understanding of the mechanisms behind moral behavior and perception presents itself. The present study seeks to examine these factors together within the evolutionary framework, bridging social and evolutionary perspectives of morality and behavior. The presence of self-serving bias in sexual morality is studied through reports of the morality of sexual acts for oneself, and another of the average population. Through this, the study seeks to determine whether individuals rate the morality of various sexual acts differently when answering as themselves, versus answering as a perceived other within their peer group. In conjunction with this, self-esteem and personal comfort with sexuality are also examined. In line with

evolutionary psychology, gender and whether or not an act promotes reproductive fitness are examined as well.

In terms of self-serving bias, it is predicted that individuals will rate actions more severely, judging actions perceived as immoral more critically and judging actions perceived as moral with higher regard. It is also predicted that self-esteem will lead to lower ratings of high-morality actions. Given the existing body of knowledge pertaining to evolved sex differences, it is predicted that males will rate sexual acts as more moral than females. In line with evolutionary psychology, it is also predicted that acts leading to reproductive success will be judged as more moral than acts which do not lead to reproductive success, in males.

METHOD

Participants

Adult college students (128 women, 66 men, age range 18-49 years) were recruited from psychology courses at Texas A&M University – Corpus Christi. Participants were recruited through emails sent out by their professors, and in-class recruitment in the form of a brief description of the surveys. Emails contained a link to Qualtrics surveys, which held all materials used for the study. At the conclusion of in-class presentations, handouts were provided which also contained the link. Half of the classes were provided with the "Self" survey, and half of the classes were provided with the "Other" survey. Participants were awarded extra credit for their respective courses for their participation at the discretion of their professor. Out of all respondents, 71 participants were assigned to the Self group, and 160 participants were assigned to the Other group, based upon which link they were provided with.

Materials

The study utilized a pair of sexual morality surveys which were constructed through Qualtrics for the purposes of this study. The sexual morality surveys constructed were identical between two groups, save for special instructions. One survey instructed participants to answer the survey as themselves, while the other survey asked participants to answer as an average person within their age group. The sexual morality surveys consisted of 60 sexual acts to be rated on a six-point scale (1 = highly immoral, 6 = highly moral), with varying degrees of intensity in nature, and varying degrees of intensity. The survey was tested for validity. Additionally, two 10-item scales were utilized: The Personal Attitude Towards Sexuality scale (Zeng, Luo & Zhou 2015), and the Rosenberg Self Esteem Scale (Rosenberg 1965).

Procedure

Participants were introduced to either of the two surveys (Self or Other), depending on the course taken. Participants were first asked to complete the Personal Attitude Towards Sexuality (PAS) scale. Following, participants were then asked to complete the Rosenberg Self-Esteem (SE) scale. Participants then proceeded to the sexual morality surveys, where 71 were instructed to answer for themselves, and 160 were instructed to answer as an average person their age. Participants rated sexual acts on a five-point scale (1 = highly immoral, 6 = highly moral) based on the acts described and their instructed perspective.

RESULTS

From the responses given by participants, three sets of sexual act descriptions were created. These sets were labeled low morality, moderate morality, and high morality. From the initial 60 acts, items were picked based on calculated response averages. Items with a score of less than 2 were included in the low morality set, while items with a score of more than 5 were included in the high morality set. Items scored close to 3 were included in the moderate morality set. The low morality set consisted of 8 items, the moderate morality set consisted of 6 items, and the high morality set consisted of 9 items. This allowed for simple identification of actions clearly perceived as immoral or moral, as well as allowed for easy comparisons. From the self-esteem scores, a median split was performed to produce a high and low self-esteem group. Sexual morality scores were then analyzed using a 3 (Level of Morality: Low vs. Moderate vs. High) X 2 (Perspective: Self vs. Other) X 2 (Gender: Male vs. Female) X 2 (Self-Esteem Group: Low vs. High) mixed ANOVA with level of morality serving as the only within subjects factor.

As seen in Figure 1, an interaction was found in Perspective, where participants using a self-perspective judged the high moral set of sexual acts as being more

moral than those using the other perspective, while also judging both low and moderate moral behaviors as less moral, F(2, 374) = 3.64, p = .027. In line with evolutionary psychology, male participants were found to judge low moral behaviors as slightly more moral than female participants F(2, 374) = 3.76, p = . 024, as seen in Figure 2. No significant differences were found between self-esteem groups, and no interaction with other factors was found.

Correlational analyses were performed using PAS scores, morality, self-esteem, and age. One analysis in particular revealed that scores on the PAS scale were positively correlated with the low morality category, $r(193) = .225$, $p < .01$. Additionally, it was positively correlated with moderate, $r(193) = .648$, $p < .01$, and high morality scores, $r(193) = .15$, $p < .05$. PAS scores were also positively correlated with self-esteem, $r(193) = .241$, $p < .01$, and age, $r(193) = .17$, $p < .05$. Age also had a positive correlation with low morality, $r(193) = .379$, $p < .01$, and moderate morality, $r(193) = .184$, $p < .01$. Other correlational analyses failed to yield significant results.

Additionally, a t-test was performed to determine whether acts which led to reproduction would be perceived as more moral than acts which did not. Six items were identified based on the possibility that they could lead to reproduction. Using the mean of these six items, males (M = 3.99) were found to rate this item set higher in morality than females (M = 3.33), $t(200) = 5.3$, $p < .001$

DISCUSSION

Participants who answered the survey under the "self" perspective tended to judge high-morality acts as more moral than the "other" participants, while also rated low-morality actions as less moral. There was not a notable difference in the ratings of the moderate morality category. The tendency to rate actions as more moral or immoral respectively is in line with the traditional framework of self-serving bias (Andrews, 2001). Within this framework, individuals rate actions as more moral or less moral in order to enhance their own self-regard, as well as come off in a more positive fashion. Interestingly, the results do suggest a double-standard in regards to sexual morality – but this double-standard does not appear to be one of permissiveness. Rather, participants were more critical of actions when judged under the lens of themselves, and were more permissive when considering an action under the lens of another. This stands in contrast to the assertion that an adaptive double-standard exists to benefit one's own reproductive fitness (Buss & Asao, 2013). Neither do the results support separate adaptive mechanisms of morality, which would alter the means by which one judged one's own actions, and another's differently (Asao & Buss, 2016). The results also suggest, however, a tendency for males to be more sexually permissive than females – a finding perfectly in line with the traditional views of evolutionary psychology, biology, and reproductive fitness (Lance, 2007; Galperin, Haselton, Frederick, Poor, von Hippel, Buss, & Gonzaga, 2012). Males were also found to view acts leading to reproduction as more moral than females, further highlighting the differences between perceptions of sexual behavior and morality between males and females. Such results indicate that evolved differences in sexual morality exist, though as a separate mechanism from self-serving bias.

Correlational analysis indicated a positive correlation between high scores on the PAS scale with higher morality judgements, and higher self-esteem. That is, participants who were more comfortable with sexuality were (perhaps unsurprisingly) more likely to judge actions as more moral, and had higher self-esteem ratings. More surprising was the positive correlation between PAS scores and age, where older individuals displayed higher levels of comfort with sexuality. While not a matter of evolutionary psychology, such finds do indicate a potential relationship between sexual comfort and sexual permissiveness. This makes a fair amount of sense, when considering that exposure and comfort would likely lead to increased acceptance of an act. Age was also positively correlated with morality judgments. This may be explained in much the same way – perhaps with more age, and more exposure, further comfort and acceptance is fostered. These results do not however support the notion of moral adaptations in sexual morality, nor do they illuminate the role of self-serving bias in sexual behaviors and perceptions. While it was expected that self-esteem scores would yield differences in morality ratings – thus suggesting self-serving bias, by virtue of the tendency of self-esteem to moderate the phenomenon – such results were not found.

Overall, self-serving bias appears to stand on its own as a unique function in regards to sexual morality. However, this function works alongside conventional notions of evolved sexual behaviors, and the evolution of morality. Paired together, traditional sexual behaviors and moral perceptions, such as male permissiveness, and self-serving bias together paint a more nuanced picture of sexuality, morality, and mate-selection. However, this isn't to say that a unique moral adaptation does not exist within sexual morality – further investigation is needed.

Several limitations presented themselves within the study. First and foremost, the sample had a relatively small age range (18-49). This may have adjusted the results found in regards to age, morality, and sexual comfort. Many of the individuals were within a relatively close age group. Further, all participants were from the same University. In some respects, this was advantageous for ease of access and completion of the study. However, it did limit the sample size and range of ages available. Additionally, influences such as regional homogeneity, as well as regional norms, values, and mores may have adjusted results. It is also important to note other possible explanations for the findings regarding the effects of self-serving bias in perceptions of sexual morality. Nearly twice as many respondents were in the "other" group, and this higher rate of response may have adjusted the outcome. Subsequent studies should consider targeting other universities, or other institutions altogether. Future studies should strive to increase the sample size, and increase the age range for a more representative and diverse sample.

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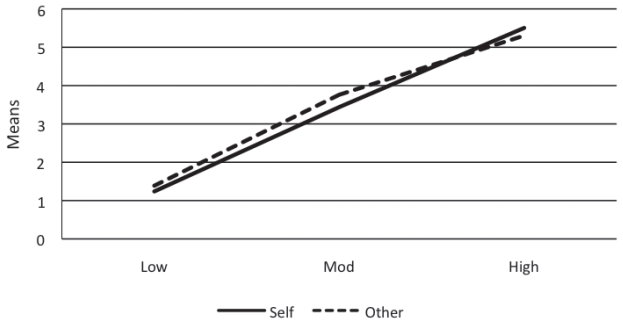
FIGURE 1.
Interaction between perspective and morality



NOTE: Participants responding under the "self" perspective rated high morality actions as more moral, and low morality actions as less moral than participants who responded under the "other" category.

FIGURE 2.
Interaction between gender and level of morality

NOTE: Males rated low-morality actions as more moral than female participants.

THE EFFECTS OF STATIC MAGNETIC FIELDS ON THE SKIN EFFECT IN CONDUCTORS

by MICHAEL L. MARTINEZ

ABSTRACT

In this study, the effects of a static magnetic field on the skin effect resistance of a conductor are considered. A theoretical derivation over possible effects is derived from implementing the free-electron model. A decrease in the effective resistance due to the skin effect was predicted to occur in the presence of a static magnetic field of specific configuration. The conductor under study was a thin sheet of silicon steel, with the slab placed under a strong static magnetic field. The resistance was measured across the conductor before and indirectly after the application of the static magnetic field for increasing values of frequency through the measurement of the voltage input to voltage output ratio.

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INTRODUCTION

During the flow of direct current (DC), the current density is homogenous in its flow along a conductor. However, during the flow of an alternating current (AC), the current density is generally found to reside closer to the surface of the conductor, as opposed to being homogenous as in the DC case. Since most of the current density resides mostly along the surface of the conductor, the inhomogeneity of the current density in AC flow within a conductor is known as the skin effect. The skin effect is due to induced electromagnetic fields within a material due to the changing magnetic field of the conductor with AC flow [7]. These induced currents are known as Eddy currents, and their rotational flow within a conductor is such that they reduce the current density with increasing depth of a conductor.

Maxwell introduced the idea of a transient period in which the position of a time-invariant current can be altered by an external static magnetic field in his *A Treatise on Electricity and Magnetism*. For a time varying current (specifically, an AC sinusoidal waveform), this transient period can be expected to become temporally

variable, as the current continuously changes direction, thereby leaving the effects of the static magnetic field on the position of the AC to vary over time as well, as demonstrated in the article *Influence Of The Skin-Effect On Hall Voltage In Semiconductors* by authors S. Sikorski and A. Kobus. Eddy currents are the result of induced electric fields (due to the changing magnetic field of the AC) that effect the charges in nearby materials to flow in the direction they point in space. Since the application of an external static magnetic field can provide a time varying force on charge flow in the same fashion that the induced electric fields do, the cancelling of the induced Eddy currents while maintaining the AC's characteristic sinusoidal variation is possible. Thus, the cancellation of the skin effect is a possibility, as preventing Eddy currents will prevent the formation of the skin effect in the first place.

Literature over the skin effect is largely based on the mathematical derivation and understanding of such. Numerous books such as *Foundations of Electrodynamics* by Parry Hiram Moon and Domina Eberle Spencer, and *Introductory Electromagnetics* by Zoya B Popović and Branko D Popović offer a full undergraduate mathematical treatment of the skin effect and how such can be an issue to begin with. In *Foundations of Electrodynamics*, the skin effect is mathematically described via the use of the AC steady state Maxwell equations for metals. The authors thoroughly discussed the various geometries and conductor combinations in which the skin effect could be studied for, such as a semi-infinite, a plated, and tubular conductors. The authors Parry Hiram Moon and Domina Eberle Spencer use this analysis to develop relations that illustrate the skin effect in its full potential. Other books such as *Introductory Electromagnetics* by authors Zoya B. Popović and Branko D. Popović take a less rigorous, but still highly mathematical approach to understanding the skin effect. In both texts, the primary characteristics of the skin effect are uncovered for students at the undergraduate level. Some papers such as *The Skin Effect. I. Introduction the Current Distribution for Various Configurations* by authors H.B.G. Casimir and J. Ubbink, offer insightful analysis in demonstrating the ability that configurations and geometries conductors could have in affecting the skin effect developed within them. As such, the article is similar to the before mentioned books on the subject. However, a better illustration of the Eddy current effects within the conductor is given and an algorithm for deriving the skin effect's properties for arbitrary conductor geometries make this paper distinct. A brief discussion over the unattractiveness of the phenomena is given in the article as well, stating that the skin effect can cause power losses when transmitting energy [1]. Within the mathematical derivations of the skin effect, both books and articles make use of Ohm's law. Ohm's law is used in a fashion that includes magnetic effects, as can be seen in David Griffiths' *Introduction to Electrodynamics* in the section of the electromotive force. In Griffiths' treatment of the electromotive force, the electric field and magnetic field can contribute to changing the current density of a specific conductor with an electrical current. As explained by Griffiths, the velocity of the charges in relation to that of the conductor is typically much slower, and hence, the magnetic term is usually ignored [3]. However, if the magnetic field and charge velocities are sufficiently large (i.e. large charge mobility), such a term can become significant [3]. In *Magnetoresistance in Metals* by Alfred Pippard, such implementation of the above magnetic term is referred to as the free-electron model. In order to yield a relatively simple mathematical hypothesis, the free-electron model was included in the hypothesis of the following study.

The significance of such a term has important consequences, and has been studied in a slightly different manner. In the *Influence of the Skin-Effect on Hall Voltage in Semiconductors* by S. Sikorski and A. Kobus, the magnetic field is assumed static when studying its effects on an AC flow within a semiconductor. As shown by the authors, the magnetic field term contribution to Ohm's law is of a form similar to that introduced by Griffiths, but one which considers the holes and electrons that affect the dynamics of the current within a semiconductor. The application of a static magnetic field in the paper by Sikorski and Kobus is also one of importance to the present paper, as the idea being studied here regards the biasing of an externally static magnetic field inside a conductor with AC flow exhibiting the skin effect. Sikorski and Kobus also make the helpful assumption of superimposing a magnetic field that has a magnitude much larger than that of the AC flow within the conductor. This technique allows

for easier calculation when considering time effects [8]. As such, it will be employed in the following study as well.

With a resulting hypothesis developed mathematically, literature regarding the experimentation of such a prediction is important. In the article *Study of Eddy Currents in a Cylindrical Wire: An Undergraduate Laboratory Experiment* by authors J. R. Gosselin, P. Rochon, and N. Gauthier, the electrical and measurable effects of the skin effect are discussed for a small portion of the paper. In regards to the impedance of a conductor, the skin effect can be easily classified as an increase in the resistance of the conductor. As described by the authors, one can expect both an increase in the effective resistance and decrease in the inductance of the conductor [2]. The decrease in inductance of the conductor is illustrated as a decrease in the inductive reactance of the material. Since the inductive reactance is decreased while the effective resistance of the conductor is increased, the total impedance of the conductor should be expected to increase. Thus, if the biased static magnetic field has any effect on the skin effect executed in a conductor at all, a variation in the impedance of the conductor should be observed. More importantly, the resistance can be observed to be frequency dependent. As such, the article renders itself extremely helpful in determining an experiment to test out such the hypothesis. Namely, that of observing circuit behavior for varying frequencies.

THEORETICAL FOUNDATION

In order to arrive at a mathematical model, one must clearly indicate the models and equations used as well as any assumptions made. Since a sinusoidal AC circuit was at play in the experiment, it is appropriate to make use of Maxwell's equations in steady-state form:

$$\nabla \times \mathbf{E} = -i\omega \mathbf{B}_{int} \tag{1}$$

$$\nabla \times \mathbf{B}_{int} = \mu \mathbf{J} \tag{2}$$

$$\nabla \times \mathbf{B}_{ext} = 0 \tag{3}$$

$$\nabla \cdot \mathbf{B} = 0 \tag{4}$$

where $\mathbf{E}$ is the electric field produced by the changing magnetic field and resulting charge distribution, ω is the angular frequency of the AC, $\mathbf{B}_{int}$ is the magnetic field produced by the AC signal in the aluminum sheet, $\mathbf{J}$ is the current density within the silicon steel slab, and $\mathbf{B}_{ext}$ is the external static magnetic field. One may also note that (2) is an approximation, as the effects of the time-varying electric field add some contributions to the curl of the external magnetic field. It is therefore assumed that the frequencies of the AC in the conductor are not large enough to create such an effect significantly. The divergence of the electric field is non-zero however, since the magnetic field affects the moving charges in a conductor to create an electric field of their own due to their distribution. In combination with the above four vector equations is the use of Ohm's law, mentioned earlier, in a form considering magnetic effects:

$$\mathbf{J} = \sigma\left(\mathbf{E} + \frac{\mathbf{J} \times \mathbf{B}_{ext}}{\rho}\right) \tag{5}$$

where σ is the electrical conductivity of the aluminum sheet and ρ is the charge-carrier density of the aluminum sheet. As can be seen, if the charge mobility is small, the magnetic term in the above equation may become insignificant. Another observation that can be seen is that of the time-varying form of the fields. The time-varying forms are of complex nature, which allows for better manipulation of the equations that contain sinusoidal signals. The complex form of the fields is shown below:

$$\mathbf{E} = \mathbf{E}' e^{i\omega t} \tag{6}$$

$$\mathbf{B}_{int} = \mathbf{B}' e^{i\omega t} \tag{7}$$

$$\mathbf{J} = \mathbf{J}' e^{i\omega t} \tag{8}$$

where the variables with an apostrophe are the complex spatially-varying terms for each field. Taking the curl of (1) and implementing (2) into the right-hand side of (1) gives:

$$\nabla(\nabla \cdot \mathbf{E}) - \nabla^2 \mathbf{E} = -i\omega\mu\mathbf{J}. \tag{9}$$

The divergence of the electric field could be obtained by solving for such through Ohm's law while making use of the following:

$$\nabla \cdot \mathbf{J} = 0. \tag{10}$$

The divergence of (2) yields such. One can then obtain the following:

$$\nabla \cdot \mathbf{E} = -\frac{\mathbf{B}_{ext} \cdot (\nabla \times \mathbf{J})}{\rho}. \tag{11}$$

Upon incorporating (11) into (9), one can then obtain the following equation:

$$\nabla \left[\frac{\mathbf{B}_{ext} \cdot (\nabla \times \mathbf{J})}{\rho}\right] + \nabla^2 \left(\frac{\mathbf{J}}{\sigma} - \frac{\mathbf{J} \times \mathbf{B}_{ext}}{\rho}\right) = -i\omega\mu\mathbf{J} \tag{12}$$

where a stark difference between the above and regular (i.e. zero static magnetic field) skin-effect dynamics is present, as shown below in (13):

$$\nabla^2 \left(\frac{\mathbf{J}}{\sigma}\right) = -i\omega\mu\mathbf{J}. \tag{13}$$

Equation (12) can be observed to contain terms that have the potential to reduce the skin-effect in a conductor. By using the following considerations and assuming a solution to (12) of the form given below by (16):

$$\mathbf{J} = (J_x', J_y', J_z') \tag{14}$$

$$\mathbf{B}_{ext} = (B_x, 0, 0) \tag{15}$$

$$\mathbf{J} = (J_x, J_y, J_z) e^{K(x+y+z)} \tag{16}$$

one can obtain three complex equations that can be solved for the constant *K*. Such a form was assumed since the skin-effect typically takes a similar form. Since the magnetic field effects on the conductor were shown to be small when relatively small charge mobility's are considered, one can expect the solution to be similar to that assumed in (16), which is the approximate solution given for the current density distribution in a rectangular conductor from the skin effect [7]. Another assumption is that of a constant magnetic field. The field is assumed to be spatially constant in order to simplify calculations. When solving the resulting three equations, one obtains the following quartic equations for *K*:

$$\left(\frac{9}{\sigma^2} + \frac{3B_x^2}{\rho^2}\right) K^4 - \frac{6i\omega\mu}{\sigma} K^2 - \omega^2\mu^2 = 0 \tag{17}$$

where *i* is the imaginary number. Solving for *K* through the use of substitution to reduce the order of the equation to that of a quadratic gives:

$$K = \pm \sqrt{\frac{\frac{3i\omega\mu}{\sigma} \pm \frac{\sqrt{3}\,\omega\mu B_x}{\rho}}{\left(\frac{9}{\sigma^2} + \frac{3B_x^2}{\rho^2}\right)}} \tag{18}$$

which when compared to the same result in the absence of an external static magnetic field as shown below:

$$K = \pm \sqrt{\frac{i\omega\mu\sigma}{3}} \tag{19}$$

demonstrates the ways the magnetic field could impact the skin effect itself. In order to obtain a result where the complex number can be taken out from the square root, one can assume the constant solution to be of the form:

$$K = \sqrt{\alpha i + \beta} = ai + b. \tag{20}$$

The constants *a* and *b* can be found by solving (20) for *a* and *b*. The values are found to be:

$$b = \sqrt{\left(\frac{\sqrt{3}\omega\mu B_x}{2\gamma\rho}\right)\left(1 \pm \sqrt{1 + \frac{3\rho^2}{\sigma^2 {B_x}^2}}\right)} \tag{21}$$

$$a = \frac{3\omega\mu}{2\sigma\gamma}\left(\left(\frac{\sqrt{3}\omega\mu B_x}{2\gamma\rho}\right)\left(1 \pm \sqrt{1 + \frac{3\rho^2}{\sigma^2 {B_x}^2}}\right)\right)^{-1/2} \tag{22}$$

where

$$\gamma = \left(\frac{9}{\sigma^2} + \frac{3B_x^2}{\rho^2}\right) \tag{23}$$

$$B_x \neq 0 \tag{24}$$

are to be held true. As can be seen, the real part *b* indicates an attenuated skin-effect for large external magnetic field fields. The current density still decreases exponentially, but with a depreciation in the rate at which it does so. For the imaginary portion *a*, the internal changes in phase are also changed as a result of the magnetic field. Thus, the resistance of the conductor should be observed to shift in a decreasing direction.

FIGURE 1.
Equivalent RL circuit of the two resistors

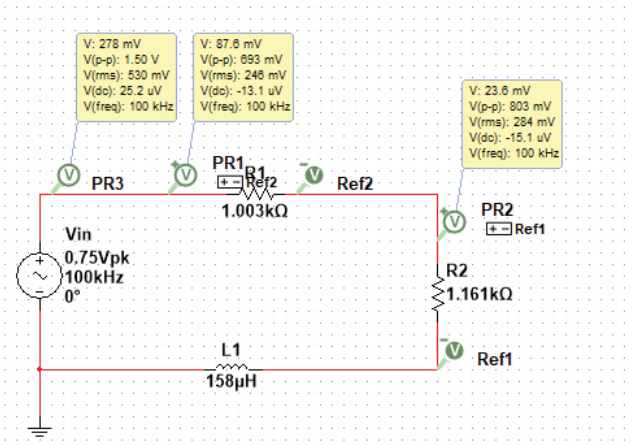
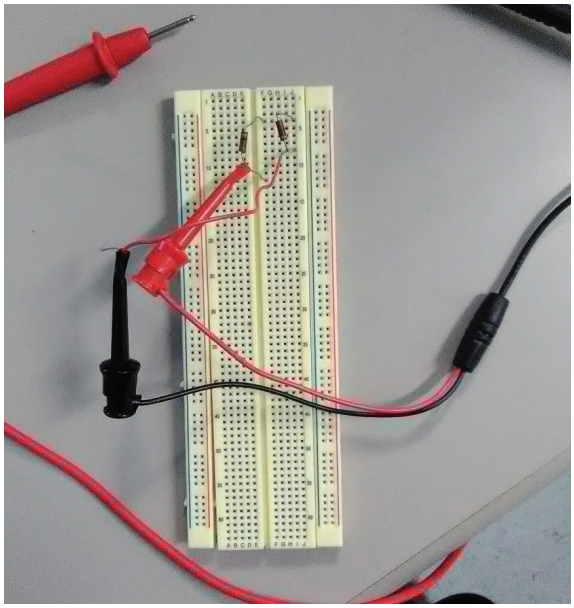


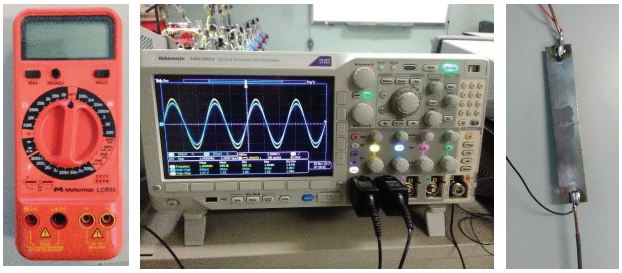
FIGURE 2.
Agilent 34401A multimeter used to measure AC voltage

FIGURE 3.
Resistor circuit used for the experiment



NOTE: The voltage of the leftmost resistor was measured as the voltage output.

FIGURE 4.
Starting from the left: the Meterman LCR55 used to measure the inductance of the resistors, the Tektronix MDO3014 oscilloscope used for its AFG, and the silicon steel sample under experimentation

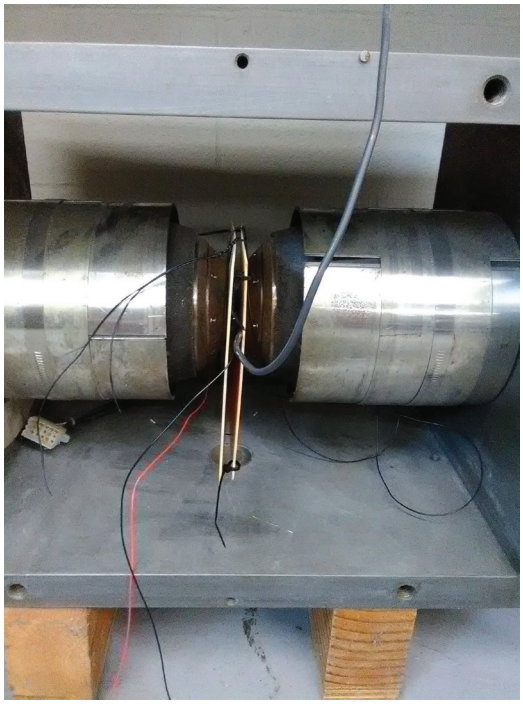


METHODS

For the experimental setup, a thin silicon steel slab was placed in an electrical circuit comprised of two resistors of values 1.003 kΩ and 1.161 kΩ, a digital multimeter, a digital oscilloscope, as shown in the following figures. The digital oscilloscope model was the Tektronix MDO3014 Mixed Domain Oscilloscope while the model of the digital multimeter was the Agilent 34401A 6 1/2 Digit Multimeter. The internal DC resistance of the silicon steel conductor was measured previously before the experiment to have a value of 0.08 Ω. The value was obtained through the usage of the four-wire method with the digital multimeter. The oscilloscope was utilized for its 50 MHz Arbitrary Function Generator (AFG) to generate the sinusoidal input voltages across the circuit under experimentation. The source of the magnetic field was that of a permanent magnetic field, of strength of at least 3 T, pointing perpendicular to the flow of the current within the thin silicon steel slab, as shown in **Figure 5**.

In the first portion of the experiment, the ratio of the voltage across one resistor V_{rms} to the input voltage

FIGURE 5.
The silicon steel insulated and kept within the external static magnetic field



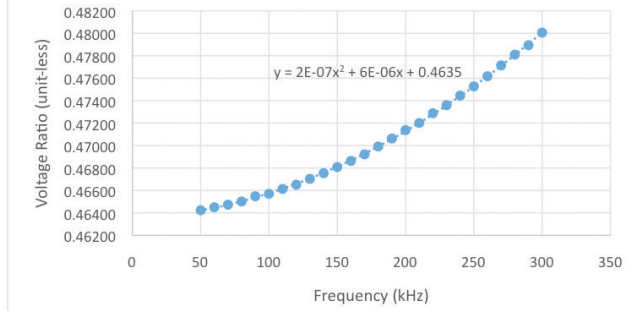
signal V_{in} of the circuit was measured and varied over frequency of an input sinusoidal AC signal. The voltages were measured in their rms values (root-mean-square). The circuit was modelled using NI Multism 14 and is shown in **Figure 1**. The resistors in the circuit contained inductance values, each resistor containing 79 µH, totaling to an equivalent inductor of 158 µH. The inductance was considered as a consequence, as the frequencies under question ranged from 50 kHz to 300 kHz. In the second circuit, the same resistor and inductor were used along with a rectangular silicon steel piece with dimensions 5 cm x 8cm. The thickness was 1 mm.

To calculate the ratio of the voltage across one resistor (resistor one) to the input voltage of circuit, the rms source current I_s was calculated using Ohm's law by the following

$$I_s = \frac{V_{in}}{Z_T} \tag{25}$$

where Z_T is the total impedance across the circuit (resistance of resistors and internal inductances).

GRAPH 1.
Voltage Ratio Variation



The voltage across resistor one, while including its inductance, was therefore

$$V_{rms} = I_s Z_1 = \frac{V_{in} Z_1}{Z_T} \tag{26}$$

where Z_1 is the impedance across the resistor. Dividing both sides by V_{in}, one obtains

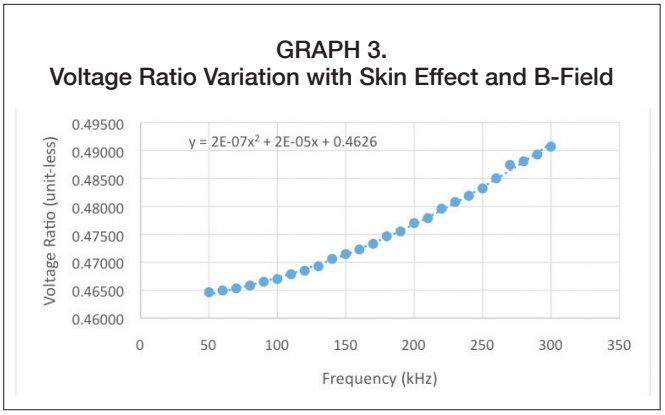
$$\frac{V_{rms}}{V_{in}} = \frac{Z_1}{Z_T} \tag{27}$$

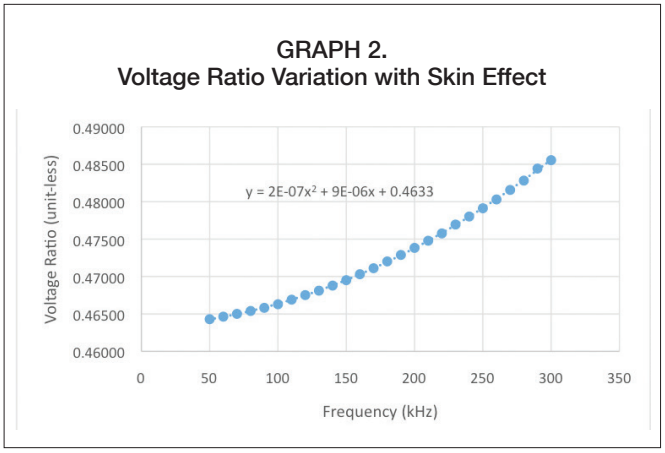
Therefore, the voltage ratio gives an indication over the impedance across resistor one and the entire circuit. With such situation in mind, and the idea that the impedance of a conductor with skin effect occurrence must increase in some cases, one can use the voltage ratio as a measure of how prevalent the skin effect is in a particular circuit. This idea is explored in the last portion of the experiment.

In the last portion of the experiment, the second circuit is utilized while the silicon steel plate is subjected to an external static magnetic field of at least 3 T. The hypothesis of the following study determines that the presence of the external static magnetic field yields a reduction in the skin effect, and thus, a decrease in the frequency dependent resistance of the second circuit.

RESULTS AND DISCUSSION

The first portion of the experiment regarding the implementation of an AC sinusoidal signal in two circuits (one with the silicon steel) allowed a visual representation of how the voltage ratio was affected by increasing value of frequency. In the following graphs, the results are displayed. The voltage ratio





versus frequency curve can be seen to demonstrate a characteristic increase with frequency. For the first portion of the experiment, the data can be observed in **Graph 1**.

As can be seen, a characteristic curve approximating a polynomial of second order is observed for the resistor circuit before the introduction of the silicon steel. The trend line equation is used to make a reference as to how the data varies over the frequency ranges. Such curve considers the effect of inductance as well as resistance in the circuit. Since inductive reactance is proportional to frequency, the curve in **Graph 1** is expected. After the introduction of the silicon steel material into the circuit, the results of the voltage ratio can be observed in **Graph 2**. Besides for an increase in the rate of the voltage division, the values for the amplitude of the trend line equation (also approximated by a second order polynomial) are almost the exact same as that in **Graph 1**. This demonstrates just how weak the skin effect is when demonstrating it in smaller dimensioned materials (as they have low initial DC resistance).

The data in **Graph 1** thus demonstrates itself as a control. The high frequency effects in the silicon steel show changes as a result of direct comparison of the trend line equations of the two graphs. Thus, if the static magnetic field in the second portion of the experiment has any effect on the silicon steel, the results would show the curve to tend to or move from that shown in **Graph 1**. Once introduced into the static magnetic field, the voltage ratio curve generated is given in **Graph 3**.

The curve indicates that the change in the voltage ratio with respect to frequency is increased. Thus, the results show that the magnetic field does change the voltage ratio when the skin effect occurs. Unfortunately, one cannot determine precisely whether the magnetic field changed the inductance or the skin effect directly. However, one of which or both, must have occurred. Given that the skin effect of the silicon steel was quite possibly a small effect, one can observe from comparison of the **Graph 2** and **Graph 3** that the curve has increased farther away from **Graph 1**. The data in **Graph 3** indicates that the collective decreases/increases in the voltage output and input give a general positive nonlinear trend in frequency. This may have been due to the use of 1 kΩ resistors, as they're resistance may have been much larger than that generated by the skin effect. Thus, the results display how the magnetic field possibly affects both inductance and skin effect of the silicon steel, since the behavior of the circuit deviates from its normal mode of operation (that in **Graph 1**).

However, a crucial possible explanation for the results may largely in the both the application of a weak magnetic field and material with a relatively small electron mobility. As indicated by the *K* equations obtained from the theoretical analysis, a small magnetic field and conductor with small electron mobility was predicted to render extremely small changes to the skin effect in a conductor. Contrary, the silicon steel used may not have behaved well for the implementation of the free-electron model. If such, then the theoretical prediction of a decreased effective resistance upon the application of static magnetic field may need a more complicated model in order to allow for the experimentation of silicon steel.

CONCLUSIONS

In conclusion, the results indicated quite possibly two effects at play when a conductor under the skin effect is exposed to an external static magnetic field. The inductance and/or the effective resistance change upon being exposed to the magnetic field. As indicated by the mathematical model derived in this study, if the magnetic field and electron mobility may not significant enough, then research into the above experiment with a material displaying large electron mobility (e.g. semiconductors) while exposing said sample to a much stronger DC magnetic field may render different results. The material with large electron mobility would also have to behave according to the free-electron model. If the material does not obey the free-electron model for the regime under study, then a more complicated model may be necessary in order to predict any changes to the skin effect within a conductor. As such, research should be done in determining whether how the magnetic field affects both the inductance and effective resistance due to the skin effect in a separate manner. Instruments with higher resolution must be used as well.

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ASSESSMENT OF HISTORICAL OIL-FIELD BRINE DISCHARGE INFLUENCES ON SEDIMENT-SUPPORTED RADIONUCLIDE ACTIVITIES

by MELISSA PEÑA

ABSTRACT

Much variability exists in naturally occurring radium and radon (^{223}Ra, ^{224}Ra, ^{226}Ra, ^{228}Ra, ^{222}Rn) activities due to natural and anthropogenic sources that result in a wide range of groundwater and sediment-supported isotope concentrations. Nueces Bay, Texas is a shallow, microtidal bay with low riverine inflow and highly disturbed bottom sediments from dredging of navigation channels and the oil/gas industry. A history of discharge of oil field brines is concentrated along the north shore with a few sites in the lower Nueces River. Previous studies suggest that high Ra activities in this bay could be associated with oil-field brine leakage from oil and gas wells and submerged petroleum pipelines. These studies do not account for Ra additions from these historical surface discharges. Sediment analyses from multiple depth profiles in sediment cores were conducted at seven stations within the bay at locations identified as historical discharge points and from control sites (non-impacted) in order to determine inputs of Rn and Ra to the system from sources other than groundwater and "pristine" sediments. Samples were collected from discrete intervals and analyzed for porosity, grain size, and sediment-supported ^{222}Rn (determined through sediment equilibration experiments) using published methods. Results show supported ^{222}Rn activities higher at the station closest to the discharge sites (94.5 dpm/L) than the control sites (66.5 dpm/L). Enrichment in ^{222}Rn increases as porosity increases (meaning larger content of silts and clays). Porosity and ^{222}Rn have a positive correlation at the 95% confidence level. Grain size analysis confirms the connection between increase in ^{222}Rn and increased clay content. Results show oil-field brines may be a potential source of increased radionuclides in Nueces Bay sediments but further research is necessary to constrain any other processes (i.e. oxidation-reduction reactions associated with early diagenesis of organic matter) that may be playing a role in radium sequestration in sediments.

MENTOR

Dr. Dorina Murgulet

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INTRODUCTION

Submarine groundwater discharge (SGD) is acknowledged as a source of water, essential nutrients, and other dissolved constituents to coastal ecosystems (Zektser et al. 2006). Globally, total freshwater flux

from SGD has been estimated to be approximately 10% of the fresh riverine flux; however, freshwater flux from SGD may vary due to fluctuations in riverine flux (i.e. may exceed riverine fluxes during low flow) (Moore 1996; Zektser et al. 2006). Meteoric groundwater and intruding seawater mix and will result in chemical reactions taking place in the subterranean estuary (Beck et al. 2007). Locating and quantifying SGD rates to the ocean can be determined by the use of geochemical tracers. Many studies have been conducted using geochemical tracers including the naturally occurring radionuclides from the uranium and thorium decay series (Beck et al. 2007; Moore 1996). Radium (^{223}Ra, ^{224}Ra, ^{226}Ra, ^{228}Ra) is a decay product of thorium and its principle sources to the ocean are SGD, riverine discharge, and shallow sediment fluxes (Zektser et al. 2006). Radon (^{222}Rn) is the decay product of ^{226}Ra and its enrichment in groundwater relative to seawater makes it a useful tracer for SGD. Thus, groundwater discharge rates into the ocean can be determined using the mass balance approach of radium and radon (Zektser et al. 2006). The mass balance approach accounts for all sources such as sinks and seeps, sediment-supported ^{222}Rn and potential contaminants.

Some issues that come with oil exploration are related to the amount of produced waters which exceeds that of extracted oil. Produced water (i.e. oil-field brine) is extracted from a reservoir with hydrocarbon resources and brought to the surface with oil or gas (Veil et al. 2004). While inland disposal of oil-field brines is generally accomplished through injection into geologic formations of non-commercial use, in coastal areas brines have been historically discharged directly into estuaries (D'Unger et al. 1996). In addition to high levels of total dissolved solids, there are high quantities of trace elements, hydrocarbons, and radionuclides in these produced waters (Veil et al. 2004). Chemical properties of produced water vary depending on the geographic location and geologic formation of the field; regardless, any field brine contains various salts in solution, such as sodium, calcium, bromides, and hydrocarbons. The most abundant naturally occurring radioactive material present in produced water are radium-226 and radium-228 (Veil et al. 2004).

^{226}Ra is a decay product of the uranium-238 decay chain with a half-life of 1,600 years. ^{222}Rn, which has a half-life of 3.82 days, is the daughter product of ^{226}Ra (Clark and Fritz 1997). Enriched radionuclides and highly saline water are characteristics of oil-field brine, making it very dense, and thus, as it is discharged into the surface water, it sinks down to the sea-floor (Kraemer and Reid 1984). Once the radionuclides in the oil-field brine sink and infiltrate bottom sediments, they may bind to the surface of the grains, becoming an additional source of ^{222}Rn in the porewater and surface water through submarine groundwater discharge or benthic fluxes. Thus, studies that use shallow porewater ^{222}Rn activities as their groundwater endmember may underestimate SGD compared to studies using deeper groundwater or groundwater from terrestrial wells. The final step in ^{222}Rn mass balance calculations is converting from radon inventories to water fluxes by dividing by a groundwater endmember ^{222}Rn concentration (Burnett and Dulaiova 2003). Identification of an appropriate groundwater endmember for SGD calculations remains the biggest source of uncertainty in these studies (Santos et al. 2012). Even though uranium behaves somewhat conservatively in oxygenated seawater, under chemically reducing conditions such as in sediments underlying low-oxygen bottom water or those exposed to high fluxes of particulate organic carbon, it is precipitated (Zheng et al. 2002). Unlike its highly particle reactive parent thorium, Ra also becomes more soluble in brackish and saline water, so as salinity increases, the ionic strength of the water changes and Ra will desorb, increasing the porewater concentrations of dissolved Ra (Breier et al. 2010). Thus, depending on salinity and ionic strength of porewater or reducing sediment characteristics, ^{222}Rn, an inert gas, will be produced in porewater in excess to the upwelling groundwater, or it could be produced from dissolved Ra.

In Nueces Bay, the greatest concentration of discharge sites was along the North Shore (i.e. White Point) with just a few sites in the lower Nueces River (D'Unger et al. 1996). Previous studies associate the high radon (^{222}Rn) activities in this bay with oil leakage from submerged pipelines and production wells; however, these studies do not account for sources of radium (Ra) associated with these historical surface discharges (Breier et al. 2005). The present study uses porosity and grain size analysis to characterize sediment types found in the bay in order to determine if any sediment characteristics may play a role in the distribution of Rn concentrations and

accumulation within the bay depth-sediment profiles; for instance, was Ra derived from historic oil-field brine discharges sequestered in the bay sediments?

The motivation for this approach arises from the previous work conducted in this bay by TAMU-CC doctoral student Audrey Douglas and the Murgulet hydrology research group showing the relatively high content of fine sediments in this bay (Hill and Nicolau 2014), Ra concentrations in bay waters (Breier et al. 2010), and low sedimentation rates (Hill and Nicolau 2014). Furthermore, because of the different cation exchange capacities of different minerals, it is expected that this study will determine if there is a connection between sediment types and the accumulation of Ra in Nueces Bay bottom sediments. Bonding occurs at the atomic level where negatively charged clays are attracted to oppositely charged ions. Clay attracts many ions such as Al^{3+}, Ca^{2+}, Mg^{2+}, K^{+}, H^{+}, and Na^{+} (Velde 1992). These negatively charged clay particles likely attract and hold the positively charged Ra, allowing it to remain trapped in sediments (Ketterings et al. 2007). On the other hand, sands have no charge, meaning they do not retain cations, facilitating Ra percolation through the sediments and migration through surface water with positive SGD and benthic fluxes (Ketterings et al. 2007).

Porosity and permeability of the sediments are indicators of fluid movement. Moderate porosity and good permeability can be found in sands because the large and interconnected void spaces between grains facilitate water flow more easily (Fetter 2000) and carry Rn-infused water through them. Rn diffuses from sediments into the porewater and advection carries this Rn-laden water through the permeable sediment to the overlaying surface water. Once in the surface water, ^{222}Rn will escape into the atmosphere as it is mobilized by wave activity at the water surface or as dictated by Henry's Law (Clever 2013).

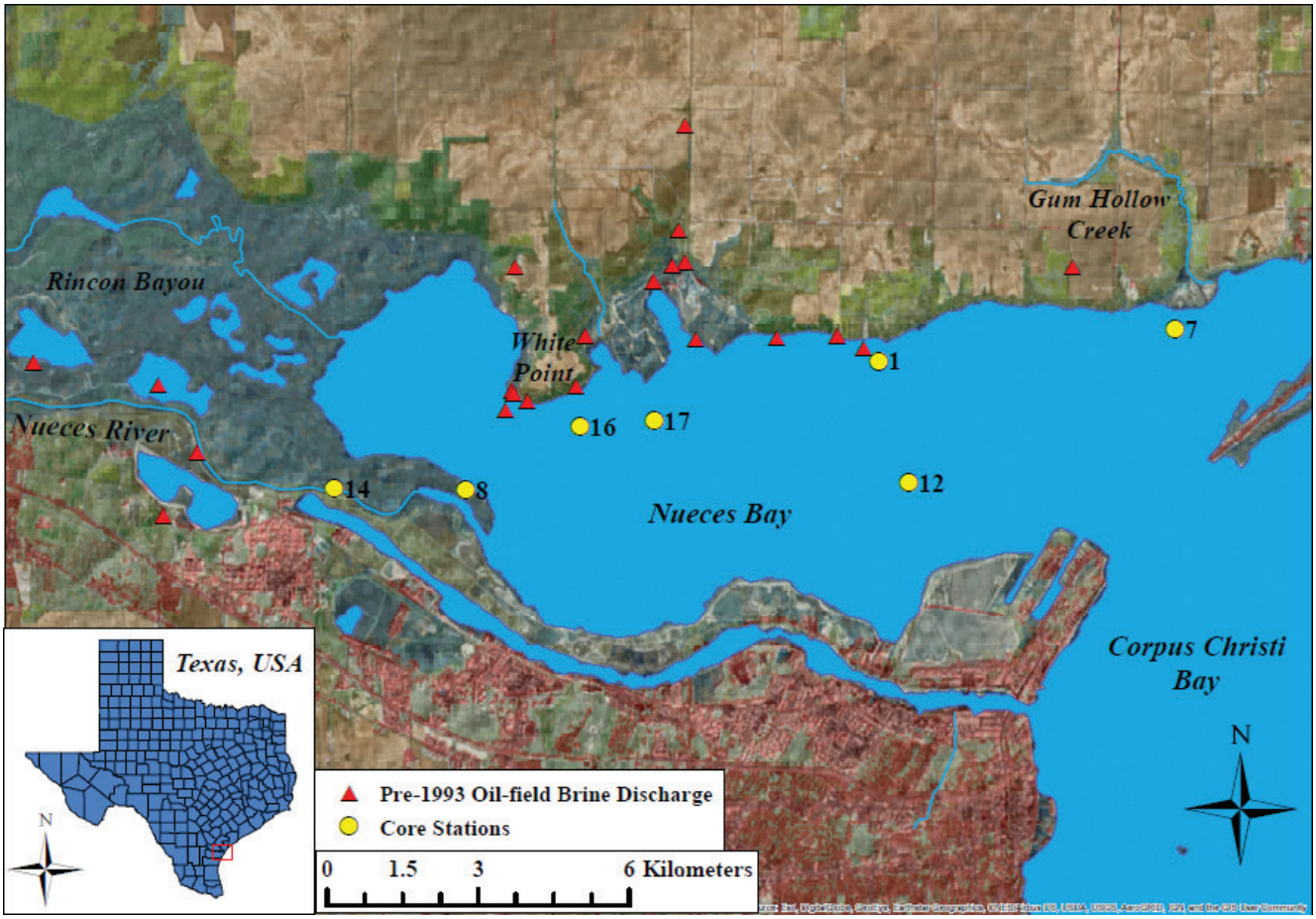
Clay minerals have an inherent static charge on their surface; the book-shaped minerals cause the particles to repel each other creating large void spaces and in turn high porosity (Velde 1992). Although clay porosities are very high (dependent on the type of clay minerals), it is an inhibitor of water movement because of its platy structure and the closeness of particles (Fetter 2000). Compaction, which occurs frequently in clays, rearranges and reshapes the grains, which reduces the pore volume and helps trap Ra in the sediments (Fetter 2000). This Ra contributes the least to the groundwater endmember for SGD calculations or to supported surface water concentrations. Thus, compacted clay may trap ions and charged particles and serve as poor conduits of flow to surface water; however, studies have shown that unconsolidated clays may enhance groundwater flow through osmotic processes, air entrapment beneath an inverted water table, and capillary action (Bighash and Murgulet 2015 and references therein).

The aim of the present study is to investigate whether sediment supported Rn activities are greater in bay sediments with close proximities to historic oil-field brine discharge locations. By combining measurements of sediment radon activity with porosity and grain size analysis of cores in comparison with published sedimentation rates, we can assess the relationships between sediment-supported ^{222}Rn and sediment type (i.e. sand, silt, clay) and attempt to establish implications of historic oil-field brine discharge timing. This analysis will help determine the role of these discharge brines in the spatial heterogeneity of sediment-supported ^{222}Rn characteristics to Nueces Bay, Texas. Thus, the present study is a comparative investigation that illustrates the diverse progression associated with the flux of fluids and gases in the sediment.

Physiographic Location

Nueces Bay is a shallow, well-mixed bay with direct connection to Nueces River and Delta and Corpus Christi Bay in Corpus Christi's back bay-barrier island system in south Texas (Figure 1). Nueces Bay is located in a semi-arid climatologic area and experiences microtidal influences with an average semi-diurnal tidal range of 0.15 meters (Diener 1975). This bay exhibits a large wetland area with the Nueces River, Rincon Bayou and Gum Hollow Creek as tributaries. The bay covers an area of 75 square kilometers with a mean depth of 2.3 meters (Hill and Nicolau 2014). The area of investigation is Nueces Bay, Texas, given its long-term exposure to oil-brine discharge to surface water and disturbances associated with the oil/gas industry on its coastal environment. Nueces Bay is surrounded by oil and gas fields with the earliest record of production dating back to the 1900's (D'Unger et al. 1996). In this

FIGURE 1.
Map of Nueces Bay showing core stations (yellow dots) and historic oil-field brine discharge locations (red triangles).



area, there are large predominantly depleted oil and gas formations; the wells in this area yield high water to oil ratios of up to 95% or greater (D'Unger et al. 1996). There is also extensive disposal of dredged material into Nueces Bay. The bay has fluctuations in its salinity regime from oligohaline to hypersaline levels, which are dependent on evaporation and flashy freshwater inflows

METHODS

Sample collection

Sediment cores were collected at 7 locations identified as historical discharge points (stations 1, 7, 16, 17) within the bay and from control sites (non-impacted stations 14, 8, 12) (Figure 1) in order to assess sediment-supported ^{222}Rn heterogeneity within the bay sediment. Sediment cores were extracted by pushing a clear PVC pipe, by hand, into the sediment and creating an airtight seal with the sampler head to remove the core sample intact from the surrounding sediment. Some areas had layers of impenetrable material resulting in the extraction of relatively shorter length core samples, which ranged in length from 42 cm to 132 cm. Once the core is taken, it is then capped and sealed until analysis can be performed in the lab.

Sample analysis

Sediment-supported ^{222}Rn activities were determined through sediment equilibration experiments as described by Corbett et al. (1998). Two centimeters of sediment were sub-sampled from every 10 cm down to 60 cm and then every 25 cm for the rest of the core length. Sediment samples were weighed to ensure all samples exceeded 100 g and were placed into flasks with radium free bay water from the sample station.

The flasks were then sealed and agitated on a shaker table for >21 days to allow radon ingrowth. After 21 days, the flasks were connected to the Durridge RAD-7 Radon-in-air Detector via tubing built into the cap and their ^{222}Rn activity was measured.

Porosity was measured from 5 cm long cross sections extracted every 10 cm in the upper 60 cm and then every 25 cm for the remainder of the core (length dependent upon sediment characteristics). The sample wet weight was recorded and the sample was then dried in an oven at 105 °C until the dry mass stabilized and the final dry weight was recorded. Porosity was then derived using the relationship between bulk density and particle density, assuming a conventionally agreed upon particle density of 2.65 g/cm^3 (Fetter 2000).

For grain size analyses, 1-2 cm cross sections were extracted from every 10 cm in the upper 60 and then every 25 cm for the remainder of the core length for laser diffraction analysis (Beckman Coulter Limit of Detection (LOD): 0.375µm-2000µm). The samples underwent an organic matter digestion process. This procedure is crucial to obtaining accurate results. Organic matter was oxidized from the sediment using hydrogen peroxide in multiple stages, from 5% hydrogen peroxide concentration to 40% concentration, to control reaction rates (Welschmeyer 1994). After removal of organic matter through digestions, the sediment went through a process of washing with DI, agitation, and centrifuging two times before instrumental analysis.

RESULTS AND DISCUSSION

Correlations and p-values for sediment supported ^{222}Rn with porosity, percent sand, percent silt, and percent clay are shown in Table 1. All data for sediment supported ^{222}Rn porosity, percent sand, percent silt, and percent clay for each sample station and sample depth down core are provided in Table 2. Also included in Table 2 are sediment classifications following the Shepard (1954) classification scheme, as modified by Schlee (1973), and the Folk scheme (1974); Folk (1954) as determined using the USGS SEDPLOT program (Poppe and Eliason 2007).

Radon and Porosity

Distribution of porosity and sediment-supported ^{222}Rn activities with depth are depicted for each investigated site (Figure 2). Overall, the control sites (non-impacted stations 8, 12, 14), have lower radon activities (average ^{222}Rn of 67.4 dpm/L, 70.6 dpm/L, and 61.6 dpm/L, respectively) than the sites near historical discharge points (stations 1, 7, 16; average Rn of 92.4 dpm/L, 115.8 dpm/L, and 109.8 dpm/L, respectively); however, one impacted site was lower even than the control sites (station 17, 59.8 dpm/L). Assuming sedimentation rates between 0.4 to 0.6 cm/yr (Hill and Nicolau 2014) and the end of the discharge period (1930-1993), an increase in sediment-supported ^{222}Rn activities would potentially be expected starting from ~9 cm below the sediment surface down to ~86.1 cm. For stations in the northern transect close to the discharge points (i.e. 1, 7, 16, 17) and mid-bay (i.e. 12), activities start increasing at an average depth of 15 cm while for river and river mouth stations (i.e. 14 and 8, respectively) activities become more enriched below the 20cm mark.

A visual inspection of the depth profiles shows that enrichment in ^{222}Rn could be associated with higher porosities for stations in the northern transect (i.e. 1, 7, 16) except one (i.e. 17). Despite the observed weak correlation between porosity and supported ^{222}Rn at most stations, a positive trend indicates that larger activities are in general associated with higher porosities, which, in turn, are associated with larger contents of silts and clays. Station 7 shows the strongest positive relationship between porosity and supported ^{222}Rn. Overall, porosity and ^{222}Rn are significantly positively correlated at a 95% confidence level ($r = 0.34$, $p = 0.018$) suggesting a relationship between sediment type and supported ^{222}Rn.

Radon and Grain Size Analysis

Distribution of supported ^{222}Rn activities and percent sediment type (i.e. sand, silt, and clay) are shown for each investigated site (Figure 3). Sand and ^{222}Rn have a significant negative correlation ($r = -0.41$, $p = 0.003$) while clay and ^{222}Rn have a significant positive correlation ($r = 0.46$, $p= 0.001$) and silt and ^{222}Rn have a weak positive correlation that is not significant at a 95% confidence level ($r = 0.28$, $p = 0.058$). ^{222}Rn activities at stations 8 (i.e. river mouth) and 14 (i.e. lower river) are low in the shallow sediments and increase with depth, peaking around 80 cm and 35 cm, respectively. These peaks in ^{222}Rn activities coincide with increased clay content and decreased sand content of the sediment

at these depths. Station 14 exhibits alternating layers of predominantly sand or silt and clay reflecting the changing depositional conditions that occur in the lower Nueces River. The sand-rich layers were likely deposited during higher energy periods (i.e. high river discharge) whereas the silt/clay layers likely reflect low energy periods (i.e. low river discharge) (Wright 1977). These alternating layers are not seen further downstream at station 8 which is clayey silt. Studies have shown higher sedimentation rates (0.7 cm/yr) at Nueces River mouth than in the bay (Hill and Nicolau 2014; White et al. 2002). Currently, 95% of the suspended sediment load is trapped after the construction of the Seale Dam in 1958 (White et al. 2002). Although, runoff during flooding events may contribute more sediment to the river (i.e. causing higher sedimentation rates) than during normal conditions.

Oxidation-Reduction Reaction Influences on Radium

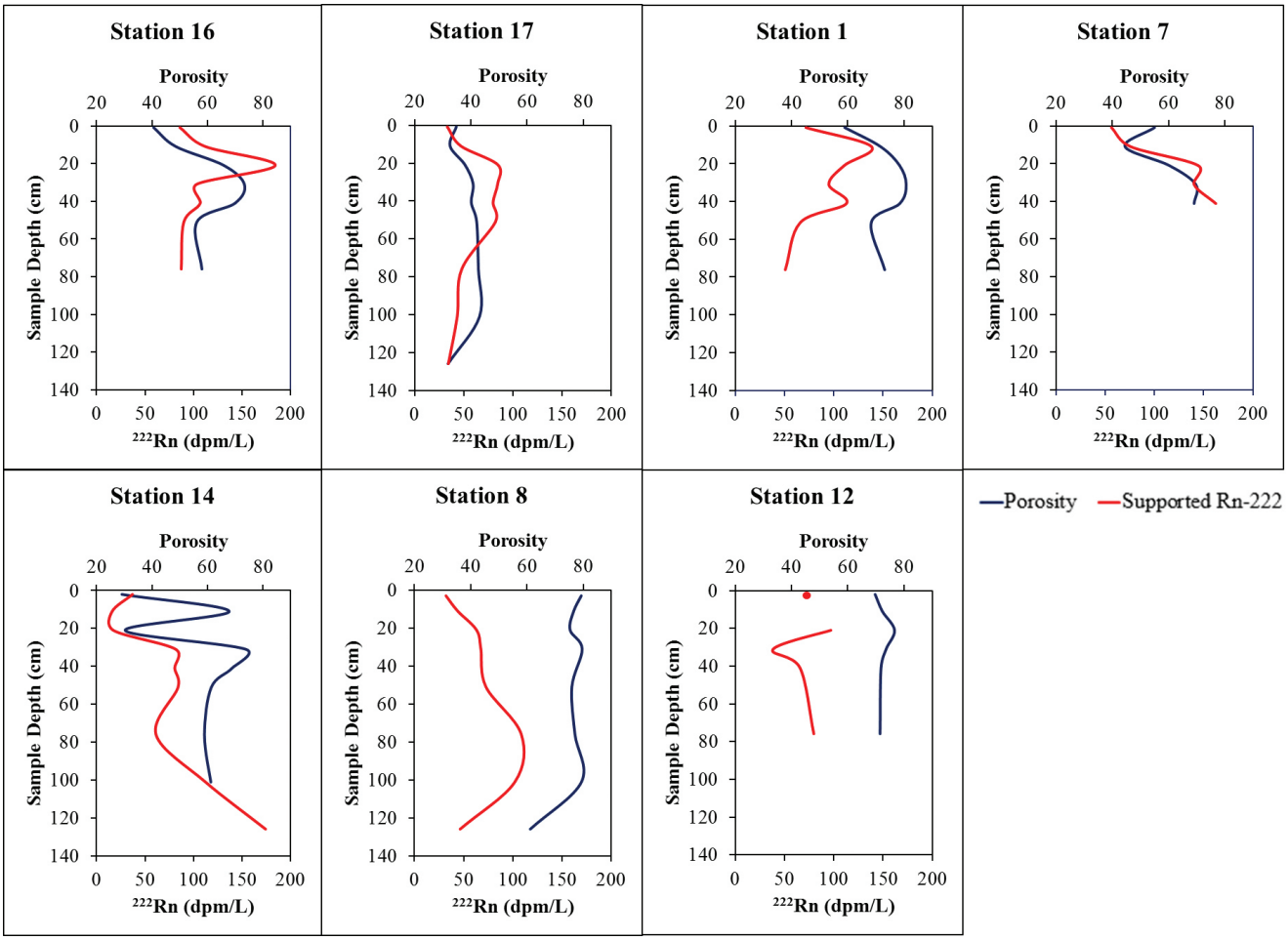
While increases in supported-^{222}Rn occur around 10-20 cm in most of the sediment profiles and are significantly correlated with clays, we cannot rule out other processes that may be playing a role in Ra sequestration. Oxidation-reduction reactions accompanying early diagenesis of organic matter can greatly influence the chemical nature of estuarine sediments. The rate of organic carbon accumulation influences the depth into the sediment where reduction processes occur (i.e. rapid carbon accumulation results in the accumulation of MnO_2 within centimeters of the sediment-water interface) (Kadko et al. 1987). As sediments accumulate and are buried, manganese may cycle through reduction and mobilization in sediment porewater, and upward diffusion to the oxic zone, re-oxidation and precipitation creating a highly Mn-rich layer. The depth of this layer is principally governed by the balance between downward O_2 diffusion and upward Mn^{2+} diffusion. The presence of this Mn-rich layer is significant to our study as manganese oxides are important scavengers of trace metals, including radium, in marine environments and the adsorptive properties of the upper sediment column can be significantly altered by the redistribution and concentration of manganese oxides (Kadko et al. 1987).

It has been demonstrated that in oxic sediments solid phase ^{226}Ra will be depleted relative to its parent ^{230}Th in the upper 10-20 cm due to diffusive loss into the overlying water and incomplete ingrowth of thorium, but equilibrium will be approached at depth (Kadko et al. 1987). Thus, porewater concentrations will increase to a maximum and then decrease as ^{226}Ra production decreases. However, in suboxic sediments ^{226}Ra in excess of ^{230}Th has been observed in the zone of Mn oxidation and then ^{226}Ra becomes deficient relative to ^{230}Th in the zone of Mn reduction before approaching equilibrium at depth (Kadko et al. 1987). Cores from stations 1, 16, and 17 appear to follow the trend described for oxic sediments with deficient supported ^{222}Rn in the upper 10-20 cm, reaching a maximum between 10-40 cm, and then decreasing to equilibrium. The core for station 7, while the shortest core collected, does not follow either pattern described, as the supported-^{222}Rn activity has continued to increase to a maximum. However, ^{222}Rn may begin decreasing after this maximum, as seen in all other cores, but due to the shortness of the core, which is as long as the cores observed by, we did not capture the decrease down core.

Trends with Depth

Sediments found at shallow depths (upper 30 cm) show an overall weak correlation between porosity and ^{222}Rn ($r = 0.32$, $p = 0.187$) and do not meet the 95% confidence level. However, when analyzed by sediment type, sand was significantly negatively correlated with ^{222}Rn ($r = -0.47$, $p = 0.041$) at the 95% confidence interval. Silt and ^{222}Rn show an insignificant weak correlation ($r = 0.30$, $p = 0.208$). The strongest correlation found in the upper 30 cm of sediment was between clay and ^{222}Rn, which have a significant positive relationship ($r = 0.58$, $p = 0.009$). For sediments sampled below 30 cm, ^{222}Rn is positively correlated with porosity and clay, and negatively correlated with sand; however, these correlations are insignificant at the 95% confidence interval, but are significant at the 90% confidence interval ($r = 0.36$, $p = 0.056$; $r = -0.34$, $p = 0.075$; respectively). Similar to the upper 30 cm, silt and ^{222}Rn have an insignificant positive relationship ($r = 0.25$, $p = 0.196$). These different significances in correlations the two depth-intervals indicate that a weaker relationship exists between supported-^{222}Rn and sediment type with increasing depth. This decreased supported-^{222}Rn below peak activities is likely due to the oxidation-reduction conditions at each site and radium approaching equilibrium with thorium at depth, as discussed above,

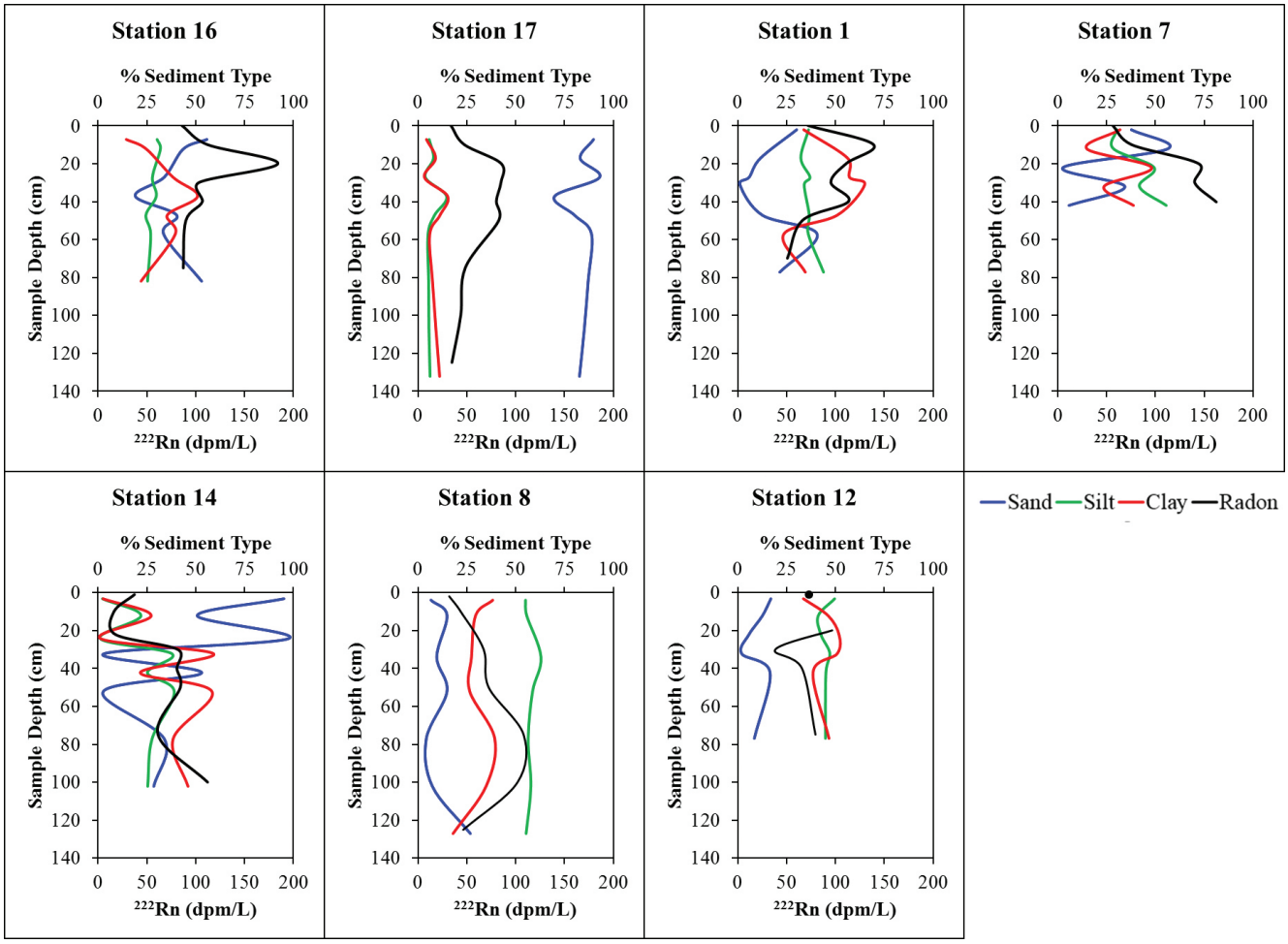
FIGURE 2.
Sediment supported ^{222}Rn (dpm/L) and porosity with depth down core.
Supported ^{222}Rn is red line and porosity dark blue line.
Top row: northern bay sites from head of the bay (left) toward Corpus Christi Bay (right).
Bottom row: from Nueces River (left) to middle of Nueces Bay (right).



but the higher peak activities at the impacted sites dominated by clay sediments (i.e. 1, 7, 16) may indicate the entrapment of Ra from oil-field brines.

Stations 8 and 14 (i.e. the river mouth and the lower Nueces River, respectively), show an increase in ^{222}Rn at greater depths compared to all other stations (Figures 2 and 3). Studies have determined the sedimentation rates in the river to be higher, 0.7 cm/yr (White et al. 2002), than those found in the bay, 0.4 cm/yr (Hill and Nicolau 2014). The higher sedimentation rates in the river and river mouth facilitate faster sediment accumulation that may explain why the peak in ^{222}Rn is deeper in the sediment column. Both, station 8 and 14 were originally identified as non-impacted control sites; however, after data analyses the stations showed high ^{222}Rn activity at greater depths than all other sites. Given the greater sedimentation rates in the river-influenced areas, the location sites and temporal extent of oil-field brine discharge for our Nueces River sampling sites, we would expect to see peaks in supported-^{222}Rn between ~16 cm and ~60 cm. However, the peak in ^{222}Rn is deeper than the expected interval, as explained above, at both stations. Although identified as control sites, downstream transport of oil field brine-rich water from the upstream discharge site could be responsible for some of the Ra in the sediment at these locations. Furthermore, the higher predominance of silts at station 8, for instance, could potentially favor downward

FIGURE 3.
Sediment grain size analysis results (i.e. percent sand, silt, clay) and sediment supported ^{222}Rn (dpm/L) plotted down core. ^{222}Rn is black line. Clay is red line. Silt is green line. Sand is blue line. Top row: northern bay sites from head of the bay (left) toward Corpus Christi Bay (right). Bottom row: from Nueces River (left) to middle of Nueces Bay (right).



transport of Ra-rich waters to depths greater than those at bay stations (Figures 1, 2, 3). Another explanation for the occurrence of high ^{222}Rn activity in these stations may be from oxidation-reduction reactions taking place over a greater depth into the sediment and thus the manganese-rich layer occurs deeper in the sediment column trapping Ra deeper; however, we do not have sufficient data on the redox conditions within these sediments to support this conclusion.

CONCLUSION

Given the shallow water depths, Nueces Bay is a well-mixed estuary as a result of physical processes such as wind and wave action, along with river discharge. As a result, the top few centimeters of the sediment are frequently resuspended, decreasing the rate of accumulation. This constant mixing and sediment resuspension enhances scavenging and remobilization of radium (i.e. ^{226}Ra) which are highly particle reactive and are associated with sediments. On the other hand, as sediment accumulates and is less exposed to flushing (i.e. the highly porous, but low permeability fine sediments) or resuspension, radium is more likely to get trapped/adsorbed into sediment, thus the higher sediment-supported ^{222}Rn activities. As observed at most stations, particularly in the northern transect and close proximity to the discharge points, the sediment-supported ^{222}Rn increases as porosity increases.

TABLE 1.
Correlations for sediment supported-^{222}Rn with porosity, percent sand, percent silt, and percent clay.

	Radon		
	Whole Cores	≤ 30cm	> 30cm
Porosity	**0.3402** **0.018**	0.3163 0.1871	0.3584 0.0563
% Sand	**-0.4103** **0.0038**	**-0.473** **0.0409**	-0.336 0.0751
% Silt	0.2756 0.058	0.3024 0.2083	0.2471 0.1962
% Clay	**0.459** **0.001**	**0.5786** **0.0095**	0.3307 0.0797

NOTE: Correlation coefficients (top) and p-values (bottom) are shown. Correlations that are significant at the 95% confidence interval are bolded.

For porosity ranges between 30-45% measured ^{222}Rn does not exceed 86 dpm/L while for porosities exceeding 45%, ^{222}Rn activities are increasing, which may indicate that, the impermeable sediments (of high porosities such as silts and clays) may be trapping radium through burial and compaction. Grain size analysis showed peaks in ^{222}Rn activities correspond with increased clay content and decreased sand content of the sediments. Station 17 exhibits the lowest porosities (higher content of silt and sand) and lowest ^{222}Rn activities, confirming the role of sediment type in trapping of radionuclides. At this location, also in proximity to discharge areas, flushing of the sediment with uncontaminated groundwater, for instance, could result in lower concentrations of Ra, thus supporting less ^{222}Rn. Further investigation is needed regarding manganese content in the sediments that help explain the Ra adsorption activity. X-ray diffraction of the sediments down core would also be useful in determination of clay type and aid in reasoning for Ra attachment to the sediments.

These results indicate that oil-field brines are potentially a source of increased radionuclides in bay sediments. However, accumulation of radionuclides is dependent on type of sediment, burial rates, and porewater chemistry. The presence of radionuclides associated with oil-field brines could also be an indication that other contaminants (i.e. hydrocarbon) could be trapped in the sediments, a possible source of toxins to the bay.

ACKNOWLEDGEMENTS

I would like to thank all those who helped me in the lab and/or in the field, namely: Nicholas Spalt, Cody Lopez, Mark McKay, and Sajjad Abdullajintakam. Special thanks to Dr. Paul Montagna for editorial review. I want to extent my gratitude to my faculty mentors Dr. Dorina Murgulet and doctoral candidate Audrey Douglas for providing data, services, and assistance in this research. Finally, I would like to thank the funding agencies whose financial support made this work possible: Texas Sea Grant(Award number: NA14OAR4170102), Center for Water Supply Studies, Texas A&M University-Corpus Christi, and Ronald E. McNair Scholars.

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TABLE 2: Sediment supported ^{222}Rn (dpm/L), porosity, percent sand, percent silt, and percent clay for each site and sample depth down core (cm).

Station	Depth	Radon	Porosity	% Sand	% Silt	% Clay	Shepard Class	Folk Class
1	2-7	71.7	58.8	30.0	36.2	33.8	SAND SILT CLAY	SANDY MUD
	17-18	138.6	71.6	11.5	32.2	56.3	SILTY CLAY	SANDY MUD
	27-28	110.9	78.4	5.7	37.0	57.3	SILTY CLAY	MUD
	31-38	95.2	80.8	1.1	33.9	65.0	SILTY CLAY	MUD
	47-48	113.2	78.5	12.5	36.6	51.0	SILTY CLAY	SANDY MUD
	57-58	66.1	68.3	40.5	36.1	23.5	SAND SILT CLAY	SANDY MUD
	77-78	50.8	73.1	21.4	44.0	34.6	SAND SILT CLAY	SANDY MUD
7	2-7	56.3	55.0	37.7	30.4	31.9	SAND SILT CLAY	SANDY MUD
	12-17	75.6	44.6	56.5	28.6	15.0	SILTY SAND	MUDDY SAND
	22-27	144.5	60.3	2.7	49.4	47.9	CLAYEY SILT	MUD
	32-37	140.3	69.6	34.4	41.9	23.7	SAND SILT CLAY	SANDY MUD
	42-47	162.4	69.0	5.8	55.6	38.7	CLAYEY SILT	MUD
8	4-9	31.9	79.3	6.7	55.1	38.2	CLAYEY SILT	MUD
	12-17	43.7	76.7	14.9	55.6	29.5	CLAYEY SILT	SANDY MUD
	34-39	67.3	79.6	9.7	63.1	27.3	CLAYEY SILT	SILT
	52-57	72.4	76.0	14.9	58.7	26.4	CLAYEY SILT	SANDY SILT
	77-82	108.4	77.1	4.3	56.4	39.3	CLAYEY SILT	MUD
	102-107	102.0	79.5	7.4	57.8	34.8	CLAYEY SILT	MUD
	127-132	46.3	61.2	26.9	55.3	17.8	SANDY SILT	SANDY SILT
12	3-8	72.8	69.7	16.9	49.4	33.7	CLAYEY SILT	SANDY MUD
	12-17	--	72.3	12.6	41.0	46.4	SILTY CLAY	SANDY MUD
	22-27	96.8	76.6	5.7	42.4	51.9	SILTY CLAY	MUD
	32-37	38.2	73.6	2.0	47.0	51.0	SILTY CLAY	MUD
	42-47	65.5	71.8	16.4	45.0	38.6	CLAYEY SILT	SANDY MUD
	77-82	79.5	71.5	8.5	44.7	46.8	SILTY CLAY	MUD
14	3-8	37.5	29.0	95.3	2.2	2.5	SAND	SAND
	12-15	16.4	67.8	50.8	22.0	27.2	SAND SILT CLAY	MUDDY SAND
	24-29	17.8	30.2	97.7	1.1	1.3	SAND	SAND
	32-37	81.9	73.9	2.9	37.9	59.2	SILTY CLAY	MUD
	42-47	80.9	68.7	53.0	25.3	21.6	SAND SILT CLAY	MUDDY SAND
	52-57	84.4	61.3	2.5	39.1	58.4	SILTY CLAY	MUD
	77-82	61.6	58.8	33.9	27.7	38.4	SAND SILT CLAY	SANDY MUD
	102-107	112.3	61.1	28.4	25.5	46.1	SAND SILT CLAY	SANDY MUD
16	7-8	85.9	40.6	55.6	30.1	14.3	SILTY SAND	SILTY SAND
	17-18	111.8	48.6	43.6	31.8	24.6	SAND SILT CLAY	SANDY MUD
	27-28	183.8	65.9	33.9	27.7	38.4	SAND SILT CLAY	SANDY MUD
	37-38	103.3	73.3	19.2	29.7	51.1	SILTY CLAY	SANDY MUD
	47-38	106.8	70.0	40.2	24.3	35.5	SAND SILT CLAY	SANDY MUD
	57-58	89.9	56.2	33.6	26.8	39.6	SAND SILT CLAY	SANDY MUD
	82-83	87.2	58.0	52.9	25.2	21.9	SAND SILT CLAY	MUDDY SAND
17	7-8	33.4	34.9	89.9	5.8	4.3	SAND	MUDDY SAND
	17-18	47.0	32.7	83.1	8.0	9.0	SAND	MUDDY SAND
	27-28	84.9	38.0	92.9	3.8	3.3	SAND	SAND
	37-38	84.7	40.9	70.0	14.8	15.2	CLAYEY SAND	MUDDY SAND
	47-48	80.0	40.2	80.2	8.5	11.3	SAND	MUDDY SAND
	57-58	82.5	42.1	88.9	5.2	6.0	SAND	MUDDY SAND
	82-83	48.1	42.8	87.1	5.5	7.4	SAND	MUDDY SAND
	107-108	43.5	43.2	85.2	5.6	9.2	SAND	MUDDY SAND
	132-133	34.5	32.0	82.7	6.2	11.1	SAND	MUDDY SAND

NOTE: Sediment classification by Shepard Class and Folk Class are also provided.

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TESTING FOR SPATIAL PATTERN IN GENETIC RELATEDNESS AMONG OYSTERS

by CYNTHIA ANNE SOLIZ

ABSTRACT

Oyster reefs have been declining in population on a global scale, consequently placing bays and estuaries in a negative health status. In order to offset this chain reaction of decline, a substantial amount of research has been placed in determining recruitment patterns of juvenile oyster larvae based off genetic relatedness. Spatially non-random patterns of recruitment have been observed in populations of broadcast-spawning organisms that have a pelagic larval stage, such as the California spiny lobster (*Panulirus interruptus*). We sought to test wheter non-random patterns of recruitment are also evident in *Crassostrea virginica* oysters. Oysters were collected from two natural reefs and ten artificial reefs made up of five of different substrata (oyster shell, river rock, limestone, and concreate). The collected DNA was then subjected to ddRAD sequencing and compared to determine if groups of oysters were genetically related to one another. The overall result will aid in recruiting new oysters to locate themselves in areas where they will thrive and remain in the ecological process.

MENTOR

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INTRODUCTION

Spatial patterns of relatedness in broad-cast-spawning marine species are more common than originally postulated, where it was originally presumed that individuals would be randomly distributed with respect to their relatives due to mixing in the plankton prior to settlement. Despite exhibiting high gene flow, as is characteristic among many broadcast spawners, adult California rock lobsters (*Panulirus* interruptus) were more likely to be found in aggregations with close relatives and may be settling in areas where there must be a strong localized recruitment (Iacchei, M. *et al*. 2013).

Likewise, a study performed by Selwyn *et al* (2016) found patterns of chaotic genetic patchiness (Johnson & Black, 1982), which are genetic patterns that cannot be easily explained, among geographic samples of *Coryphopterus personatus*, the Masked goby. Their expected levels of relatedness were at a higher proportion than expected at random when considering individuals that were either full-siblings or half- siblings based on the genetic structure of individuals in short distances.

The frequencies of the genetic structures were found to be in non-equilibrium within the specific locations indicating that there were clusters of family groups.

The mechanisms that result in aggregations of related broadcast-spawning individuals have yet to be determined, but these studies have given cause for further study. Iacchei *et al* (2013) and Selwyn (2016) both recognize that there can be different mechanisms that could create the chaotic genetic patchiness such as temporal variability in ocean currents, deep water upwelling, selection at time of settlement, and the formation of larval kin-aggregations that tend to settle together.

Following these studies, we can test whether the same phenomenon also occurs in another broadcast-spawning species, such as *Crassostres virginica,* also known as the Eastern oyster. Here, we test for spatially non-random patterns in relatedness of oysters, in reefs separated by 10-500 m located near Goose Island State Park, Rockport, Texas. We used ddRAD sequencing to interrogate ~2000 single nucleotide polymorphisms (SNPs) and calculated an index of kinship. If aggregations of kinship are detected, then it is highly likely that the settlement substratum is the driver, given the great dispersal potential of oyster larvae, the limited ability of oyster larva to control transport, and our very fine scale of sampling.

METHODS

Crassostrea virginica were collected from the bay of Goose Island. There were a total of 240 oysters collected from the bay with 2 replicates of 5 substrata (natural oyster reef, river rock artificial reef, limestone artificial reef, concrete artificial reef, oyster shell artificial reef) and each treatment contained 24-48 oysters (Figure 1). Samples were transported to the laboratory, dissected live, and a tissue sample was preserved in RNAlater. DNA was isolatedand purified from the preserved tissue with Omega BioTek E-Z 96 Tissue DNA kit. The quality of the isolated DNA was evaluated using gel electrophoresis. For individuals with low molecular weight DNA, the Beckman-Coulter SPRI-Select kit was used to isolate high molecular weight DNA. One hundred and seventy-three oysters moved forward after passing quality control standards (67 concrete, 41 limestone, 37 river rock, and 28 natural).

The double digest restriction site associated DNA sequencing (ddRAD Peterson *et al.* 2012) protocol wa then used on the remaning samples. Conditions for the PCR protocol were modified from Peterson et al (2012). Modifications are as follows: each DNA sample (150ng) was concentrated to 16.67ul for preparation of the restriction digest. A master mix was prepped using RNAse (10mg/ml), ThermoScientific Fast Digest Enzyme 1, ThermoScientific Fast Digest Enzyme 2, 10xx FastDigest Buffer, and water. 10.14ul of DNA was placed in a 96 well plate and 4.332 ul of the master mix was aliquoted for each sample. This plate was placed on the thermocycler and incubated at 37° C overnight. Next, the Beckman-Coulter AMPure clean up protocol (1.5x) was used and the remaining DNA was eluted in 20 ul of sterile H_2O. The samples were then quantified using the AccuBlue master mix (20ml AccuBlue Solution and 200 ul of enhancer). For each sample, 1ul was added to quant plate followed by 9ul of 1X TE. After reviewing the DNA concentration data, an amount of DNA was determined that would be sufficient for the ligation step to work properly. After dispensing the appropriate calculated amount, each sample was brought up to 19ul total volume using sterile DI water. For the addition of the adapters, each DNA sample (19 ul) was given 2 ul of H2O, 3 ul of ligation buffer, 2 ul of P2 adapter, 2 ul of P1 adapter, and 2 ul of T4 ligase. The P1 adapter contained a unique identifier to be given to one specific individual. The samples were then divided into pools based on doubles of using the P1 adapter. There were 192 oysters used for separating in to two different pools based on the unique barcodes. The plate was incubated at room temp for 1 hour then heat was applied at 65C for 10 minutes. Next, the samples were cooled at a rate of 2C/ 90 seconds until the samples reached room temperature. The samples were then pooled into groups of 48 uniquely marked individuals or less into 1.5 ml tubes. The pools were then cleaned using the AMPure 1.5x clean up and rehydrated in 30 ul of 1xTE buffer. The dna was then amplified using PCR protocols followed from Peterson et al. (2012). Samples were ran through a fragment analyzer run to determine dimer presence; if so, another AMPure clean protocol was performed. The pools were then sent off to another facility to be sequenced using an Illumina sequencer. There were two lanes that was processed using Illumina HiSeq 4000 for the 150 bp dna strands and there was

another was performed with Illumina HiSeq 2500 for the 100 bp dna strands.

The samples received from the sequencing facility were a total of 124 individual oysters that were attached to one of the four substrates we collected oysters from; river rock, limestone, concrete, and natural substrate. Upon receiving the sequences, a read count was performed and established to be about 76,832,868 reads for our Run 1 and Run 2. The dna was represented in fastq files along with the quality score of that particular nucleotide sequence. Next, a program called dDocent constructed by Puritz (2014) was used to quality control and filter the individually barcoded individuals. The identification of SNPs was needed to be able to find viable individuals for analysis. The dna sequences were then manipulated using the 'Guide for Processing Population Genomic Data on a High Performance Computing Cluster (HPC)' manual (Bird 2016, unpublished).

An index of kinship was calculated for each pair of individuals following Manichaikul *et al.* (2010) using the vcfTools software package (Danecek 2011). For this index of kinship, genetically identical individuals are represented by 0.5, siblings by 0.25, and half siblings by 0.125. We categorized each pairwise relationship into these three categories, or as "unrelated". We performed permutation tests to determine if there were significantly elevated levels of kinship. We also constructed a pairwise matrix of relatedness and color-coded the cells by the level of kinship, with higher kinship values being brighter red.

RESULTS

In total 2,015 SNPs were analyzed in 155 oysters that were successfully sequenced and passed all quality control filters. The heatmap of kinship (Figure 2) reveals a clearly non-random pattern of kinship. Upon closer inspection, it seemed that there was elevated kinship in samples that were sequenced twice. Samples that were sequenced a second time didn't yield enough sequence reads on the first sequencing run. In total, 670 pairwise comparisons were classified as half-sibs, sibs, or identical in samples that were sequenced twice, as compared with two comparisons in individuals that were only sequenced once. This hypothesis, that there was a non-random relationship between sequencing run and kinship, was tested with a permutation test and confirmed ($p<0.01$).

TABLE 1.
Counts of pairwise kinship values categorized by equivalent kinship classification [identical (0.375-0.5), siblings (0.1875-0.375), and half-siblings (0.09375-0.1875)] and comparisons within and among sequencing runs.

	Among Seq Runs	Seq Run 1, Within	Seq Run1 & Run2, Within
Identical	12	2	2
Sibling	24	0	14
Half-sibling	36	0	654

A pattern of elevated kinship that is correlated with sequencing run is extremely unlikely to be due to natural phenomena. Indeed, a closer inspection of the sample treatments revealed no association between sampling location, substratum, and sequencing run. Consequently, we ended the analysis because any natural patterns were occluded by the effect of sequencing run.

DISCUSSION

Comparing the genetic patterns across the cohort of oysters can give us the necessary information to determine genetic relatedness of groups. After reviewing our data, we have determined that the spatial pattern of relatedness cannot be tested for due to a statistically significant overabundance of halfsiblings in individuals that were sequenced two times. To be clear, this pattern cannot be attributed to natural phenomena, and therefore, must be due to experimenter error. For these individuals which were sequenced twice, the sequences resulting from the two sequencing runs were combined, which could be the source of the error. If the sequence files were mislabeled in either sequencing run, then this could result in elevated kinship because the DNA from the same individuals could be combined with and labeled as different individuals. The sporadic "diagonal" patterns of elevated kinship in the heatmap (Figure 2) are consistent with the mislabeling hypothesis.

Alternatively, the non-biological pattern seen in Run1/Run2 may be due to a laboratory procedural error that resulted in possible contamination of 10+ samples located on plate prep for Run2. We checked to see

FIGURE 1.
Location of sample collection

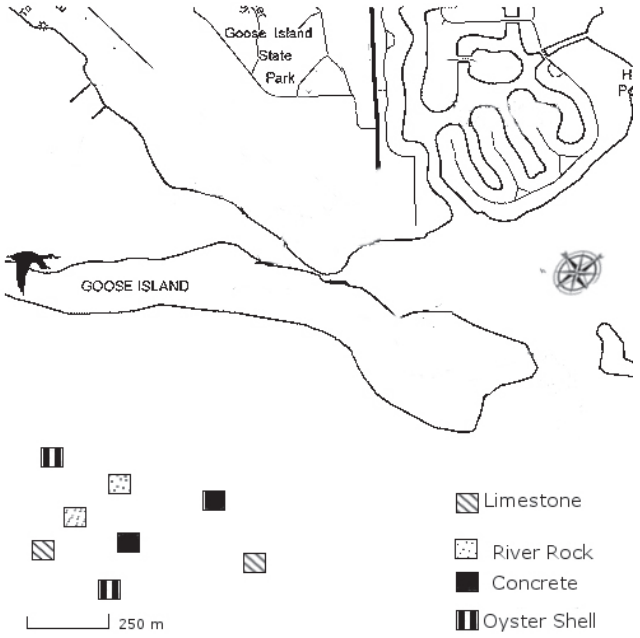
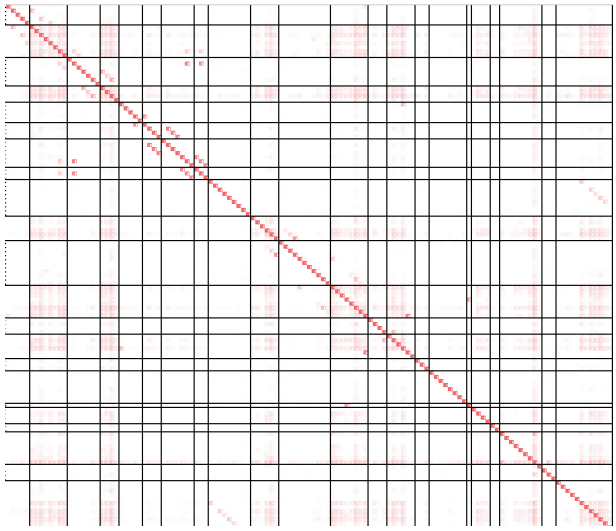


FIGURE 2.
Heatmap of kinship



if these individuals exhibited elevated kinship with respect to each other. Regardless, many more than 10 samples were affected and this mishap cannot explain the entire pattern. It is also possible that samples were mislabeled during library preparation for sequencing run 1 or run 2. If this occurred, it would have the same effect as mislabeling the sequencing files.

To decipher among these two hypotheses (mislabeling of samples during library preparation and mislabeling of sequence files) there are a few different strategies. We can reprocess the sequencing files, but not combine the sequences from runs 1 and 2. Kinship values could be calculated and used to identify mislabeling. If an error in naming files occurred, then we expect that there would be a different pattern of kinship and no indications of mislabeling. If an error in labeling tubes during library prep occurred, then we would expect no change in the pattern. If the pattern changes, but there is still an indication of mislabeling, then both labeling errors during library prep and errors in labeling sequences can explain the observed pattern. We also kept detailed records of all tube transfers (performed by a fluidics robot), which can be evaluated to identify exactly what errors occurred and fix them. Once this process, then we can test for non-random patterns of kinship that are caused by biological phenomena.

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CHARACTERIZATION OF A PATHOBIOME CONTRIBUTING TO A DISEASE OUTBREAK IN PACIFIC WHITE SHRIMP (*LITOPENAEUS VANNAMEI*)

by MEGAN WOODS

ABSTRACT

The Earth's 7.3 billion people are increasingly reliant on aquaculture as a major source of animal protein. This fact has prompted vigorous growth and innovation in aquaculture including the use of zero-exchange, biofloc-dominated, recirculating raceways for growing shrimp. These systems are regarded as more sustainable than traditional pond aquaculture, as they minimize the use and discharge of water. However, the high biosolid content of these systems also encourages the growth of both beneficial and non-beneficial bacteria. Here, we report a bacterial disease outbreak in Pacific white shrimp (Litopenaeus vannamei)*, occurring during the grow-out phase in a biofloc dominated system. The culturable pathobiome was composed of 19 Gram-negative bacteria belonging to 9 species including* Vibrio vulnificus, Photobacterium damselae *and* Aeromonas hydrophila. *Preliminary typing of bacterial strains was determined by biochemical tests. The identity of two strains* (V. harveyi *and* P. damselae) *was confirmed by whole genome sequencing. Analysis of these two genomes revealed that both carry a large repertoire of genes associated with antibiotic resistance. Findings suggest that intensive aquaculture systems may unknowingly select for the evolution and maintenance of antibiotic resistance. This study is especially novel in that the concept of a pathobiome – a collection of co-occurring pathogens responsible for a disease – represents a recent paradigm shift in the traditional one pathogen one disease model.*

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INTRODUCTION

Aquaculture now accounts for nearly half of the global fishery food supply (1). Looking toward the future, human population growth and a rising demand for fishery products is predicted to further expand the aquaculture industry (2). A key challenge to meeting this demand will be the reduction of environmental impact. For example, traditional pond shrimp aquaculture relies on high water exchange to remove waste and maintain water quality, but high water exchange systems consume large quantities of water and the effluent can load coastal ecosystems with excessive nitrogen and phosphorous, which leads to coastal eutrophication (3). In contrast, zero water exchange systems aim to eliminate the release of nutrient-rich effluent (4).

A recent innovation in zero water exchange shrimp aquaculture utilizes super-intensive, indoor recirculating systems (5). These new indoor systems offer enhanced biosecurity, and the ability to control environmental parameters offers increased year-round production. Additionally, shrimp grown in these systems are thought to receive supplemental nutrition from feeding on biofloc particles, which are composed of bacteria, fungi, algae, protists, and zooplankton (6). However, the use of these intensive, zero exchange, biofloc dominated, raceway systems is a relatively new strategy and research is needed to understand the biology of these systems. In particular, the control of disease outbreaks remains a limiting factor (7).

The control of disease has long been a barrier to aquaculture production (8). It is estimated that disease outbreaks cost the industry $6 billion (US) per year and in certain sectors (e.g., shrimp), disease related losses exceed 40% of global capacity (9, 10). Furthermore, the recent emergence of infectious diseases with obscure etiology has decreased production across much of Asia (11). In particular, some species of bacteria belonging to the *Vibrio* and *Photobacterium* genera (e.g., *V. vulnificus, V. harveyii, V. parahaemolyticus, V. alginolyticius, P. damselae*) are significant pathogens of shrimp (12). The symptoms of *Vibrio* infection (i.e., vibriosis) include lethargy, reduced feeding, reddening of the body, severe necrosis and increased mortality (13). Histopathological examinations have shown that the digestive track and hepatopancreas, in particular, can harbor high *Vibrio* densities (14).

The etiology of a vibriosis outbreak is commonly established by isolating the pathogen on media that is selective for *Vibrio* species (15). The pathogen can then be identified by a series of biochemical tests or by direct detection with polymerase chain reaction (PCR) targeting conserved species-specific biomarkers (16). Importantly, this process commonly assumes that one pathogen is responsible for a given disease, but this assumption is anachronistic, as new research has shown that disease can often be attributed to multiple pathogens, which are collectively called a pathobiome (17). Thus, the etiology of a given disease outbreak may be more complicated than the one pathogen one disease model.

In this study, we characterized a vibriosis outbreak in Pacific white shrimp (*Litopenaeus vannamei*) from a zero exchange, biofloc dominated system. We hypothesized that multiple co-occurring pathogens (i.e., a pathobiome) were responsible for the disease outbreak. Results indicate that at least 9 bacterial species from 6 genera were associated with the disease outbreak. To our knowledge, this is the first report of a pathobiome in an aquaculture setting.

MATERIALS AND METHODS

Sample collection

Hepatopancreas samples were collected aseptically from two moribund Pacific white shrimp (*Litopenaeus vannamei*) during the month of August 2014. The shrimp were grown in a biofloc-dominated, recirculating raceway (40 m^3) at the Texas A&M AgriLife Research and Extension Center (Corpus Christi, TX, USA). The samples were collected from two moribund adult shrimp during a vibriosis outbreak of unknown etiology as evidenced by high mortality and localized necrosis (personal communication, Dr. Tzachi Samocha, Texas A&M AgriLife).

Culture conditions

Samples of hepatopancreas were homogenized, serial-diluted with PBS, plated on *Vibrio*-selective CHROMagar (CHROMagar, Paris, France), and subcultured for isolation three times on *Vibrio*-selective thiosulfate-citrate-bile salts-sucrose (TCBS) agar (Oxoid, Hampshire, England). For each culturing step, bacteria were grown in the dark at 30°C overnight (18 hours).

Biochemical tests

Preliminary identification of bacterial isolates was conducted with an API 20 NE kit (bioMérieux, Marcy-l'Étoile, France). The API 20 NE is a series of biochemical tests (8 conventional tests and 12 assimilation tests) for the identification of non-fastidious, non-enteric Gram-negative bacteria. The tests were conducted according to the manufacturer's protocol.

DNA isolation

Isolated colonies were grown overnight (18 hours) at 30°C in tryptic soy broth (TSB) (Becton & Dickinson, Heidelberg, Germany) with shaking (100 rpm).

Bacterial cells were pelleted by centrifugation (8,000 g for 10 minutes) and washed twice with 1 mL PBS. Genomic DNA was isolated from the pelleted cells using a ChargeSwitch gDNA Mini Bacterial Kit (Invitrogen, Carlsbad, CA) according to the manufacturer's protocol. The DNA was quantified and assayed for quality (260/280) using a BioPhotometer D30 (Eppendorf, Hamburg, Germany) and stored at -20°C.

Whole-genome sequencing

The presumptive *Vibrio* species Hep-2a-10 and the presumptive *Photobacterium* species Hep-2a-11 were selected for whole-genome sequencing. The draft genomes were sequenced at the New York University (NYU) Genome Technology Center (New York, NY) with the Illumina MiSeq instrument using 2 x 300 paired-end chemistry. Raw sequence reads were processed with TrimGalore! (http://www.bioinformatics.babraham.ac.uk/projects/trim_galore/) to remove adapters and low quality bases. Overlapping paired reads were merged using FLASH (18). Processed reads with assembled *de novo* with velvet (19) using the optimal *k*-mer size predicted by KmerGenie (20). The draft genomes were annotated with the NCBI Prokaryotic Genome Annotation Pipeline (21).

Comparative genomics

The draft genomes of Hep-2a-10 and Hep-2a-11 were annotated using the Rapid Annotation using Subsystem Technology (RAST) Server (22) and analyzed with the SEED Viewer (http://theSEED.org). Analyses included general genome metrics (e.g., genome size and %GC content), average nucleotide identity (ANI) based nearest neighbor predication and the investigation of antibiotic resistance.

RESULTS AND DISCUSSION

Pathobiome isolation

To isolate the etiologic agent of the disease outbreak, hepatopancreas samples were plated on *Vibrio*-selective CHROMagar. This yielded more than 200 colony forming units (CFU). The appearance of those colonies ranged from mauve (indicative of *V. parahaemolyticus*), turquoise (indicative of *V. vulnificus* and *V. cholerae*) and colorless (indicative of *V. alginolyticus*). Thus, it was apparent that the etiology of the disease outbreak was more complicated than the one disease one pathogen model. Nineteen randomly selected isolates were subcultured on TCBS agar, which proved effective for isolation and purification, as the high salt content and alkalinity of this media was predicted to limit the growth of non-*Vibrio* species (23).

Biochemical tests

Preliminary species assignment was achieved by biochemical testing using the API 20 NE system. The API system is regarded as an appropriate first step in the identification of a bacterium, but API-based assignments with low likelihood scores are frequently incorrect (24). Here, eight assignments were based on likelihood scores less than 70%. Common analyses to confirm API-based assignments include the PCR-based detection of species-specific genes (16), sequencing of the 16S rRNA gene (25) and whole-genome sequencing (26). Regardless, the biochemical tests differentiated the 19 bacteria to 6 genera and 9 species: *V. vulnificus*, *V, alginolyticus*, *Aeromonas salmonicida*, *Pasteurella multocida*, *Photobacterium damselae*, *A. hydrophilla*, *P. aerogenes*, *Plesiomonas shigelloides* and *Ochrobactrum anthropi* (Table 1). All but one species (i.e., *O. anthropi*) have previously been recognized as major pathogens in aquaculture (27). In particular, *V. alginolyticus* and *V. harveyi* are agents of mass mortality in penaeid aquaculture (28). In contrast, *O. anthropi* is regarded as normal microflora of penaeid shrimp (29) although some strains are responsible for disease in humans (30).

Whole genome sequencing

Two isolates (Hep-2a-10 and Hep-2a-11) were selected for whole-genome sequencing. The above biochemical tests indicated that Hep-2a-10 was *V. alginolyticus* and Hep-2a-11 was *P. damselae* (Table 1). The whole-genome sequencing projects have been deposited at DDBJ/ENA/GenBank under the BioProject numbers PRJNA324107 (Hep-2a-10) and PRJNA324108 (Hep-2a-11). The draft Hep-2a-10 genome assembly was 5,917,091 bp in length and was comprised of 67 contigs with a 44.8% GC content (31). The draft genome of Hep-2a-11 was 4,225,618 bp in length and was comprised of 125 contigs with a 40.8% GC content (this study).

Comparative genomics

Draft genomes were examined using RAST and the SEED Viewer. A BLASTN based comparison of

TABLE 1.
Summary of biochemical test results (API 20 NE test) showing the likelihood of a species assignment.

Isolate	Species assignment	% likelihood
Hep-1a-1	*Vibrio vulnificus*	*49*
Hep-1a-2	*Vibrio alginolyticus*	99
Hep-1a-3	*Aeromonas salmonicida*	61
Hep-1a-4	*Vibrio alginolyticus*	99
Hep-1b-6	*Vibrio alginolyticus*	99
Hep-1b-7	*Vibrio alginolyticus*	98
Hep-1b-8	*Pasteurella multocida*	96
Hep-1b-9	*Vibrio alginolyticus*	79
Hep-2a-10	*Vibrio alginolyticus*	79
Hep-2a-11	*Photobacterium damselae*	98
Hep-2a-12	*Aeromonas hydrophila*	83
Hep-2a-14	*Pasteurella aerogenes*	NA
Hep-2a-16	*Plesiomonas shigelloides*	NA
Hep-2a-17	*Vibrio vulnificus*	49
Hep-2b-18	*Pasteurella multocida*	64
Hep-2b-19	*Vibrio vulnificus*	99
Hep-2b-20	*Aeromonas hydrophila*	54
Hep-2b-21	*Aeromonas hydrophila*	83
Hep-2b-22	*Ochrobactrum anthropi*	NA

Hep-2a-10 and Hep-2a-11 against the SEED database identified these isolates as *V. harveyi* and *P. damselae*, respectively. The draft genome of *V. harveyi* Hep-2a-10 was announced previously (31). *V. harveyi* and its closely related species (e.g., *V. alginolyticus*, *V. campbellii*, *V. owensii*, *V. parahaemolyticus*) form a phylogenetic clade that is difficult to resolve without whole-genome sequencing (32). *P. damselae* is a separate but closely related genus in the *Vibrionaceae*, formally known as *V. damselae*, that is best resolved with 16S rRNA gene sequencing or whole-genome sequencing (33). Both *V. harveyi* and *P. damselae* are commonly identified as the etiologic agents of disease affecting penaeid shrimp (34, 35).

A query of subsystem features in the SEED Viewer revealed that Hep-2a-10 and Hep-2a-11 harbor large repertoires of genes associated with antibiotic resistance (N = 86 and 65 genes, respectively) (Table 2). These features include genes that confer resistance to penicillin (N = 1 and 2 genes, respectively), fluoroquinolones (N = 4 genes each) and tetracycline (N = 2 genes each).

TABLE 2.
In silico prediction of antibiotic resistance in isolates V. harveyi Hep-2a-10 and P. damselae Hep-2a-11 indicated by the number of genes encoding each feature.

Feature	*V. harveyi* Hep-2a-10	*P. damselae* Hep-2a-11
Penicillin resistance	1	2
Fluoroquinolone resistance	4	4
Tetracycline resistance	2	2
Multidrug resistance	32	19
Toxin-antitoxin systems	3	4

In addition, the presence of multiple multidrug efflux pumps (N = 32 and 19, respectively) may confer resistance to a wide range of antimicrobial compound. The extensive use of tetracycline in shrimp aquaculture has been correlated with rising levels of resistance among bacterial pathogens like *Vibrio* species (36). Similarly, the presence of several toxin-antitoxin (TA) systems in Hep-2a-10 (i.e., RelB/StbD, RelE/StbE, YdcE/YdcD) and Hep-2a-11 (i.e., MazE/MazF, VabB/VabC, RelB/StbD, YoeB/YefM) could help these bacteria survive antibiotic challenge by initiating a state of dormancy during sublethal stress (37).

CONCLUSION

In this study, we determined that multiple, co-occurring bacterial pathogens were associated with a disease outbreak in Pacific white shrimp (*Litopenaeus vannamei*). This discovery of a pathobiome is a stark contrast to the traditional one pathogen one disease model (17). Biochemical assays indicated that the culturable pathobiome (N = 19 isolates) was comprised of 6 genera and 9 species. Whole-genome sequencing further confirmed that the common shrimp pathogens *V. harveyi* and *P. damselae* were members of the pathobiome. Closer inspection of the two draft genomes revealed the presence of numerous antibiotic resistance genes, suggesting that intensive, biofloc dominated shrimp aquaculture may unknowingly select for the evolution and maintenance of antibiotic resistance.

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TEXAS A&M UNIVERSITY-CORPUS CHRISTI

A BRIEF HISTORY

Texas A&M University–Corpus Christi began in 1947 as the University of Corpus Christi (UCC) which was affiliated with the Baptist General Convention of Texas. In 1970, Hurricane Celia causes more than $1,000,000 dollars in damage to the campus. In 1971, the Baptist General Convention of Texas sold UCC to the state of Texas and the Texas Legislature authorizes the Texas A&I University System to establish a state-supported upper-level institution of higher education in Corpus Christi. In 1973, Texas A&I University at Corpus Christi opens its doors on 4 September 1973 to 969 students as an upper-level institution of higher education. In 1977, the Texas Legislature changes the name of the University to Corpus Christi State University. In 1989, Corpus Christi State University joins the Texas A&M University System. In 1993, the Texas A&M University System Board of Regents renames the institution Texas A&M University–Corpus Christi and a year later it becomes a four-year comprehensive university and enrollment increases to 5,000 students. In 2004, the Board of Regents approves the College of Nursing and Health Sciences which opened in 2005. In 2005, Dr. Flavius Killebrew becomes President/CEO and initiates Momentum 2015, a ten year plan to establish Texas A&M University–Corpus Christi as the flagship university of South Texas. In 2016, Dr. Killebrew announced his retirement and former Provost and Vice President for Academic Affairs Kelly Quintanilla was appointed interim president. Today the University has over 12,000 students.

Today Texas A&M University–Corpus Christi is not only a proud member of the Texas A&M University System but it is also the premier public university in the region and is currently the only university in the United States to be situated on an island. Texas A&M University–Corpus Christi is currently a member of the Southland Conference under the NCAA division I.

All information on this page can be found at http://www.tamucc.edu.

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