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From the Director

It is indeed a pleasure to serve as the director of the Ronald E. McNair Post-baccalaureate Achievement Program. The academic year of 2014 – 2015 has been an exciting and fruitful year for the students whom we serve. Fourteen students completed research activities this year, 12 McNair Scholars and two EPSCoR Scholars; topics ranging from "Design of an Exoskeleton Device" to "Porcine Hypo-glycosylated Follicle-Stimulating Hormone." Each of these students completed over 200 hours of research work outside of the classroom. They have made a true commitment to their education and seeking out the things that lie ahead. I commend them for all of their hard work and share my gratitude with the faculty members who made the effort to work with each Scholar and push them toward success.

Thank you to the WSU community, faculty, staff and administrators for sending excellent students our way. We all work together for the common goal of student success. To the McNair staff: Ashley Cervantes, Maria Lucas, Matthew DeAngelis and Noah Trammell, your commitment and support has been unwavering and I thank you.

Lastly, the staff and I thank Ms. Deltha Q. Colvin for her trust and support in all that we do to serve these students who have been entrusted into our care. Your vision and guidance is much appreciated.

I look forward to continued success with the McNair Program and the students that we serve. Thank you for going above and beyond the classroom to do great work.

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Religiosity and Sexual Shame among Young Women

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Abstract

Many religious teachings, particularly those from Judeo-Christian traditions, have commonly taught abstinence until marriage. Because religious doctrine is more inclined to address female sexuality negatively, females are shown to hold more sexual shame than their male counterparts (Daniluk, 2008). The purpose of this study was to examine how adolescent religiosity influences young women's attitudes toward sex and birth control in adolescence, as well as contraceptive behavior in adulthood. Secondary analysis was conducted for this study using the National Longitudinal Study of Adolescent Health (Add Health), which is a nationally representative, longitudinal study, conducted between 1994 and 2009 using adolescents in the U.S. who were in grades 7 – 12 in 1994 – 1995. Analyses were conducted based on a sample of 6,503 young women in the Add Health study. We hypothesized that higher levels of adolescent religiosity would be associated with higher levels of sexual shame, more perceived obstacles to birth control, and lower expectations of sexual pleasure. Results of this study demonstrate that religiosity is significantly associated with young women's sexual attitudes. Young women reporting higher levels of overall religiosity and fundamentalist beliefs also reported higher levels of sexual shame. This research implies that adolescent fundamentalist beliefs may be a key factor in predicting sexual attitudes, making fundamentalist belief an important dimension of religiosity to examine when researching overall sexual well-being. This study should encourage future researchers to examine other connections that fundamentalism may have on young women's sexuality in order to explore their overall sexual well-being.

Literature Review

The World Health Organization (2010) has defined sexual well-being as "a state of physical, emotional, mental and social well-being in relation to sexuality…." This may include healthy sexual outcomes such as personal satisfaction with one's sexual life, a high sexual self-efficacy, and a low level of sexual shame. Building on previous research regarding shame (Murray, Ciarrocchi, &Murray-Swank, 2007), we define sexual shame as expectations of self and others to have negative evaluations of one's sexual behavior. Research suggests that cultural messages about female sexuality contribute to sexual shame among young women. Women's sexuality is seen as positive only as long as it is contributing to some alternative cause such as reproduction or for the gratification of others; it is less common to find positive attitudes toward female sexuality when the sexual experience is solely for pleasure or personal desire. Existing research supports the idea that sexual shame interferes with sexual well-being. For example, in a study of 14 and 15 year old Norwegian adolescents by Traeen and Kvalen (2006), sexual shame was found to have a direct effect on sexual self-efficacy. Female participants who reported feeling shame had lower self-efficacy in regards to communicating about condom usage with their partner, and those who reported more shame were less likely to have used birth control during their last intercourse. Female participants were also significantly more likely to feel shameful for stopping unwanted sexual intercourse than male participants. These results suggest that shame is a barrier to healthy sexual behaviors such as discussing contraception use with a partner, stopping unwanted sexual intercourse, and using oral birth control (Traeen & Kvalem, 2006). These findings raise questions about how shame affects sexual well-being through its effects on sexual satisfaction and overall sexual self-efficacy.

Cultural messages about sexuality permeate our social institutions, and young people's sexual well-being has been shaped by the sexual values and norms learned through interactions within institutions such as education, family, and religion. In 1988, Michelle Fine explored sexual messages within the institution of school in a piece titled "Sexuality, schooling, and adolescent females: The missing discourse of desire" and found that sex education programs often highlighted the negative consequences of sex. Her findings suggested that the portrayal of female sexuality in the sex education curriculum omitted discussion of sexual desire (Fine, 2003). This was an important finding because it brought to light the minimal education that was available to girls about their sexual desire which can be seen as an integral piece of overall sexual well-being. Recent literature has extended Fine's look into sexuality in a school context and explains that sex education programs may have sufficient information regarding biological aspects of sex such as anatomy and reproduction, but lack information that students feel is personally relevant such as sexual relations, desire, unwanted sexual experiences, and pregnancy and birth control (Ekstrand, 2011; Rye, Mashinter, Meaney, Wood, & Gentile, 2015). Along with the sexual education that students receive from schools, research suggests that the family has been an influential resource in shaping adolescents' sexual attitudes. Although recent studies suggest that sex is still an under discussed topic among teenagers and their immediate families, parental

expectations have played an important role in shaping adolescents' sexual attitudes, and parent-child sex discussions have increased the likelihood of safer sexual practices (Wisneiski, Sieving, & Garwick, 2015; Zaleski, Martin, & Messinger, 2015). For example, one study of Baptist families found that daughters who had mothers with higher parental availability more often modeled their mothers' attitudes regarding their definition of sex and when it is appropriate to engage in sex (Baier & Wampler, 2008). These institutions' powerful influence on adolescent sexual attitudes and behaviors has created a need to explore how they shape female sexual well-being. Although many institutions contribute to young women's sexual practices, our main focus in this study is to explore the role of the institution of religion and its powerful messages about sexuality. More specifically, we will examine the influence of specific aspects of religiosity on young women's sexual attitudes and practices. Our objective is to understand how specific aspects of adolescent religiosity impact sexual attitudes during adolescence and sexual behaviors in adulthood. We ultimately aim to provide information that can be used to contribute to a healthy sexual well-being for women who are influenced by religion.

Religion and Sexuality

Understanding the role of religion in young women's sexual development is important given the high levels of religiosity among Americans: Over 80% of individuals 18 and older in the United States identify with a religion (PEW Research Center, 2007). The United States is a nation with a heritage rooted in the stance "One Nation under God," and with the rich religious culture flourishing in the United States, this creates an environment for religion to have a strong influence over the beliefs, values, and behavior of the masses. Religion can influence sexuality through moral teachings of sexual regulation. This has been a common aspect in religious teaching, especially in Judeo-Christian religions.

We can see the effect of religious teachings about sexuality through research that has examined the links between religiosity and sexual attitudes and behaviors. Past literature has shown that many aspects of religiosity influence the sexual behaviors of an individual. In one study, religiosity, which was a combined measure of importance of religion and frequency of attendance at religious services and religious youth services, decreased the likelihood of adolescents ever having had sex (Rostosky, Regnerus, & Wright, 2003). However, when dimensions of religiosity are explored individually, the details about how religiosity affects sexuality can be seen more clearly. Fundamentalism, defined as belief in one religion as ultimately true and necessary for an optimal life, has been negatively associated with a variety of young adult females' sexual behaviors such as vaginal sex, masturbation, giving oral sex, number of sexual partners, and anal intercourse (Farmer, Trapnell, & Meston, 2008). Cochran and Beeghley (1991) explored religiosity and sexuality further in a study that found strength of religion, defined as "a member's commitment to church doctrine," and a belief in afterlife have both been negatively correlated with attitudes of acceptance towards premarital sex (p. 49). Strength of religion has also negatively correlated with many other sexual attitudes and behaviors such as sexually permissive attitudes, casual sex, and masturbation (Murray et al., 2007).

Church attendance has been reported to decrease the number of sexual partners within the last three months for college students, and greater importance of religion has been associated with a lower report of ever having engaged in penetrative sex among young adults (Murray et al., 2007; Vasilenko & Lefkowitz, 2014). Religiosity may have a bidirectional relationship with sexual attitudes and behaviors as well: In a study which looked at the levels of religiosity after participants had engaged in first sexual intercourse, researchers found that during the first 12 months after sexual debut these emerging adults reported less importance of religion than before sexual intercourse. After the 12 months, importance levels returned to the baseline (Vasilenko &Lefkowitz, 2014). Overall, these findings tell us that religiosity generally has had a negative relationship with sexual behaviors and sexual attitudes (Murray et al., 2007; Runkel, 2008; Vasilenko & Lefkowitz, 2014). Because religion can create a taboo around talking about sex, it is important to examine whether these results have been influenced by religion acting as an inhibiting factor for young adults' discussions about sex.

Many theories have been used to explain the influence religion has on its followers' behavior. Religion may work to shape sexual attitudes and behaviors through a mechanism of social control. Social control is the idea that through socialization, individuals learn what is valued, accepted, and expected within a particular group and model their behaviors based on what is accepted by that particular group (Hirschi, 2002). In one study, religious participants reported there is a custom within their Christian community of accountability and keeping each other on track as far as having a Christian approved sexual life. Sex, rather than being a personal decision, was described as a decision made for the well-being of the church community (Sharma, 2008). Another common theory used to explain religion's influence on sexuality is reference group theory. This is the idea that individuals model their sexual behavior after the behavior and ideals of the group or groups which they are most often around or feel that they identify with best (Mirande, 1968). For example, using this theory we could say that someone who heavily associates with a group that advocates for safer sex is more likely to use barrier methods with their next sexual partner. However, Durkheim (1912) suggests that even those who do not categorize themselves in a specific group may still learn values and attitudes from the dominant or majority group that surrounds them. This can be associated with Bandura's (1977) social learning theory that states that individuals learn from observing others' behaviors. For example, Adamczyk and Hayes (2012) found that the larger the population of Muslims in an area, the less likely individuals were to engage in premarital sex, regardless of their own religious affiliation. They concluded that the dominant Islamic religion was an influencing factor in shaping individuals' premarital sexual attitudes and behaviors despite participants' religious identity (Adamczyk & Hayes 2012). Adamczyk & Hayes's (2012) research is not only a good example of Durkheim's theory but can also be applied to other religious societies as a possible social learning explanation of sexual attitudes and behaviors.

Traditionally, Judeo-Christianity has imposed conservative restrictions regarding sex, and we have seen that these restrictions can have negative consequences. For example, some religious sects have attempted to regulate adolescents' sexuality through abstinence

pledge ceremonies, in which adolescent participants vow to abstain from sex until marriage, or purity rings, which are worn by participants as a symbol of sexual abstinence until the ring is replaced by a wedding band. Indeed some sects, such as Catholicism, frown upon sexual relations for any other reason than reproduction (Runkel, 2008). With this in mind, the conservative attitude of Catholics towards condom usage discussed above, supports the idea of social control theory, as using condoms is seen as unacceptable because it contradicts a strongly held norm within this group.

Within many Judeo-Christian groups, sex is not to be fantasized about and is not for self-gratification; instead, it has been set aside to be experienced solely within the institution of marriage. There is a separation created between spiritual pleasure and bodily pleasure, and an importance is placed on restraining oneself from indulging in unapproved sexual pleasures (Daniluk & Browne, 2008). Consistent with reference group and social learning theories, religious individuals refrain themselves from engaging in these restricted thoughts and behaviors because they are not parallel with the ideals of their surrounding group. Because of many religions' strict and conservative ideals regarding sex, religious followers may find it difficult to remain within the boundaries of religiously approved sexual behavior, and as a result may experience sexual shame and its unhealthy effects. The group found to most commonly experience these results of sexual shame is Protestants, followed by Catholics and Jews, with Atheists reporting the least amount of sex guilt (Gerrard, 1980). The fact that Atheists have been found to have the least amount of sexual shame has served as more evidence of the effects of sexually restrictive religious teachings. Atheism has no official principal or standard restricting sexual behavior; this creates more room for sexual freedom and less opportunity to deviate from the sexual norms of the group. Runkel (2008) sums up these findings about religion and guilt by saying "The permanent anxiety in religion is activated by a guilty conscience that originates from the violation of fixed norms" (Runkel, 2008, p. 105.) The more sexual regulation a religious group imposes on its followers the more difficult it may become to abide by these sexual norms resulting in sexual shame.

Religion, Sexuality, and Gender

It is especially important to examine sexual shame and its effects in the lives of young women because of the gender specific sexual roles within religion that seem to limit women in a different way than men. Many religions have "fixed norms" that proscribe specific roles to male followers and complementary or opposing roles to female followers. Past researchers have explored the effects that these gender roles have on their followers. The reasons behind why these roles are in place may vary based on religion and sect. For example, some sects maintain these gender roles as a means to emphasize procreation. The emphasis on procreation has placed an importance on male pleasure, as male orgasm is needed for the conception of a child while female orgasm is not (Daniluk & Browne, 2008). This has diminished value in female pleasure while male pleasure has been regarded of high importance and even seen as necessary during sex. In this view, women seem to be valued for purposes of procreation and fulfilling male sexual desires. Within these boundaries, women have not been portrayed as active agents who have sexual desires and are entitled to seeking

sexual pleasure and having equal and even autonomous control over their sex lives. This portrayal of women within religious context has provided reason to actively seek information about religious women's sexual well-being.

Aspects such as the policing of female sexuality and the emphasis on male pleasure reveal a power structure within Judeo-Christian faith that has placed women at the bottom of a hierarchy with God first, then Christ, followed by men, and last women (Runkel, 2008). Virginity and sexual purity have been praised in many religions, and this has especially been true for women (Daniluk & Browne, 2008). The Catholic faith has emphasized Mary's status as a virgin, and certain sects of Islam have promised a prize of virgin women in heaven for male martyrs of the faith (Runkel, 2008). This can create an atmosphere where women who are not virgins or are not within their religion's standards of sexual purity may feel shame regarding their sexual experiences or may even feel reprehensible. Sharma's (2008) study of the Protestant church revealed an interesting perspective when a participant said that the sexual policing within her church has not kept her from committing sexual acts that her church community would not approve of, but instead she kept her sexual life hidden from her church community for fear of being judged. Fear of judgment and alienation for engaging in sexual relationships makes sense for women within the boundaries of Judeo-Christianity.

The heavily regulated sexuality of religious women has the potential to strongly influence women's sexuality differently than men. Research has found that woman's sexual attitudes, expectations, and values differ from their religious male counterparts (Cochran& Beeghley, 1991; Luquis, Brelsford, & Rojas-Guyler, 2011). In a study by Earle, Perricone, Davidson, Moore, and Harris (2007), college age women at a religious university were shown to have more consistently conservative attitudes towards premarital sex than men. When women predicted having positive feelings after sex they were more likely to begin engagement in sexual activity than those who did not predict positive feelings after sex (Rostosky et al., 2003). Women were found less likely than men to approve of pre-marital sexual relationships without serious commitment (Earle et al. 2007). Traeen and Kvalem (2006) reported that women showed higher sexual self-efficacy when they felt more emotional intimacy for their partner. Traditionally, religious teachings have deemed sex as acceptable only within the confines of marriage, and modern views of marriage involve love and intimacy within the relationship. These findings suggest that religious women often value intimacy of a relationship when forming attitudes about the appropriateness of premarital sex. Research has also suggested that young women's religious teachings and sexual regulation may influence sexual shame. For example, many Judeo-Christian religions consider sexual fantasy inappropriate despite the fact that research has suggested that sexual fantasies can play a beneficial role in developing healthy sexual agency (Nicholas, 2004). Research has suggested that this is an inhibiting factor in developing healthy sexual agency as one may see this type of imagination as shameful (Knox, 2005). Tolman (2005) explored experiences of teenage girls in regards to their sexual self and more specifically sexual agency. She found that girls internalized societal messages that said a woman must be sexy to be desirable as well as contradictory messages in which girls' own sexual desires and feelings are

taboo. Tolman (2005) found that girls are not taught that it is acceptable for them to take the lead in sexual situations and that if their sexual desires are exposed to others there are social consequences. Through this research we have seen how societal expectations of female sexuality can create restrictions of young women's sexual agency. When this is examined in the context of a powerful social institution like religion which creates an intimate reference group, we can see how important it is to explore the outcomes for these young women. We know that guilt is more likely to be present when an individual attributes events to an external cause (Brophy, 2013). The fact that religious communities are external factors that play heavily into shaping the values of their followers puts religious followers at risk of unhealthy guilt and shame. Within these religions, the emphasized sexual purity of females may have been influencing young women to feel shame motivated by social responsibility for those who deviate from religious sexual boundaries. Although less likely to engage in sexual behaviors, when religious young women do have sex, their levels of religiosity have been shown to decrease creating contingent feelings of alienation from God (Vaselinko & Lefkowitz, 2014), and this alienation or disconnection from God has been shown to increase shame (Murray et al., 2007).

The literature has shown us the connection between religiosity and sexual shame. Religion, as a major social institution that has created a normative context, has set boundaries and constructs of what is appropriate sexuality. Many religions have proscribed sex only within married hetero-sexual relationships and have sent gender-specific messages such as an emphasis on male pleasure through the importance of procreation, and an emphasis on female purity through various religious values and symbols. Research has shown that high religiosity has been associated with more conservative sexual attitudes and behaviors and religion has been associated with sexual shame. However, past literature lacks information on how different dimensions of religiosity shape sexual attitudes more broadly.

Current Study

The objective of this study was to explore the relationship between adolescent religiosity and sexual well-being in adolescence and adulthood. With the knowledge that we have about religion's gendered sexual regulation, we decided to focus this study on religiosity's influence on young women's sexual well-being through its association with sexual shame. We conducted secondary data analysis using data from the National Longitudinal Study of Adolescent to Adult Health (Add Health). Previous research has not only supported a relationship between various types of religiosity and unhealthy guilt and shame, but also found that females had higher levels of guilt than males (Allport, 1963; Helm, Berecz, & Nelson, 2001; Lynn, 1993; Maltby, 2005; Woo, Negar, Brotto & Gorzalka, 2012). Past research has shown the effects of sexual shame on aspects of sexual well-being such as sexual practices, sexual self-efficacy, and sexual desire (Traeen & Kvalem, 2006; Woo et al., 2012). Because the effects of sexual shame have been shown to be unhealthy, we aimed to use this study to examine the lasting effects that adolescent sexual shame may have on young women's sexual experiences in adulthood. We asked the following research questions: 1) How is adolescent religiosity associated with young women's attitudes toward sex and birth control in adolescence?; 2) Do these

associations vary by dimension of religiosity, including overall religiosity, fundamentalist beliefs, and religious affiliation?; and 3) How are adolescent religiosity and sexual attitudes associated with women's contraceptive use in young adulthood? We hypothesized that adolescent religiosity would have a positive association with sexual shame and perceived obstacles to birth control, religiosity would have a negative association with expectations of sexual pleasure, and religiosity in adolescence and contraceptive use in adulthood would be associated with one another as they would both be correlated to sexual shame.

We used data from Wave I, Wave II, and Wave III of interviews done inside the participants' homes in Add Health Study. Waves I and II provide detailed information about adolescents' attitudes toward sex and birth control, and Wave III provides information about sexual behaviors and relationships in adulthood. Because our study focused on young women's sexual attitudes and experiences, we further limited our sample to female respondents. The sample was further reduced as the Add Health study only asked questions about sexual attitudes of participants who were 15 or older at the time of Wave 1. We also excluded respondents who did not respond to questions about religious affiliation and practices. The young adulthood sample was further restricted to include only those who participated in Wave 3, who answered questions about their sexual experiences and who reported having had sex during the past 12 months. Our final sample size included n= 6,707 young women who were between the ages of 15 to 21 at Wave 1 and n =3,592 adult women between the ages of 18 to 26 at Wave 3.

Measures

Religiosity. We examined three dimensions of religiosity including overall religiosity, fundamentalism, and religious affiliation. Those who reported "no religion" were not asked questions about religiosity and therefore we imputed the lowest values for religiosity questions in response for these participants. Our measure of *overall religiosity* included both public and private aspects of religiosity. We looked at the mean of the participants responses to the following four questions: "In the past 12 months, how often did you attend religious services?" (1 = never , 2 = less than once a month, 3 = once a month or more, but less than once a week, 4 = once a week or more), "Many churches, synagogues, and other places of worship have special activities for teenagers—such as youth groups, Bible classes, or choir. In the past 12 months, how often did you attend such youth activities?" (1 = never, 2 = less than once a month, 3 = once a month or more, but less than once a week, 4 = once a week or more), "How important is religion to you?" (1 = not at all important, 2 = fairly unimportant, 3 = fairly important, 4 = very important), "How often do you pray?" (1 = never, 2 = less than once a month, 3 = at least once a month, 4 = at least once a week). The first two categories of frequency of prayer were combined in order to form a 4-point scale similar to the other measures. We combined these measures by taking the average across all four items (alpha=.844). We measured *fundamentalism* using the participants' Likert Scale rating of the statement "Do you agree or disagree that the sacred scriptures of your religion are the word of God and are completely without any

mistakes?" (0 = no, 1 = yes). Finally, we grouped *religious affiliation* similarly to the suggestions of Adamcyzk and Hayes (2012) and Steensland et al. (2000), creating six religious groups: Conservative Protestant (consisting of religious identifications such as Adventist, Pentecostal, and Baptist), Mainline Protestant (consisting of religious identifications such as Episcopalian, Quaker, and Methodist), Other Protestants (Protestants whose denomination was not ascertained), Catholic, and Other Religion (consisting of smaller religious groups such as Baha'i, Christian science, Muslim, Eastern Orthodox as well as those who did not specify their religion). We included those who responded "none" when asked their religious affiliation in the No Religion group.

Sexual Attitudes. We also examined three measures of sexual attitudes in adolescence: sexual shame, sexual pleasure, and sexual self-efficacy. In order to examine *sexual shame* among the participants at Wave 1, we used the mean score of Likert scale ratings on the following statements: "If you had sexual intercourse, your partner would lose respect for you", "if you had sexual intercourse afterward you would feel guilty, "if you had sexual intercourse it would upset your mother" (1= strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree; alpha = .681) *Expectations for sexual pleasure* were measured at Wave 1 by the question "if you had sexual intercourse, it would give you a great deal of physical pleasure"" (1= strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree). We measured respondents' perceived *obstacles to using birth control* at Wave 1 by examining the mean Likert Scale ratings on the following statements: "In general, birth control is too much of a hassle to use.", "In general, birth control is too expensive to buy", "It takes too much planning ahead of time to have birth control on hand when you're going to have sex.", "It {is/would be} too hard to get a {girl/boy} to use birth control with you.", "For you, using birth control {interferes/would interfere } with sexual enjoyment.", "It is easy for you to get birth control.", "Using birth control is morally wrong.", "If you used birth control, your friends might think that you were looking for sex." " (1= strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree; alpha = .815).

Consistency of Condom Use. We examined one dimension of sexual behavior in young adulthood: consistency of contraceptive use. To determine the consistency of contraceptive use in adulthood, we examined a five category ordinal measure of responses to the Wave 3 question "On how many of these occasions of vaginal intercourse in the past 12 months did you or your partner use some form of birth control or pregnancy protection?" (0 = none, 1 = some of the time, 2 = half of the time, 3 = most of the time, 4 = all of the time).

Controls. In order to better estimate the effects of religion on sexual attitudes, it is important to control for variables that are related to either religiosity or sexual attitudes. This study controlled for the variable of race/ethnicity. Race/ethnicity was measured using two questions from the Wave 1 survey "Are you Hispanic or Spanish origin" to which participants could answer "No", "Yes", "I don't know" and "What is your race? If you are

of more than one race you may choose more than one." to which participants could answer "White", "Black or African American", "Asian or Pacific Islander", "American Indian or Native American", and "Other". We combined these questions to create five racial/ethnic categories (Hispanic, Black non-Hispanic, Asian non-Hispanic, other non-Hispanic, White non-Hispanic). We also used family structure as a control. Family structure was measured as participants were asked to list all members of their household and their relation to each member. We used this information to create four categories of family structure (two biological parents, step family, single parent family, and other).We controlled for parents' highest level of education. This was done using parents' responses when asked about their highest level of education. For missing responses we used the information about highest level of parent education given by the student. In the case of more than one parent in the residence we used the highest level of education between the two parents. We used this information to create 6 categories for parent's highest level of education (0 = no school, 1 = less than high school diploma, 2 = HS diploma or equivalent, 3 = some college, 4 = BA, 5 = more than college degree).

In models predicting contraceptive use in young adulthood, we added controls for age at first sex using questions about timing of first sexual intercourse from Waves 1, 2, and 3. We also controlled for whether or not the respondent had ever been married using a question from the Wave 3 survey. This factor is an important control as past research has found a relationship between marital status and contraceptive use.

Plan of Analysis. First, we examined the distribution of all variables among our sample of young women. Descriptive statistics for all variables are presented in Table 1. Then, we ran a bivariate analysis of the variables in order to look at individual relationships between the dimensions of sexual attitudes and religiosity. Last, in order to determine adolescent religiosity's effects on young women's sexual attitudes in Wave 1 and sexual practices in Wave 3, we ran multivariate OLS regressions analysis to predict 1) sexual shame, 2) expectations of pleasure, 3) obstacles to using birth control, and 4) consistency in contraceptive use.

Results

Descriptive Statistics. In regards to religiosity variables, *overall religiosity* had a mean of 2.656. On a 1 to 4 scale this means that on average participants rated their religiosity levels moderately. Sixty one percent of the participants reported *fundamentalist belief*. Regarding religious affiliation, 13% of participants reported *no religion,* 21.5% of participants were identified as *Mainline Protestant,* 29.1% of participants were identified as *Conservative Protestant*, 3% of participants were identified as *Other Protestant*, 25.4% of participants were identified as Catholic, and 8.1% of participants were identified as *Other Religion*.

With regards to adolescent sexual attitudes, *sexual shame* had a mean of 3.288, which is 1.2 points above the median of the 1 to 5 Likert scale. *Expectations of sexual pleasure* had a mean that was .5 higher than the median of the Likert scale at 3.087, and *perceived obstacles to using birth control* had a mean of 2.0, one point lower than the Likert scale median. Regarding

contraception use in young adulthood 16.1% of participants reported using contraception "none of the time" within the past 12 months, 10.9% reported using contraception "some of the time" within the past 12 months, 7.9% of participants reported using contraception "half of the time" within the past 12 months, 16.9% of participants reported using contraception "most of the time" within the past 12 months, and 48.1% of participants reported using contraception "all of the time" within the past 12 months.

Bivariate Analysis. First, correlations were run in order to assess the relationship among the sexual attitude dimensions. Results showed that all adolescent sexual attitude variables had a significant relationship with one another. Expectations of pleasure during sex and sexual shame had a weak but significant negative relationship, as participants who had higher levels of sexual shame had lower expectations of pleasure during sex (r = -.244, p = .000). Perceived obstacles to birth control and expectations of pleasure during sex had a very weak but significant negative relationship, as those who perceived more obstacles to birth control expected less pleasure during sex (r = -.043, p =.000). Sexual shame and perceived obstacles to birth control also had a weak significant positive relationship, as those who had more sexual shame perceived more obstacles to birth control (r = .146, p = .000).

Our first research question asked "How is adolescent religiosity associated with young women's attitudes towards sex and birth control in adolescence?" In order to initially examine this question we ran correlations between overall religiosity and the three dimensions of adolescent sexual attitudes: sexual shame, perceived obstacles to using birth control, and expectations of pleasure during sex. All sexual attitude dimensions were significantly related to overall religiosity. Those who had higher levels of overall religiosity had significantly higher levels of sexual shame, and this association was moderate in strength (r = .316, p = .000). Religiosity had a significant but weak association with obstacles to birth control (r = .063, p = .000) as those with higher levels of religiosity saw more obstacles to birth control, and a significant and moderate association with expectations of pleasure during sex (r = .-151, p= .000) as those with higher levels of religiosity had lower expectations of pleasure during sex. We ran an independent T-test analysis to compare the sexual attitudes of those with fundamentalist beliefs to those without fundamentalist belief. Those who identified as not having fundamentalist beliefs (M = 3.047, SD = .919) reported significantly lower levels of sexual shame t (5494) = -16.89, p < .000, than those who identified as having fundamentalist beliefs (M = 3.440, SD = .929). Those who identified as not having fundamentalist beliefs (M = 3.22, SD = .95) reported significantly more expectations of pleasure during sex t (5519) = 8.97, p < .000, than those who identified as having fundamentalist belief (M = 3.00, SD = .996). Those who identified as not having fundamentalist beliefs (M = 1.932, SD = .715) reported significantly fewer obstacles to birth control t (5755) = -6.33, p < .000, than those who identified as having fundamentalist beliefs (M = 2.049, SD = .768). To further answer our research question we ran a one way ANOVA to determine if the sexual attitude dimensions varied by religious affiliation. Results showed that there were significant differences in sexual shame F (5, 6619) = 35.87, p = .000, expectations of pleasure F(5, 6499) = 14.55, p = .000, and

perceived obstacles to birth control $F(5, 6648) = 12.09$, $p = .000$ between the different religious affiliations. Those who identified as having no religion had significantly higher expectations of pleasure ($M = 3.31$, $SD = .995$) and a significantly lower amount of sexual shame ($M = 2.910$, $SD = .946$) than all other religious affiliations. Conservative Protestants had a significantly higher amount of sexual shame ($M = 3.399$, $SD = .930$) than those who identified as having no religion ($M = 2.910$, $SD = .946$) and perceived significantly more obstacles to birth control ($M = 2.068$, $SD = .752$) than Mainline Protestant ($M = 1.924$, $SD = .719$) and the Other Religion group ($M = 1.862$, $SD = .676$). Conservative Protestants had the highest level of sexual shame ($M = 3.399$, $SD = .930$) among all religious affiliations, had the lowest expectations of pleasure ($M = 2.97$, $SD = 1.027$) among all religious affiliations, and perceived the most obstacles to birth control ($M = 2.068$, $SD = .752$) among all religious affiliations.

The third research question asked "How are adolescent religiosity and sexual attitudes associated with women's contraceptive use in young adulthood?" In order to explore this, we first ran a correlation between overall religiosity and contraceptive use in adulthood. Results showed that there was no significant relationship between contraceptive use in adulthood and overall religiosity. We ran a T-test analysis in order to examine adulthood contraceptive use of those with fundamentalist belief in adolescence as compared to adulthood contraceptive use of those without fundamentalist belief in adolescence. Those who did not have fundamentalist beliefs in adolescence ($M = 2.86$, $SD = 1.457$) more frequently used contraception in adulthood than those who did have fundamentalist beliefs ($M = 2.59$, $SD = 1.577$), $t(3647) = 5.249$, $p < .000$. We further explored the relationship between adolescent religiosity and contraceptive use in adulthood by examining the relationships between contraception use and each religious affiliation. Mainline Protestants ($M = 2.88$, $SD = 1.453$) most frequently used contraception in adulthood while Other Protestants ($M = 2.43$, $SD = 1.651$) were least likely to use contraception in adulthood. Conservative Protestants ($M = 2.44$, $SD = 1.576$) used significantly less contraception in adulthood than Mainline Protestants ($M = 2.88$, $SD = 1.453$), Catholics ($M = 2.85$, $SD = 1.524$), and other religion ($M = 2.84$, $SD = 1.500$) $F(5, 3643) = 11.138$, $p = .000$.

Finally, correlations were run to determine the relationship between adolescent sexual attitudes and adulthood contraceptive use. There was a weak relationship between sexual shame in adolescence and frequency of contraceptive use in adulthood as those who had more sexual shame in adolescence used contraception more frequently in adulthood ($r = .034$, $p = .038$). Participants who saw fewer obstacles to birth control in adolescence used contraception more frequently in adulthood ($r = -.163$, $p = .000$). There was no significant relationship between expectations of pleasure in adolescence and contraceptive use in adulthood. Bivariate associations reveal significant associations among dimensions of religiosity, sexual attitudes in adolescence, and contraceptive use in young adulthood. We turn now to multivariate models to examine these relations after controlling for important background and confounding factors.

Multivariate Analysis. We present coefficients from OLS regression models predicting sexual shame in adolescence (See Table 2) with Model 1 showing the relationship between overall religiosity, Model 2 showing the relationship between religious fundamentalism and sexual shame, Model 3 showing the relationship between religious affiliation and sexual shame, and Model 4 showing the relationship between the separate dimensions of religiosity and sexual shame. As seen in Model 1, overall religiosity had a significant and positive association with sexual shame, as overall religiosity increased sexual shame also increased. Similarly, religious fundamentalism had a significant and positive association with feelings of sexual shame (Model 2); fundamentalist belief was a predictor of sexual shame. Model 3 shows us that compared to mainline Protestants, those reporting no religious affiliation had lower levels of sexual shame, and conservative Protestants reported higher levels of sexual shame. The final model displays that these dimensions of religiosity all had significant independent effects on sexual shame.

In Table 3 we present coefficients from OLS regression models expectations of sexual pleasure in adolescence. As seen in Model 1, overall religiosity was significantly and negatively associated with expectations of sexual pleasure. In other words, more religious adolescents had lower expectations for pleasure during sex. Fundamentalism was also significantly and negatively associated with expectations of pleasure during sex (Model 2). Compared to mainline Protestants, adolescents reporting no religious affiliation had higher expectations for pleasure (Model 3). As seen in the final model, overall religiosity was the only religion variable that had independent effects on expectations of pleasure.

Results for perceived obstacles to using birth control are presented in Table 4. Model 1 shows that overall religiosity was significantly and positively related to perceived obstacles to birth control, but notice the coefficient is quite small. Similarly, the estimated effect of fundamentalism is positive and significant, but also small (Model 2). Compared to mainline Protestants, conservative Protestants perceived significantly more obstacles to using birth control (Model 3). After including all dimensions of religiosity in the model (Model 4), fundamentalism and religious affiliation remained significantly associated with perceived obstacles. Compared to mainline Protestants, both conservative Protestants and adolescents reporting no religion perceived more obstacles to birth control. The group "Other religion" had a significant relationship with perceived obstacles to birth control; however, because of the nature of this religious category as a "catch-all" it is difficult to give meaning to the significant relationship.

Finally, we predicted contraceptive use in young adulthood with adolescent religiosity and sexual attitudes. Results are presented in Table 5. Young adults who reported more fundamentalist beliefs during adolescence reported less consistent contraceptive use. However, overall religiosity and religious affiliation during adolescence did not appear to be significantly associated with contraceptive consistency in young adulthood (Model 1). As seen in Model 2, young adults who perceived more obstacles to using birth control in adolescence used birth control less consistently in adulthood. However, adolescent sexual shame and expectations for sexual pleasure were not significantly

associated with contraceptive use in adulthood, suggesting that these sexual attitudes did not mediate the association between religiosity and sexual attitudes. Although the estimated effect of fundamentalism was somewhat reduced after controlling for adolescent sexual attitudes, it still had a significant and independent association with contraceptive use.

Discussion

Scholars have been in search of answers to enhance the overall sexual well-being of the population for decades. In this pursuit researchers are exploring the institutions that construct and influence perceptions of an ideal sexuality. Due to religion's norms and regulations regarding sexuality, we can see that this is an important institution from which young women construct ideas about sexuality, and our research supports this.

As this study first explores how adolescent religiosity shapes attitudes toward sex and birth control, it provides support that religiosity does influence these young women's sexual attitudes as those who had higher levels of overall religiosity had more sexual shame, perceived more obstacles to birth control, and had lower expectations of pleasure. These findings not only support our hypothesis, but also are consistent with previous literature on sexual pleasure finding that the more closely an individual identifies with a religion the more difficult it may be for them to experience sexual pleasure (Runkel, 2008). Our study is also consistent with previous literature on sexual shame and religiosity finding that females with a strong relationship with religion had higher levels of two different kinds of sexual guilt than their male counterparts (Maltby, 2004; Gerrard, 1980).

Our hypothesis for the second research question, regarding how separate dimensions of religiosity shape sexual attitudes, is supported by our research. We see that those with fundamentalist beliefs experienced more sexual shame, lower expectations of pleasure during sex, and perceived more obstacles to birth control than those without fundamentalist beliefs. This supports previous literature that emphasizes fundamentalism as an important dimension of religiosity in regards to sexuality and suggests that fundamentalism does influence sexual behaviors among individuals (Farmer et al., 2009). Although levels and dimensions of religiosity seem to play important roles in shaping sexual attitudes, this study also provides support that identifying with no religion plays a key role in shaping these attitudes as compared to identifying with the Judeo-Christian religions in this study. While we find generally similar sexual attitudes among the young women who identified with Judeo-Christian religions, the non-religious young women had significantly different outcomes with the lowest levels of sexual shame and the highest expectations of pleasure during sex. Conservative Protestantism also had an important effect on sexual attitudes, as respondents with this religious affiliation had the highest amount of sexual shame and perceived the most obstacles to birth control. These findings are in congruence with previous literature on comparisons between those who identify as non-religious or atheist and Judeo-Christian affiliations in regards to birth control and sexual shame (Gerrard, 1980; Traeen & Kvalem, 2006).

In exploring our third research question we can see that, contrary to our expectations, there were few significant

effects of adolescent religiosity and sexual attitude variables on adulthood contraceptive use. Findings did support the expectation that fundamentalist beliefs influence contraceptive use, as participants who reported fundamentalist beliefs in adolescence used contraception less often in adulthood, compared to those without fundamentalist belief. This study also shows associations between participants' perceived obstacles of birth control in adolescence and their contraceptive use in adulthood as, not surprisingly, the young women who perceived fewer obstacles to birth control in adolescence were more likely to use contraception during sex in adulthood. In some ways our hypothesis is supported as fundamentalist participants and participants with more perceived obstacles to birth control used contraception less in adulthood. However, we found no support that the other dimensions of religiosity and sexual attitudes had an effect on contraceptive use in adulthood within the last 12 months. Finally, our research does not support our hypothesis that adolescent religiosity and sexual practices in young adulthood are mediated by sexual shame.

Limitations. Of course, every study has limitations that shape interpretation and limit the extent to which findings can be generalized. For example, respondents in this study were adolescents during the mid-1990s. More recent data would help to give the study more relevance to young women in current day. In addition, Add Health researchers did not ask about religious behaviors or beliefs to participants who identified as having no religion. Since this was the case we decided to impute the lowest level of religiosity variables for these participants. Recent research has separately defined religiosity and spirituality and found that those who do not identify with a religion may still carry out spiritual practices and hold spiritual beliefs. Since there was no separation of religiosity and spirituality this further limited our study. This study was further limited by its definition of sexual shame. Recent research has separately defined shame and guilt, shame being a more internal sense of humiliation about oneself, and guilt being a more external sense of wrongdoing about an action. Because the measure of shame included both questions about behavior as well as internal humiliation there was no separation between shame and guilt.

Future Research. We encourage future researchers to continue to explore the effects of sexual shame on sexual relationships in adulthood, as well as explore additional areas of adult sexuality that may be impacted by religiosity and sexual shame in adolescence. Because fundamentalism had a relationship with all of the sexual attitude and sexual behaviors variables in our study, we encourage future researchers to examine fundamentalism's relationship with sexuality further. . We believe that alternate research methods such as qualitative analysis and participant interviews might shed more light on the topic by an in-depth perspective

Implications. Our research aims to provide information that may benefit the sexual well-being of women who proscribe to religion that regulates sexuality. These findings can benefit young women's sexual well-being through the understanding that religion and sexuality are linked. Young women who reported a higher level of overall religiosity also reported more sexual shame and lower expectations of pleasure.

This suggests that, for young women, religious teachings may not send a message of sex as a pleasurable or positive experience. Prior research suggests that many religions teach that sex is solely for procreation rather than personal desire (Daniluk & Browne, 2008; Runkel, 2008). The stronger these young women identify religiously, the more they seem to see sex as taboo and associated with shame. Perhaps this is because these religious messages about sex are more internalized.

In this study, fundamentalism was shown to be an important factor in shaping sexuality. Sixty-one percent of our sample reported fundamentalist belief, and fundamentalism was the only dimension of religiosity which was associated with all of the sexual attitudes. This implies that fundamentalism may be more important than strength of religiosity and religious affiliation when it comes to predicting sexual attitudes. Fundamentalists reported more sexual shame and lower expectations of pleasure than non-fundamentalists, suggesting that messages of sexual shame may be embedded in fundamentalist teachings to young women and may not send a message of sex as pleasurable experience for young women. Fundamentalists also saw more obstacles to birth control than non-fundamentalists implying that fundamentalist teachings may inspire a negative view towards young women using birth control.

Our findings demonstrated that non-religious women and Conservative Protestants are most often at opposite ends of the spectrum regarding sexual attitudes. The differences in sexual attitude outcomes between the individuals reporting no religion and those who did identify with a religious affiliation may suggest that those who do not proscribe to a religion are socialized differently in regards to sexual shame. conservative Protestant women tended to report higher levels of sexual shame and were less likely to expect sex to be pleasurable, suggesting that sexual shame may be ingrained in conservative Protestant teachings to a greater degree than in other religions. Conservative Protestants also saw more obstacles to birth control in adolescence than any other religious affiliation; this implies that there is a negative view towards birth control in conservative Protestant teachings. However, the negative views towards birth control in conservative Protestant teachings did not seem to keep participants from actually using birth control in adulthood, as they were no less likely than other religious groups to use contraception in adulthood. Perhaps the disapproval of birth control is an emphasized teaching in adolescence for conservative Protestants, but is disregarded for adult married women. The conservative Protestant teachings may encourage young women to be sexually conservative by not using birth control when having sex because sex should be within marriage; however, it is possible that by the time these young women reach adulthood their behaviors regarding birth control do not reflect this as only half of our sample reported using contraception "all of the time" during sex.

This research supports the relationship between religiosity and sexual attitudes. This research has shown how certain dimensions of religiosity influence young women's sexual well-being.

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Appendix A

Table 1: Weighted Descriptive Statistics for Dependent and Independent Variables

	Mean or Proportion	Standard Deviation
Adolescent Sexual Attitudes (Wave 1)		
Sexual Shame	3.288	.943
Expectations of Sexual Pleasure	3.087	.982
Perceived Obstacles to Using Birth Control	2.000	.750
Young Adulthood Contraceptive Use (Wave 3)		
Consistency in Contraceptive Use - Past 12 Months	2.701	1.549
Religion Variables		
Overall Religiosity	2.656	.958
Fundamentalism	.611	.488
Religious Affiliation		
No Religion	.130	.336
Conservative Protestant	.291	.454
Other Protestant	.030	.172
Catholic	.254	.435
Other Religion	.081	.272
Control Variables		
Racial/Ethnic Identity		
Non-Latina Black	.173	.379
Latina	.119	.325
Asian	.040	.167
Other	.027	.163
Family Structure		
Step-parent family	.171	.377
Single parent family	.239	.427
Other	.071	.257
Parents' Education Level	2.768	1.248
Age	16.920	1.194

Source: National Longitudinal Study of Adolescent Health.

Appendix B

Table 2: Coefficients from Regression Predicting Sexual Shame

	Model 1		Model 2		Model 3		Model 4	
Religion Variables								
Overall Religiosity	.288	(.020) ***					.332	(.025) ***
Fundamentalism			.360	(.030) ***			.114	(.028) ***
Religious Affiliation								
No Religion					-.286	(.058) ***	.382	(.074) ***
Conservative Protestant					.205	(.054) ***	.094	(.048) *
Other Protestant					.142	(.111)	.133	(.101)
Catholic					-.037	(.047)	.004	(.041)
Other Religion					.072	(.069)	.111	(.060)
Control Variables								
Racial/Ethnic Identity								
Non-Latina Black	-.143	(.050) **	-.047	(.049)	-.076	(.054)	-.193	(.053) ***
Latina	.132	(.062) *	.179	(.064) **	.232	(.066) ***	.161	(.063) *
Asian	.172	(.070) *	.199	(.079) *	.260	(.084) **	.164	(.066) *
Other	.084	(.082)	.108	(.081)	.103	(.085)	.078	(.078)
Family Structure								
Step-parent family	-.158	(.035) ***	-.211	(.037) ***	-.227	(.037) ***	-.167	(.036) ***
Single parent family	-.269	(.040) ***	-.309	(.042) ***	-.336	(.041) ***	-.269	(.041) ***
Other	-.573	(.059) ***	-.641	(.057) ***	-.665	(.059) ***	-.577	(.058) ***
Parents' Education Level	.004	(.018)	.021	(.019)	.018	(.019)	.010	(.018)
Age	-.120	(.015) ***	-.131	(.015) ***	-.133	(.015) ***	-.118	(.015)
Intercept	5	0 ***	5	0 ***	6	0 ***	4	0

Source: National Longitudinal Study of Adolescent Health.

* p<.05 ** p<.01 *** p<.001

Investigating Guiding Attributes in Visual Search for Medication Vials

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Abstract

Medical professionals must select from a vast array of medication vials to dispense the correct medication to a patient. The vials are often small and highly similar, potentially increasing the chance of committing a medical error. Over 400,000 people die every year due to medical errors according to recent studies; a third of which are thought to be medication related. We studied the visual characteristics of medication vial labels to identify properties leading to the fastest and most accurate search. In a visual search task, participants located a target vial among an array of similar looking vials whose labels varied along a set of specific attributes (color density, text size and text orientation). Based on our data which examines response times and accuracy, we found that participants were faster and more accurate at finding vials with high color density and vertical text orientation, with the exception that when the text was large, there was no significant difference between these factors. Our research indicates that guiding attributes previously identified in basic visual search studies do in fact predict performance in search for medication vials.

Literature Review

Objective. Our goal is to help reduce the number of medical dispensation errors caused by misidentification of medication vials due to similarity of design, font, placement, color, or name. Though there are many different pharmaceutical companies, each with a distinguishable product and design, we reason that from a visual recognition standpoint there exist varying degrees of susceptibility to mistaken identification. Therefore, this project seeks to investigate the specific aspects of medication vial label design that may contribute to both effective recognition or result in a medical error due to misrecognition in order to eventually make recommendations for an optimal standard of design.

Medication Dispensation Errors. In 1999, Kohn, Corrigan, and Donaldson wrote the now well-known report "To Err Is Human," becoming one of the first collections of medical error reports. In the decade and a half since it was published, the report has been cited countless times by researchers in the field and has contributed greatly to our understanding of medical errors today. Using data compiled from a previous study of U.S. Hospitals, the report suggested that at least 44,000 Americans die annually due to medical errors making medical errors the eighth leading cause of death in the United States, killing more people than motor vehicle accidents, breast cancer, or AIDS. Data from a hospital in New York implied that the number may even be as high as 98,000 (Kohn et al., 1999). More recently, Levinson (2010) projected that the number of patients killed in the U.S. by some degree of adverse effect may be as high as 180,000 per year. Of these adverse effects, one third was due to medication errors, and physician reviewers believe that at least 44% of these errors were preventable. According to Levinson's (2010) research, preventable hospital care associated with adverse effects, for Medicare alone, cost an estimated $4.4 billion in 2008.

Lahue, Pyenson, and Iwasaki (2012) estimated that preventable adverse drug effects due specifically to injectable medications, such as the ones we are working with, are present in 1.2 million hospitalizations every year. Inpatient preventable adverse drug effects concerning injectable drugs, specifically, cost US taxpayers between $2.7 billion and $5.1 billion in extra hospital costs and an additional $300-600 million in medical professional liability costs annually (Lahue et al., 2012). The most recent study on the scope of medical errors used a program called the Global Trigger Tool, which guides reviewers through medical records and flags specific evidence of adverse effects. Using this tool, researchers collected data from 2008 to 2011 and concluded that the current rate for premature deaths due to medical errors has skyrocketed to over 400,000 people per year (James, 2013).

Though we seem to be making advancements in the field of medicine every year, the current system of organization is having trouble keeping up with the times. Peterson, Wu, and Bergin's 1999 study found that 82% of pharmacists and pharmacy owners surveyed in Australia agreed that the risk of dispensing errors is increasing, while 47% believed actual errors are becoming more common. Confusing or similar drug names or labeling were among the top six contributing factors listed by pharmacists (Peterson et al., 1999). Another notable finding was that medical errors become much more common when pharmacists are faced with high dispensing workload and fatigue. Finally, improved labels and distinctive names were among the top five factors that surveyed pharmacists believed may reduce dispensing errors.

One method to improve distinguishable labeling on medications was introduced by Eli Lilly in 1965 in the form of the Identicode System, where

the manufacturer logo and an alphanumeric code were printed on each drug. However, with the growing influx of medications and brands, this system is no longer sufficient, and it is apparent that changes need to be made. The sheer number of medication names on the market today is increasing the 'neighborhood density' of each name, a term referring to how many similar names are within a fixed distance from the target name. This increase has been shown by research to increase the probability of pharmacists making an error in a visual identification task (Lambert, Chang, & Gupta, 2003). Currently, there are over 15,000 drug names in use in the United States (Lambert, 1997), some having multiple names such as the chemical name, proprietary name, and generic name.

One way to help differentiate similar looking medications is with the use of tall man lettering, which is simply capitalizing distinguishable sections of a specific medication name (i.e., AmOXIcillin versus AmPICillin). The overall usefulness of tall man lettering is still being debated, but Filik, Purdy, Gale, and Gerrett (2006) found that if the participant is aware of the purpose of tall man lettering, it can make similar names easier to distinguish, and that tall man lettering may increase attention. Finding no significant difference between the number of errors in each condition, however, the study suggested that the tall man lettering did not reduce confusability with similar names, but simply increased attention to high risk drug names. These findings offer support for the use of tall man letters to reduce errors caused by similar looking drug names (Filik et al., 2006).

In addition, researchers at the University of Illinois in Chicago created a search engine that has achieved a 94.8% accuracy rate at detecting confusing name pairs (Lambert, Yu, & Thirumalai, 2004). Though not yet as precise as expert judgments, the program determines orthographic (visual) similarity as well as phonological (pronunciation) similarity. The researchers asserted that there is not currently an existing system for pre-approval screening of drug products that takes into consideration non-name attribute similarities and are working on developing one. The article also states, "What we used to think was a problem with drug name similarity is actually a problem of drug *product* similarity, incorporating multiple non-name attributes" (Lambert et al., 2004, p.26). These features are what we propose to test, including color, placement, design, and overall visual appearance.

In the early 2000s, the American Academy of Ophthalmology partnered with the FDA and pharmaceutical manufacturers to develop a uniform color-coding scheme for topical medications. The color schemes were selected taking into account the medication, its side effects, the disease it treats, and the risk of complications (American Academy of Ophthalmology, 2000). Some examples of this color scheme are bright red caps known as 'Anesthesia Red' on vials containing neurotransmitter blockers (ISMP Medication Safety Alert, 2003) and black caps on potassium chloride containing vials, which has many times been mistaken for sterile water or sodium chloride with deadly consequences (Cohen, 2002). This color-coding system seems to be effective so far in the fields in which it has been utilized, but it has not yet been implemented across all aspects of the pharmaceutical and medical industry.

Visual Search. Our approach leverages research in visual perception and visual search to examine medication vial confusability. According to Treisman's Feature Integration Theory, during the first stage of visual perception called the preattentive stage, features such as shape, color, motion, and orientation are unconsciously and effortlessly processed (Treisman & Gelade, 1980).

Wolfe and Horowitz (2004) list a number of guiding attributes based on a review of work in the field of visual search (e.g., color, motion, size,

shape, orientation). These features happen to be the very same features that research concerning Feature Integration Theory (Treisman & Gelade, 1980) found to be unconsciously recognized by different parts of the brain before entering conscious awareness during the first stage of visual perception called the preattentive stage. Such features were found by Wolfe and Horowitz (2004) to be effective perceptual dimensions that can be used by the visual system to guide attention quickly and efficiently to a target. Guiding attributes are typically identified on the basis of differences in measured reaction time (RT) and accuracy. For a given set size (i.e. the number of items in the display), targets containing attributes supporting guided search are typically found more quickly than targets not containing such guiding attributes. Accuracy typically mirrors the RT data, with faster-to-find items leading to fewer errors than harder-to-find items.

In the current study, we employed the visual search paradigm to identify which features of medication vials either supported quick and accurate search or not. We chose features of the labels that corresponded to known guiding attributes as closely as possible: color density, text size, and text orientation. We hypothesized that medication vials with high color density labels featuring large, horizontal text would lead to a quicker and more accurate search.

Method

Participants. Our sample consisted of 34 undergraduate students were enrolled in a psychology course at Wichita State University (13 males, mean age of 21) who were recruited using the SONA recruiting system. In the experiment recruitment description, participants were informed that the purpose of the study was to conduct research that might help limit medication dispensation errors and that their task would be to perform a visual search for medication vials. All participants received course credit for participation and provided informed consent in accord with the Wichita State University Institution Review Board guidelines.

Design. We programmed a visual search task in MATLAB (Natick, MA) using the Psychophysics Toolbox (Brainard, 1997; Pelli, 1997). The stimuli used in the experiment were selected from a Google image search and consisted of 24 different stimuli made up of two representatives each for 12 different combinations of variables. We utilized a 3 x 2 x 2 design in which the variables of Color Density (low, medium, high), Text Size (small, large), and Text Orientation (horizontal, vertical) were evaluated.

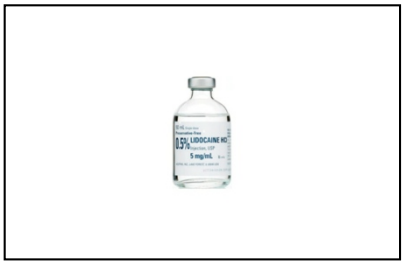

Figure 1. An example of a target vial, as shown to the participant.

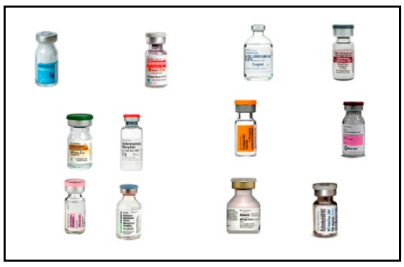

Figure 2. An example of the array of distractors with the target vial on the right side of the screen.

The search task took about 45 minutes to complete and consisted of 24 practice trials followed by 816 experimental trials. The experimental trials consisted of each of the 12 target categories appearing 30 times on the left

side of the screen, 30 times on the right, and not appearing 8 times (i.e., target absent trials). During the experimental phase, target absent trials made up 8.5% of the total number of trials. Target absent trials were included to prevent a potential strategy of participants searching only half the display and then responding based on whether the target was located on that side of the screen. Including target absent trials invalidates this potential strategy (and analysis of the data indicated that none of our subjects used such a strategy).

Stimuli. Color density was operationalized using Adobe Photoshop to categorize each vial by the percentage of colored pixels in its label, excluding black and white. Low color density vials contained 0-15% colored pixels in the label, medium color density contained 15-30% colored pixels, and high color density vials contained 30% or higher. Text size was operationalized as the average font size of the medication name and dosage in the stimulus image. Large font images had average text sizes equal to or larger than five points while small font stimuli were smaller than five points. Text orientation referred to the orientation of the drug name and dosage and was either horizontal or vertical. Font type was not controlled for in this study and varied between vials.

Figure 3. An example of two of the medication vials we used in the experiment.

The Heparin on the left displays high color density, large text, and vertical text orientation. The Amiodarone on the right displays low color density, small text, and horizontal text orientation. During each trial participants searched for a target medication vial among a set of distractor vials. The distractor vials were composed of one representative from each of the possible combinations of variables. For example, in each trial there was one of two different vials present that had *small text, vertical orientation, and low color density* as well as *large text, horizontal orientation, high color density,* and so on. This was always true, unless the trial was a target absent trial, in which the target vial would be substituted for the other stimulus version of the same condition.

The search display (39.7 x 33.4 degree visual angle) always had six stimuli (measuring 4.1 x 6.1 degree visual angle) on the left side of the screen and six on the right, with a blank gutter in the middle (measuring 7.4 degree visual angle horizontally). Stimuli were placed on a grid of three rows (spaced 8.3 degrees vertically) by two columns (spaced 10.3 degrees horizontally) on each side of the screen, with each location randomly jittered by 2.0 degrees horizontally and 1.2 degrees vertically on every trial. The placement of the vials was consistent, but the particular vial that would fill each of the 12 slots was random. The target vial and distractors for each trial were selected randomly from a counterbalanced list.

Procedure. The participant was seated at a computer monitor and used a keyboard as the input device. They were shown a picture of the target medication vial for two seconds (Figure 1), followed by a blank screen. Next, a screen displaying twelve medication vials, six on either side, appeared, and the participants were tasked with indicating whether the target vial was on the left side, the right side, or not present using the keyboard (Figure 2). Participants were asked to respond as quickly and accurately as possible and were given four short breaks during the experiment.

Results

We measured both accuracy and reaction time (RT) for each trial. To interpret the data, a three-way within-subjects analysis of variance (ANOVA) was conducted for both RT and accuracy. The ANOVA for RT indicated significant main effects for Text Orientation, $F(1,29) = .18.52$, $p < .001$, $\eta_p^2 = .390$ and for Color Density, $F(2,28) = 12.77$, $p < .001$, $\eta_p^2 = .477$.

The analyses also detected significant interactions between Text Size and Orientation (Figure 3), $F(1,29) = 37.49$, $p < .001$, $\eta_p^2 = .564$ as well as Text Size and Color Density (Figure 4), $F(2,28) = 7.06$, $p < .005$, $\eta_p^2 = .335$. The Text Orientation and Color Density main effects indicated that medication vials with vertical orientation and/or high color density were more quickly recognized.

The ANOVA for accuracy identified significant main effects for Text Orientation, $F(1,29) = 10.04$, $p < .005$, $\eta_p^2 = .257$ and Color Density, $F(2,28) = 17.99$, $p < .001$, $\eta_p^2 = .562$. The analyses also indicated significant interactions for Text Size and Orientation (Figure 5), $F(1,29) = 29.30$, $p < .001$, $\eta_p^2 = .503$ as well as Text Size and Color Density (Figure 6), $F(2,28) = 6.62$, $p < .005$, $\eta_p^2 = .321$, and a three-way interaction between Text Size, Text Orientation, and Color Density (Figure 7), $F(2,28) = 6.99$, $p < .005$, $\eta_p^2 = .333$. The Text Orientation and Color Density main effects indicated that medication vials with vertical orientation and/or high color density were more accurately recognized.

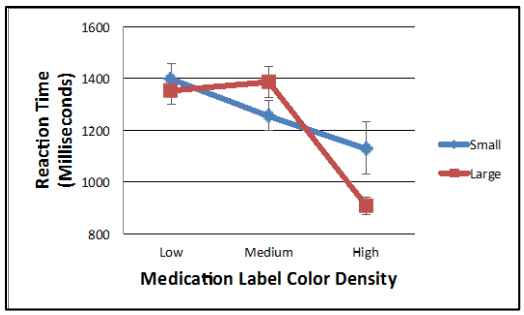

Figure 4. RT plotted as a function of text size and color density. Vials with small text size were located significantly faster at the medium color density level, but slower at the high color density level. Error bars indicate standard error of the mean.

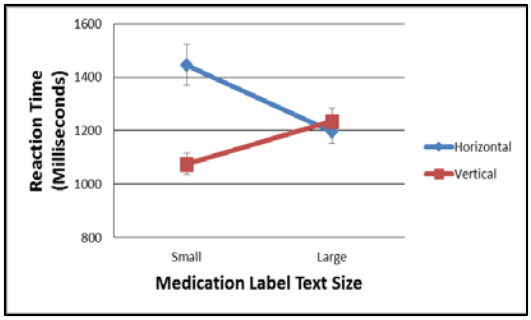

Figure 5. RT plotted as a function of text size and text orientation. Vials with small text size and vertical text orientation were located significantly faster than vials with small text size and horizontal text orientation. Error bars indicate standard error of the mean.

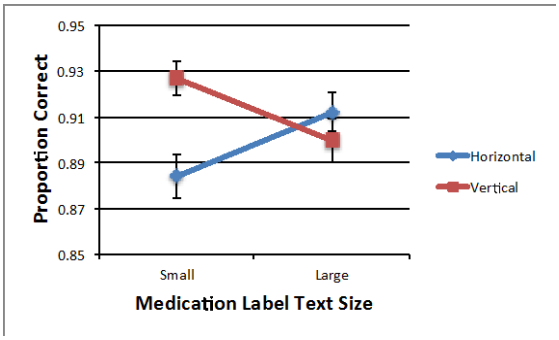

Figure 6. Accuracy plotted as a function of text size and text orientation. Vials with small text size and vertical text orientation were located more accurately than vials with small text size and horizontal text orientation. Error bars indicate standard error of the mean.

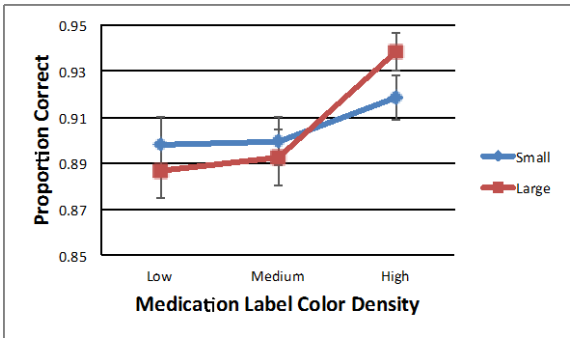

Figure 7. Accuracy plotted as a function of text size and color density. Vials with small text size were located more accurately at the low color density level but less accurately at the high color density level. Error bars indicate standard error of the mean.

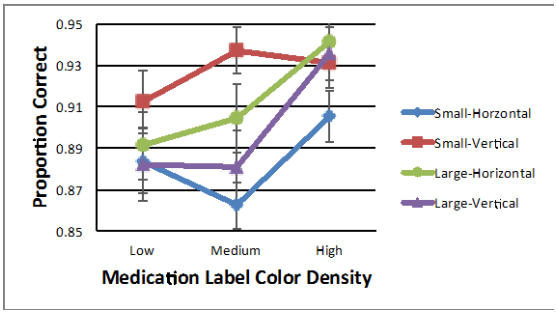

Figure 8. Accuracy plotted as a function of text size, color density, and text orientation. Vials with small text size and vertical text orientation were located most accurately at low and medium color density while small text size with horizontal text orientation was located least accurately at medium and high color density. Error bars indicate standard error of the mean.

Discussion

Major findings. Our research confirms that guiding attributes previously identified in basic visual search studies do in fact translate to search of medication vials. We found that participants were typically faster and more accurate at finding vials with high color density and vertical text orientation, with the exception that when the text was large, there was no significant difference between these factors.

Our results are consistent with the findings of Wolfe and Horowitz (2004) in the sense that color, orientation, and size seem to be effective guiding attributes in a visual search task for injectable medication vials. Our research also aligns with some of the other text-based studies of medication, such as Filik et al., (2006), because in our study text size made little difference in RT or accuracy. Because each trial in our study lasted only a few hundred milliseconds, it is possible that participants paid little attention to text at all, but instead had to rely on overall visual appearance to locate the target.

We predicted that vials with large text and high color density would have lower RTs and higher accuracy. However, only the latter turned out to be true. Perhaps it is because our study focused more on labeling than wording. Another unexpected result was that vertical text was more efficiently located than horizontal. This may be that because people see horizontal text orientation so often, it does not stand out to us as saliently as does vertical text orientation. It may also be a possibility that because our lateralized search task was vertically oriented, participants were able to pick out the vertically oriented text more easily

due to the way they were scanning the array of distractors. We are conducting follow-up studies to address both of these possibilities.

Limitations. Because we designed this experiment to closely resemble a realistic situation in which a pharmacist or another medical professional may need to quickly and accurately locate and identify the correct medication, we chose to use images of actual medication vials. However, there is a tradeoff between realism and control, and we experienced some restriction due to the limited availability of stimuli that could be found on the internet. Though over 900 stimuli were collected for this study, some of the conditions such as '*vertical text orientation x high color density x small text size*' were difficult to find, while other variations of stimuli containing the desired features such as '*horizontal text orientation x high color density x large text size*' were very common and therefore were found in abundance on the Google image search.

Future studies. To maintain realism, but gain a bit more control, we will use Photoshop to create our own medication vial stimuli. This will allow us to systematically test each feature without uncontrolled differences between stimuli. Because we were surprised to find that vertically oriented text was found more efficiently, we also plan to create a horizontally oriented search task to see if we can replicate our findings. Finally, we are also conducting a follow-up study that omits cap color to eliminate that as a possible guiding feature during the search task.

Conclusion

This preliminary work suggests that medication vials with high color density labels and vertical text may be easier to find in a visual search task compared to other label designs. If implemented in the medical field, the utilization of visually salient features in the labeling of medication vials may help to reduce medication related errors, especially errors occurring in the dispensation process. Further work is needed before making such labeling recommendations, but we believe that this approach to understanding medication vial label design has great potential for reducing medication selection and dispensation errors.

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An Experimental Study of Fiber Architecture Effects on the Stress Relaxation Behavior of Carbon Fiber Composites

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Abstract

This study examines the effects of reinforcement architecture on the stress relaxation behavior of polymeric composites. Stress relaxation of the matrix or the polymer dominates the composite relaxation behavior. Even under simple states of stress, such as the uniaxial case, the relaxation characteristics of reinforced polymers are drastically different than those of a pure polymer sample; thus, the homogenized global stress fields cannot be used to predict the relaxation of composites using simplistic mixtures models. To address this issue, flexural stress relaxation behavior of 5320-1 epoxy resin was measured and then compared with that of two carbon fiber reinforced (5320 Unidirectional and 5320-8 Harness) composites that utilized the same resin as their matrix. Measurements were taken across several degrees of polymerization at elevated temperatures below the glass transition temperature of the materials. The principle of time-temperature superposition held, and master curves were generated by manually shifting the data and calculating the shift factors. In all cases, unidirectional composite exhibited the least relaxation, while the relaxation in 8 Harness fabric reinforced composite exceeded or approached that of the pure epoxy resin. This data is currently being used to develop correction factors for rule of mixtures models. Hence, the experimental data can be used to make mathematical models that can characterize the stress relaxation behavior of a broader range of composite systems used for structural support.

Introduction

The use of composites for structural stability and support is on the rise due to its lightweight and exceptional mechanical properties. Composites are a man-made material, and they consist of two key components: fiber reinforcement and resin matrix. One of the greatest benefits of composites is their ability to utilize the properties of both the fiber and the resin. However, advanced polymer matrix composites are considered as the ultimate designer material[1]. This is because they can be prepared in several different ways regarding stacking sequence, weave pattern, materials used, and fiber orientation. Hence, one of the greatest challenges is determining the optimum resin and fiber combination. Out of the two, the resin needs more attention because it is a polymer and a viscous non-Newtonian fluid.

Although the use of composites is on the rise, they still have a few negative characteristics that designers must be aware of. One of these complications it its poor dimensional stability as compared to traditional metal material such as steel or aluminum. It is believed that composites distort due to residual stresses that develop during the manufacturing process, caused by the heterogeneous nature of the material[2]. Some of these factors include but are not limited to coefficient of thermal expansion mismatch between resin and fiber and volumetric shrinkage[1]. Besides dimensional instability, these residual stresses also produce micro cracking of the matrix system, which negatively affects the mechanical properties of the composite [3]. Hence, eliminating these residual stresses is one of the keys to improving the advancement of polymer matrix composites. Originally, it was believed that residual stresses were solely developed by the cooling stage of the manufacturing process. This stemmed from the belief that the laminates experienced a stress-free state before cooling[4]. However, many investigators have found that the formation of residual stresses is largely linked to the entirety of the cure cycle[5-13, 21].

Therefore, previous work has measured the DOC of polymer composites and compared its mechanical properties across various degrees. Also, work has been done to determine the viscoelastic behavior of the resin and how it is affected across degrees of cure. Because resin is a viscoelastic polymer material, its long term behavior can be characterized through a study of its viscoelastic behaviors. Two of the most prominently studied viscoelastic behaviors are creep and stress relaxation. The theories used to explain these two properties follow the same principles, and either can be used to create mastercurves that characterize the material's behavior over an extended timeline. The main difference between the two is that stress relaxation focuses on the how the stress of the material relaxes (or reduces) while it's held at a constant strain. However, creep focuses on the ability of the material to maintain a constant stress, and the strain tends to creep up (or increase) to accomplish this.

In terms of the DOC, several researchers have attempted to measure the mechanical and viscoelastic properties of composites to see how they vary with differing degrees of cure. By deviating from the manufacturer's recommended cure cycle, Alavi-Soltani et al.[14] found that various degrees of cure could be found simply by varying the isothermal hold. Also, it was found that storage modulus increased along with the increase of DOC, which suggests a linear relationship between mechanical properties and DOC. Krayz et al.[15] also studied the relationship between the DOC and the materials' properties, but they focused on the glass transition temperature rather than the storage modulus. It was observed that the glass transition temperature decreased as DOC increased, and a mathematical model was developed by expanding upon the model published by Kamal and Sourour[16]. This proved

to accurately predict the glass transition temperature of epoxy-based composites when compared with dynamic analysis results.

Instead of investigating composites consisting of an epoxy matrix system, Wang and Yang[17] studied the dynamic mechanical properties of polypropylene resin. It was found that regardless of the differences regarding the fiber reinforcement of the composites, their glass transition temperatures did not change significantly. This work suggests that the glass transition temperature of the composites is primarily dependent on the resin within the matrix.

One of the most prominent experimental studies in the creep behavior of epoxy reinforced composites was conducted by Goertzen and Kessler[18]. Through their work, they were able to predict the lifetime of a material without failure to be 50 years when held at constant stress levels. In order to construct the mastercurves used to predict this lifetime, the time-temperature-superposition shifted factors were calculated using two separate techniques. One of the methods was manually shifting the curves, and the other was the use of the activation energy of the glass transition relaxation. Upon comparison of the two methods, it was found that the estimations from the activation energy could be used until the onset of the glass transition temperature of the material.

Although most researchers focus on carbon fiber reinforced composites, Farsani, Khalili, Daghighi, and Fazaeli[19] investigated the creep behavior of basalt and glass reinforced epoxy resins. The results showed that the BFRE had better creep properties than that of GFRE (which had been observed in previous work), and the presence of the MGP decreased the initial strain/creep compliance in the BFRE samples. It was also observed that the creep resistance of the BFRE was superior to that of the GFRE because the slope of the GFRE was greater than that of the BFRE through the duration of the entire tests. It is believed that the presence of the MGP increased the stiffness of the BFRE, and it only had an effect on the matrix, not the fiber. The fiber is the ruling phase in creep tests; thus, through their results, it is clear that the creep behavior of polymers matrix composites, unlike glass transition temperature, is not primarily dependent on the resin.

Rees et al.[20] investigated the creep behavior of both glass-fiber reinforced epoxy composites and carbon-fiber reinforced epoxy composites, cut in different fiber orientations. In their experiments, it was observed that the creep in an epoxy matrix can be almost eliminated by aligning embedded fibers with the stress direction. They also found that when fibers and stress axes are misaligned creep has a greater effect on structural integrity and dimensional stability as the matrix material behaves in a viscous manner. Hence, the creep behavior of the composite was found to differ depending on the fiber direction and how the applied loads are orientated with respect to it. Ruiz and Trochu[21] experimentally studied the stress relaxation behavior of glass-fiber reinforced polyester composites changes across different degrees of cure and created viscoelastic models. The material was observed to relax more as the DOC increased, and they were able to show that simple mathematical models could be developed in order to generalize the creep or stress relaxation behavior of polyester material.

To gain a better understanding of the stress relaxation/creep behavior of the composites, various experiments have been conducted and mathematical models have been developed. Although, these viscoelastic behaviors within polymer composites are resin dominated, there has not been much work performed on the resin itself. Also, there has not been work presented on how the presence of the fibers within a fiber reinforced composite affects these behaviors. Even though, they are resin dominated strong evidence has been proven that composite systems

composed of the same material still behave differently due to the weave or fiber orientation. The present study aims to investigate this influence across various degrees of cure to develop a deeper understanding of the effects of weave patterns and fiber orientations on the behavior of the resin. Hence, the present study primarily focused on composite systems composed of the same material but with varying weave patterns and fiber orientations for changes in stress relaxation behavior.

Experimental Approach, Resin

The resin tested for this investigation was 5320-1 epoxy resin, and it was cured to various degrees of cure using cure cycles that were previously generated and validated. The desired degrees of cure (DOC) were 95%, 83%, 67%, and 50%, and although the cure cycles had previously been validated, thermocouples were attached to the resin samples during curing to monitor the temperature observed by the resin samples. This ensured that the resin samples were properly cured according to the correct cure cycle, and it ensured that the oven was properly working. Along with the thermocouple readings, the resin was also tested using differential scanning calorimetry (DSC) to validate the actual degrees of cure of the samples.

In order to cure the samples in the proper shapes necessary for testing silicon, molds were first created. The molds were made by first lightly gluing four or five aluminum samples to the base of plastic hexagonal cups. In a separate cup of the same shape and size, the base and catalyst for the silicon were weighed and mixed together using the manufacturer's recommended ratio. After thorough mixing, the silicon was slowly poured onto the aluminum samples until the desired thickness of the mold was obtained. Then the mold was vacuumed for approximately 30 minutes under a cyclic pressure with a lower limit of 5kPa and 20kPa. This helped minimize the air bubbles in the mold during mixing, because they could act as voids and weaken the structural integrity of the molds. Once air bubbles were reduced, the mold was taken out of the vacuum and left to cure at room temperature for 24 hours, according to the manufacturer's recommended cure time. After the mold was properly cured, the silicon was removed from the cup and the aluminum samples were removed by manually applying pressure to the back of the mold. Molds were made for two separate shapes, one of which was a dogbone shape in accordance to ASTM D1708 [22]. The other shape was rectangular and based off the standardized sizes of the compliance samples provided by Thermal Analysis for their Q800 Dynamic Mechanical Analyzer (DMA).

Uncured 5230-1 epoxy resin, which was normally kept in a freezer during inactivity to avoid accidental curing, was placed into the silicon molds to completely fill the orifices created by the aluminum samples. Then the mold was turned upside-down and laid-up using a thin aluminum tool, thermal release film, an aluminum call sheet, a breather, sealant tape, and a vacuum bag. Before placing the laid-up samples into the oven for curing, they were debulked at a constant pressure of 27kPa for at least 30 minutes. While curing in the oven, the samples were held at a constant pressure of 24kPa.

The cure cycles for this investigation all used a combination of isothermal holds and temperature ramps to obtain the desired DOC. Refer to Appendix A for an illustrative representation of the cure cycle that was used for the epoxy resin. In the present study, the cure cycles used were the ones outlined in the figure for 95% DOC, 83% DOC, and 67% DOC; to obtain 50% (DOC) the cure cycle had to be extrapolated from the equations developed to get the degrees of cure featured in Appendix A. According to the figure, the different degrees of cure are obtained in a step manner, where the higher degrees of cure follow the same cycle as that of the lower ones but ramped and isothermally held at higher temperatures. Also, the

different shaped epoxy resin samples were laid-up and cured together.

Before stress relaxation testing could start, the cured samples were tested for the glass transition temperature in the Q2000 Differential Scanning Calorimetry (DSC). This was done by taking small circular 5320-1 epoxy resin samples and testing them under a ramp with the rate of 10°C per minute. The heat flow was than plotted versus the temperature, and the glass transition temperature was measured according to ASTM E 1356-08[23]. To measure the glass transition temperature, the specimens had to be ramped to very high temperatures, and the behavior of the epoxy resin was unknown at such temperatures. Since 5320-1 is a viscous fluid, it could flow and possibly damage a testing apparatus if direct contact was used. To prevent this from occurring, the resin was tested for glass transition testing in the DSC Q2000 because a destructive test could be conducted without damaging the apparatus.

In order to correct the DOC using DSC Q2000, small epoxy resin specimens were taken from the cured panels and from an uncured roll of 5320-1. Once the specimens were ready, the heat of reaction was calculated for all degrees of cure, and the ultimate heat was taken as the heat of reaction of the uncured samples. In order to do this, the samples were tested in a temperature ramp of 10°C/min, and the heat flow was plotted against the temperature. Upon observing the plots, the first area in which the heat flow created a negative parabolic curve was investigated because it represented curing/burning of the samples. Hence, the area under this curve was integrated, and this integrated area was the calculated heat of reaction. After the heat of reaction for all degrees of cure was calculated, the actual DOC was calculated using the below equation. This equation involves the residual heat of reaction (H_{res}) and the ultimate heat of reaction (H_u) and was developed by White and Hahn[13].

$$DOC = \left(1 - \frac{H_{res}}{H_u}\right) \times 100$$

Equation 1

The Q800 Dynamic Mechanical Analyzer (DMA) was used to test for stress relaxation. The rectangular-shaped samples were tested using tension clamps. In all cases, the samples were held at a constant strain of 0.1% and isothermally held for 15 minutes. In order to get the stress relaxation behavior across a proper temperature range, the samples were isothermally held at room temperature, incremented by 10°C (for 95% DOC and 83% DOC Samples) or by 5°C (for 67% DOC and 50% DOC samples), then isothermally held again. This process was repeated until the temperature surpassed the glass transition temperature of the samples. The relaxation modulus was only measured during the isothermal hold once the constant strain was instantaneously applied. It should be noted that in all cases the samples and clamps were covered by a wire mesh during testing to ensure the temperature distribution remained constant.
After stress relaxation testing, the data was analyzed using the time temperature superposition principle (TTS) and by manually calculating the shifted factors. First, the relaxation modulus for each temperature was superimposed onto a single plot under the same logarithmic time scale. Then the relaxation modulus was normalized using the greatest overall measured value as the reference. The lowest temperature was used as the reference to shift each subsequent temperature's relaxation modulus to create a single stress relaxation mastercurve. Next, the surplus data was omitted to make the stress relaxation mastercurve easier to read and understand. These mastercurves were created for all cured samples for both the tension samples and the three-point bending samples.

B. Fiber-Reinforced Composite

There were two composite systems tested for the present study. One was 5320-8 Harness (5320-8 HS) and the other was 5820 Unidirectional Tape Extended Out-Time (5320 UDEO). Both of these composites were reinforced with carbon fibers and

had a matrix consisting of 5320-1 epoxy resin. Similarly to that of the epoxy resin, the composites were cured to the 95%, 83%, 67% and 50% degrees of cure. These samples were also cured with thermocouples attached and had their degrees of cure verified through DSC—the same reasons as those of the resin.

Unlike the resin, silicon molds were not necessary for the fiber-reinforced composites, so the uncured composites could immediately be laid-up. However, for the composites, the lay-up was slightly different than that because of the resin. Due to the presence of the reinforced fibers, the composites had to be stacked in squares following a sequence in which the fiber directions were considered. For the case of 5320 UDEO, the fiber direction was taken as the [0°] direction and for the case of 5320-8 HS the warp direction was taken as the [0°] direction. Four plies of uncured 5320 UDEO were stacked as [0/0/0/0], and four plies of uncured 5320-8 HS were stacked as [0/90/90/0] due to the nature of the respective composite system from their fiber weaves. A tool was used for the composite system thicker than the one used for the resin because a silicon mold was not used and heat conductivity was not a necessary factor. Also, thermal release film, thermal perforated release film, peel ply, a thin call sheet, a breather, sealant tape, and a vacuum bag were used to lay-up the composite. Similar to that of the resin, once laid-up the composites were debulked for at least 30 minutes at the same constant pressure of the resin. While curing, the composites were also held at the same constant pressure as the resin of 24kPa.

Because the phenomenon of curing is considered a polymer dominated behavior that is solely determined by the resin within the matrix of the composite, cure cycles for the fiber-reinforced composites were similar to that of the pure epoxy resin. The matrix within 5320-8 HS has a high amount of 5320-1 resin, so the cure cycle used for 5320-8 HS was the exact same one used for 5320-1 resin. The fiber fraction volume in 5320 UDEO is higher than that of 5320-8HS, meaning its matrix is lower in resin content. However, since DOC is a viscoelastic property purely determined by the resin, the same cure cycle was also used for 5320 UDEO.

Instead of getting the desired shapes of the samples from a mold, the samples were cut from the cured square panels. For the higher degrees of cure, 83% and 95%, a grinding saw was used to cut the samples, but the grinding saw could not be used for the lower degrees of cure due to the threat of distortion of samples. To avoid this problem, the lower DOC samples were cut using a water jet. Originally, both tension samples and three-point bend samples were going to be tested, but due to complications in preliminary testing, lower degree samples for tension were not made and tension testing ceased. Further details regarding the difficulties faced with tension samples will be discussed in other sections. However, acceptable preliminary results, three-point bend samples were produced and hence rectangular 36mm x 5.5mm samples were cut for both composite systems. The 5320 UDEO samples were cut in the [0°] direction, but the 5320-8 HS samples were cut in transverse direction to make [+-90°] samples and at a [+-45°] direction to make [+-45°] samples.

Before stress relaxation testing could start the cured samples were tested for the glass transition temperature in the Q800 Dynamic Mechanical Analyzer (DMA) developed by Thermal Analysis. In order to do this, a sample from each DOC was tested with a three point bend clamp and placed under a temperature ramp to 250°C. During the ramp, the samples experienced an oscillatory strain of 0.05% and a track of 125%. The glass transition temperature was measured through two principles: one was from the standpoint of the storage modulus and the other was from the tan delta. After testing, the storage modulus and the tan delta were each plotted against temperature. In the case of the storage modulus, the average temperature at which the modulus experienced its first slight

exponential decay was calculated. In each case this average temperature was taken as the glass transition temperature for the respective principle. In the case of the tan delta, the glass transition temperature was taken as the temperature at which the tan delta peaked. For the sake of being conservative, the lower glass transition temperature produced by the two was taken as the glass transition temperature for stress relation testing. Unlike the pure epoxy resin, the fiber reinforced composite systems are not viscous fluids and do not present the possible danger of flow. Hence, direct contact between the specimen and testing apparatus could be used, making the Q800 DMA a viable option for measuring the glass transition temperatures.

Once the glass transition temperatures of the fiber reinforced composites were calculated, the specimens were tested for stress relaxation using a constant strain of 0.1% and a relax time of an hour. Next, the stress relaxation modulus for the composites was measured across the temperature range starting at room temperature and ending at a temperature past its glass transition temperature. Then the data was analyzed using TTS by manually calculating the shifted factors, normalizing the relaxation modulus and creating the stress relaxation mastercurves for all degrees of cure. Except in the case of 5320-8HS [+-90˚] direction, the shifted factors could not be calculated manually. So instead of manual calculation, the shifted factors were calculated through the Universal Analysis software provided by Thermal Analysis, which is integrated into the Q800 DMA system.

Results, Resin

Resin samples were tested for stress relaxation under two different states of stress from room temperature past the glass transition temperature across various degrees of cure. Three point bending applies a nonhomogeneous stress to the samples that involves a combination of tensile, compressive, and shear stresses. In order to help determine which stress of the three was more dominant, the three point bend results were compared with those of the tensile testing for all degrees of cure. However, before displaying the comparison of the two states of stress investigated in this study, they will be presented separately.

As mentioned before, the stress relaxation testing could not commence until the glass transition temperature of the resin could be determined. Because the rectangular samples and the dogbone-shaped samples were cured simultaneously, a single test could be used to determine the glass transition temperature for both. Appendix B displays the glass transition temperature with respect to the DOC of the epoxy resin samples, and Appendix C shows the approximate glass transition temperature values. It can be seen that the glass transition temperature is fairly linear until it reaches the DOC between 60% and 70%; there the graph begins to gradually exponentially decay. These glass transition values were used to determine the maximum temperature used in the stress relaxation tests to ensure that a proper temperature range was used. Also, because the melting point of the material was still unknown, the maximum limit was set to be no more than 35˚C past the glass transition temperature of the respective samples. This ensured that the melting point was not accidently reached and prevented damaging the Q800 DMA used to conduct the stress relaxation test.

Appendix D shows the calculated values of the DOC that were found after using the previously mentioned equation along with the calculated residual heat of reaction and ultimate heat of reaction. This study was not concerned with the exact DOC but rather uses it as a basis for comparison; all the corrected degrees of cure were rounded up for convenience. Hence, the corrected DOCs for this study were as follow: 47% DOC, 60% DOC, 80% DOC and 90% DOC. It should be noted that generally this would not be done when calculating DOC, but for the scope of this

investigation the researchers felt rounding in such a manner would not disrupt the results.

Three point bending is not an ideal mode of testing because it is nonhomogeneous; however, it has proven to be the most reliable due to the simplicity of mounting. Appendix E shows the results gathered from the three point bending samples across all tested degrees of cure. It can be seen from the graph that the materials behave as expected under flexural testing for all degrees of cure, except the lower two. Ideally, the material should relax more as the DOC is decreased due to the decreased amount of chain linking. This chain linkage is directly proportionate to the stiffness of the material; hence, with more chain linkage the material should be stiffer and relax less. This behavior can be seen for the higher two degrees of cure, but the relaxation behaviors of the lower degrees of cures are more similar. It was believed that the material behaved in this manner due to the heterogeneous nature of the flexural state of stress.

At the lower degrees of cure, it would appear that the various contributions of stress compete for dominance and thus affect the behavior of the material differently. This is one of the main complications with the three-point bending test. It is unknown if the shear, tension, or compressive stress is dominant. In this test, this dominance appears to vary depending on the DOC of the sample, too. If the stress contributions remained constant, the difference in the relaxation of the material should be approximately equal to the subsequent DOC. However, it is seen that the difference between the subsequent degrees of cure decrease along with the cure state.

In order to gain a better understanding of how the stress contributions were distributed, samples were prepared in dogbone shapes and tested in tension. Tension testing is more ideal because it is a uniaxial test, meaning the state of stress is homogenous throughout. However, this type of testing is not perfect and oftentimes investigators face the problem of slippage. Slippage occurs when there is not enough friction between the fixture and the specimens, causing the specimen to slip slightly out of place during the test. In terms of stress relaxation, this behavior generally yields unrealistic spikes in the unanalyzed data and makes it seem as though the material gets stiffer as the temperature is increased. This behavior is nonrealistic and implies that the material will become stronger as time evolves due to the principle of Time Temperature Superposition, meaning it would never corrode. To avoid this problem, the edges of the sample that could be clapped by the fixture were sanded to increase the friction between the sample and the fixture clamps.

Appendix F displays the stress relaxation mastercurves for the samples tested under tension, and it can be seen that the material behaved as expected, unlike the results generated from flexural testing, displayed in Appendix E. As the DOC decreases, the material relaxes more, and the difference between each subsequent cure state is fairly similar except at the lowest DOC. Unlike the flexural results, the differences between the differences in stress relaxation behavior between the cure states appear to follow a more apparent pattern. As the DOC decreases, the differences between the mastercurves decease. Also, in the case of the flexural test, the difference in behavior between the higher two degrees of cure was very large, but this is behavior did not appear in the tensile case.

After individually measuring the stress relaxation behavior of 5320-1 epoxy resin using tension and three-point bending, the two were compared according to the DOCs to determine the tensile stress contribution within the heterogeneous flexural state of stress. From appendices G-J, it can be seen that the tensile and flexural stress relaxation behavior of 5320-1 epoxy resin varied along with the DOC. In the case of 90%, 80%, and

60% degrees of cure, there was an apparent trend of the flexural relaxation decreasing with respect to the tensile relaxation. At 90% DOC the tensile relaxation is less, but at 60% DOC the tensile stress relaxation is more than that of the flexural. Then, once again, at 47% DOC the material relaxes less under tensile stress. This demonstrates that the stress contributions within the material vary along with DOC when subjected to three-point bending. In the cases of 80% DOC and 60% DOC, the tensile stress contribution was dominant in the heterogeneous state of stress. However, in the cases of 90% DOC and 47% DOC, one of the other stress contributions proved to be dominant.

Results, Fiber Reinforced Composites

Once the stress relaxation behavior of the 5230-1 epoxy resin was characterized, the next step was to determine the behavior of the composite systems. The two composite systems used for this study were 5320-8HS and 5320 UDEO, both carbon fiber reinforced composites whose matrix is made of 5320-1 epoxy resin. As with the epoxy resin, before starting stress relaxation testing, the fiber reinforced composites were tested for the glass transition temperature. The composites were then tested in testing conditions similar to that of the resin to determine how the stress relaxation behavior of the resin changed due to the fiber architecture of the composite system. Hence, first the individual composite results will be presented, and then those results will be presented along with the resin.

The glass transition temperature of the fiber reinforced composites were measured for the same reason as that of the epoxy resin— to determine a proper temperature range for the stress relaxation tests. However, these tests were done on a smaller range of DOC because extremely low degrees of cure were not used for this study. Appendices K and L are the graphical and tabular representations of the glass transition temperature measured across various degrees of cure for 5320-8HS. Though the fiber orientation and the weave direction of 5320-8HS and 5320 UDEO samples are different, they are still composed of the same material. Glass transition temperature is a material property, and both the composites are composed of carbon fibers and 5320-1 epoxy resin. Therefore, the glass transition temperatures measured for 5320-8HS were used for both composite systems. As mentioned previously, two techniques were considered when measuring the DOC of the fiber reinforced composite: one based on the storage modulus, and the other based on the tan delta. For all cases, the technique which yielded the lowest glass transition temperature was the one based on the storage modulus, so these values were conservatively taken as the glass transition temperatures of the fiber reinforced composites.

Once the glass transition temperatures of the composites were determined, the samples were tested for relaxation. Originally, the samples were going to be tested under tension; however, due to several complications, three point bending had to be used instead. One of the major problems faced with testing the fiber reinforced composite samples under tension was slippage. Several solutions were tried to circumvent this problem, including increasing friction though sanding and using aluminum tape on the edges. The aluminum tape's surface was rougher than that of the composite samples, so it was felt that it could be a viable option. Along with the aluminum tape, wedges were also tried in order to impede the slippage. At first, these wedges were placed at the end of the clamps and taped to the top and bottom of the sample, but this was not successful. Lastly, the wedges were attached to the middle of the clamped area of the composites to perfectly fit the opening of the c-bar shaped clamps. However, this solution also proved to be futile, and it was decided that three point bending would be the best testing mode since it could produce more reliable results.

Although flexural state of stress proved to be the more reliable of the two, there was a complication faced with this mode as well. One important characteristic of proper stress relaxation analysis in this investigation was to maintain the same reference temperature for all the degrees of cure. However, the Q800 DMA had a force limit of 18N, and when this limit is reached data cannot be collected. This reference temperature was taken as the lowest one at which the highest relaxation modulus was taken. The relaxation modulus measured and the force produced are directly related, so if the material demanded a high stress to maintain the desired strain the 18N limit could be reached. In the case of both 5320-8HS and 5320 UDEO, this limit was reached at the beginning of the test for all degrees of cure. Despite this complication, consistent stress relaxation behavior for both 5320-8HS and 5320 UDEO was still measured and characterized.

5320 UDEO is the simpler composite system of the two because all the fibers are organized in a single direction throughout the entire system. For this composite system, there were no problems with the reference temperature, and they all have the same as the 5320-1 epoxy resin. However, when examined closely it can be seen that the time scale is smaller than that of the resin, and there is not much relaxation overall. This is due to the material increasing in stiffness at higher temperatures. As explained earlier, this behavior is unrealistic and can only occur if there is a problem in the set-up; although, three point bending is a very simple mode of testing, and there were no apparent issues regarding the test set-up. Regardless, through various stress relaxation tests this same result kept appearing, and the glass transition temperature could never be reached without the stiffness increasing. It is believed that this behavior is attributed to the inconsistency of the heterogeneous state of stress that the three point bending mode provides.

In the case of the 5320-1 pure epoxy resin, it was seen that the flexural stress relaxation was inconsistent across the degrees of cure. This was again seen in the case of the 5320 UDEO (refer to Appendix M) because the 90% DOC sample relaxed slightly more than the 80% DOC sample. Not only is it thought that the flexural stress relaxation behavior is sensitive to DOC, but it is also sensitive to the higher temperatures as well. Hence, the full relaxation behavior of 5320 UDEO was not properly characterized due to the competing stress contributions developed in a three point bend mode. If the composite could be tested under tension such as the epoxy resin samples, it is believed the stress relaxation behavior of the composite could be properly characterized.
5320-8HS is not as simple as 5320 UDEO because its fibers are not all in the same direction; instead, there is a change of fiber weave at every eighth fiber. This advanced weaving gives 5320-8HS a more complex architecture because it makes the composite consist of two different directions called a warped direction and a fill direction. The warp direction is the one that features the direction of the change in fiber architecture, whereas the fill direction is orientated perpendicular to that. These two directions behave differently than one another and even have different material properties. Hence, in the case of 5320-8HS when samples are cut they have a [+-] additive to account for these two directions. For this study, the warp direction was taken as the [0˚] direction, and the warp direction was taken as the 90˚ direction.

Samples of 5320-8HS were prepared in a sequence of [0/90/90/0], and then cut in the 90˚ direction, thus, yielding [+-90˚] direction samples. These samples were then tested under the same stress relaxation parameters as those of the 5320 UDEO samples, and the resulting mastercurves were graphed. It can be seen in Appendix N that the stress relaxation behavior of the 5320-8HS is more ideal across the differing degrees of cure than that of 5320 UDEO. There is an improvement in regards to the material relaxing more as the DOC is decreased; however, the time scale is still shorter than that of the epoxy resin. This is again due to

the heterogeneous nature of the state of stress that the material experienced. The shifted factors of these particular samples could not be calculated manually because the reference temperature would have been very far off and time scale would have been significantly smaller. This of course could be too short to properly characterize the stress relaxation behavior of the material, so the shifted factors had to be calculated with the use of the provided software for analysis. It should also be noted that the 60% DOC does experience full relaxation in that it descends to the point of zero and plateaus. This is the most ideal stress relaxation behavior that was expected to occur for all testing, but with a larger time scale.

The final samples that were tested were 5320-8HS prepared in a sequence of [0/90/90/0], and then cut in the 45° direction, thus, yielding [+-45°] direction samples. Unlike the [+-90°] direction samples, these samples could be manually analyzed like the rest of the specimens. In Appendix O, it can be seen that the material relaxed more as the DOC decreased, similarly to that of the [+-90°] direction samples. Also the 60% DOC sample decreased and plateaued at a normalized relaxation modulus of 0, which was also seen in the [+-90°] directional test for 60% DOC. However, one apparent difference is the smoothness of the curves. In all cases where the shifted factors were manually calculated the graphs are smoother for all degrees of cure than the graphed values of the software. This outlines an apparent limitation within the software and its ability to appropriately apply the time temperature superposition principle. It should also be noted that the difference in relaxation between the 80% DOC and 60% DOC is much larger than between 90% and 60%. This behavior is very different than that of the [+-90°] direction, where the difference in relaxation is not that great between the subsequent degrees of cure. Also it should be noted that the time scale for [+-45°] direction is even smaller than that of [+-90°] and 5320 UDEO.

Although stress relaxation is a viscoelastic behavior that is attributed mainly to the epoxy resin, from the 5320-8HS results it is obvious that the reinforced fibers have an effect in the composite system. The two samples of 5320-8HS had everything in common except the direction in which the fibers were cut, yet there is an obvious distinction in the stress relaxation behavior of the two. Also, the stress relaxation behavior of both the 5320-8HS differed from that of 5320 UDEO. Hence, the stress relaxation behaviors are not solely dependent on the epoxy resin, but also on the architecture of the composite regarding both weave patterns and fiber orientation. Although it is obvious that the stress relaxation behavior of the composite systems differ from each other, this study is mainly concerned with how the reinforced fibers contribute to the stress relaxation behavior of the pure epoxy resin.

Results, Epoxy Resin and Fiber Reinforced Composite Comparison

Once the stress relaxation behavior was characterized for 5320-1 epoxy resin, 5320-8HS carbon fiber reinforced composite was prepared in [+-90°] and [+-45°] directions and 5320 UDEO and the results were compared on an individual DOC basis. Because the composites had to be tested using the three point bending mode, the flexural stress relaxation results were used in the comparison. Hence, all the results were placed under the same heterogeneous state of stress. They are shown in appendices P-R.

All of the cases demonstrated similar stress relaxation behaviors when the resin and composite results were compared. 5320 UDEO relaxed significantly less than the 5320-8HS and 5320-1 through the entire duration of its time scale. Conversely, 5320-8HS [+-45°] direction relaxed

the most. With respect to the composites, 5320 [+-90°] direction was in the middle, but with respect to the resin the results were similar. In all cases [+-90°] direction began its time scale by relaxing less than the pure epoxy resin, and then relaxing more than it at a later point in time. Interestingly, at 80% DOC the stress relaxation behavior of 5320-1 and 5320-8HS [+-90°] direction were comparable with little difference, especially at the beginning of relaxation. Also, at 60% DOC 5320-8HS [+-90°], direction began by relaxing less than the resin, and then it relaxed more; before the end of its time scale, it relaxed less than the resin once again. It should be noted that 60% DOC was the only tested cure state that demonstrated a full time scale for the fiber reinforced composites. It is believed that this relation between 5320-8HS [+-90°] direction and 5320-1 resin would be the time for all degrees of cure if a full relaxation time scale was present. This is easy to see for 80% DOC because the stress relaxation mastercurve of 5320-8HS [+-90°] direction starts tending towards that of 5320-1 as if it would overtake it, before abruptly ending.

The shifted factors that were used to construct the mastercurves for the pure epoxy resin and the fiber reinforced composites were compared with the William-Flerry Equation[24]. In this equation, the reference temperature is represented by T_o, a_T, is the shifted factor, and C_1 and C_2 are empirical constants. The comparison was done by using the curve obtained at the lowest temperature as the reference and horizontally shifting the curves obtained from the other curves with respect to that reference. The factors taken from this method were then plotted and fitted with the predictions of the equation below. These comparisons can be seen in appendices R-W, and in order to do the fitting, the constants of C_1 and C_2 necessary for the shifted factors found in the present study were analytically solved. Although the reference was below the glass transition temperature, it was seen that the William-Flerry Equation was unsuccessful in predicting the shifted factors. This is because the equation expects a linear regression in shifted factors as the temperature increases. However, it was observed that the shifted factors did not decrease linearly with respect to temperature while below the glass transition temperature. Appendix X gives the equations for the linear curve fits calculated using Equation 2. Also similarly to the stress relaxation behavior, the shifted factors are expected to become more negative as the DOC decreases. This is seen in the cases expected for 5320-1 epoxy resin under flexural testing and 5320-8HS [+-90°]. This is because the all the temperatures were shifted horizontally to the right of the reference. According to standard nomenclature, a leftward horizontal shift indicates a positive shifted factor, whereas a rightward horizontal shift indicates a negative shifted factor.

$$Log(a_T) = \frac{-c_1(T-T_o)}{c_2 + (T-T_o)}$$

Equation 2

Discussion

The results observed in most cases have proven to be consistent with those that were expected before experimentation based on intuition and past research. The glass transition temperature was one of the primary properties measured for this investigation, and there was an obvious trend observed for both the resin and the composite. In both cases, the glass transition temperature of the material decreased as the DOC of said material increased. This was the same trend observed in the experiments previously conducted [17-21]. However, unlike the work done by Wang and Ying [17], the glass transition temperature of the pure resin differed from that of the composite systems. The difference was even greater if the storage modulus was used in DMA. It should be noted that the resin systems used in the two studies were different: in the present study an epoxy resin was used, and in the other study a

polypropylene resin was used. From this, one can infer that when a polymer matrix composite is created with polypropylene matrix, the resin is dominate in terms of glass transition temperature, but this is not true for all polymer matrix composites.

Another important aspect considered for this study was that of the DOC and the efficiency of proper curing. Like the work done by Alavi-Soltani et al.[14] , the cure cycle used deviated from that recommended by the manufacturer. The cure cycle also was composed by modifying the final isothermal period of the cure cycle to change the DOC. In both cases, the cure cycles were validated successfully through the use of DSC testing, but in the present study the cure cycle did not quite reach the desired DOC. Even though the temperature of the oven used for curing was thoroughly monitored through the use of thermocouples, the desired DOC and the actual DOC were not always consistent. This suggests that better models need to be made for the cure cycle that will be more efficient and more capable of predicting the DOC of the composite materials.

Although the DOC and the glass transition temperature are important concerns for this study, the main focus is on the stress relaxation behavior of the polymer matrix composites and the individual resin. There has not been much work on the stress relaxation or creep behavior of the individual resin; rather, most researchers have investigated the composite systems in their entirety. When testing the pure epoxy resin in three point bending and in tension, the behavior observed in tension complied with that observed in previous studies, but they did not for three-point bending. In stress relaxation, the relaxation modulus is synonymous with the material's stiffness. Also, the DOC of the polymer is associated with the chain linking within the structure. As the DOC is increased, more chain links between the individual monomers develop, increasing its stiffness. For this reason, the relaxation modulus of the material is expected to decrease as DOC is increased. A limitation in this study that should be noted is that the normalized relaxation modulus does not relax to zero in most cases. Therefore it is possible that sufficient relaxation was not observed in the case of the composites at higher degrees of cure.

In the case of the epoxy resin, the flexural stress relaxation behavior of the material did not wholly comply with this expectation. The material was observed to relax more at 60% DOC than it did at 47% DOC, and this was observed through the entire time scale of testing. This would imply that the material is stiffer at 47% DOC than it is at 60% DOC, which cannot be true. This idea completely contradicts what was previously observed in previous literature, making one speculate that it may be a behavior associated with the particular resin tested. Conversely, the tensile stress relaxation results measured in this investigation upon the same resin does comply with that previously observed. Hence, the behavior observed in the flexural results cannot be contributed to the natural tendency of the epoxy resin tested, or else it would have been observed in tension.

The discrepancy between the flexural and tensile stress relaxation behavior observed is believed to be due to the heterogeneous state of stress of the three point bending apparatus. As previously stated, there are three stress contributions within three point bending: tensile, compressive, and shear. These stress contributions compete with one another for dominance, and it is difficult to depict which is more dominant than the others. Therefore, as shown in the flexural results, three point bending is not always the most appropriate testing method. Also, because the flexural relaxation behavior deviated only for the lower degrees of cure tested and not the higher two, it is believed there is not a single dominant stress. The stress that was dominant in the testing for 67% DOC was not the same stress that was dominant

for 47% DOC. This suggests that pure epoxy resin's ability to resist shear, tension, and compression varies as the DOC changes. Hence, it seems advisable to use a testing apparatus that creates a simple (homogenous) state of stress to conduct a study of this nature. In order to successfully do that, researchers must overcome the problem of slippage, which this study was unable to do.

It should also be noted that the samples in this studies were small in size, and thus the behavior observed in this studied would best characterize a small-scale case. When the fiber pattern is significantly larger with respect to the size of the sample, the state of stress experienced by the sample compared with that to which it is initially subjected to may vary. This possibility does not occur in the sample sizes, such as the ones used in this study, and therefore the results in this study are not best to characterize large-scale behavior. Hence, the results from this study would be best to describe the behavior of a small unit cube of a material at a given point, rather than the entire material in unity.

Interestingly, although the carbon fiber reinforced composites were tested with a three point bending apparatus, the same trend was not seen across all cases. The flexural stress relaxation of the 5320-8HS behaved in an expected manner, but the unidirectional tape did not. Also, the discrepancy within the pure epoxy resin occurred at the lower degrees of cure, whereas it occurred at the high degrees of cure for the unidirectional tape. Even with the reinforcement of the fibers, the heterogeneous nature of the three point bending apparatus disrupts consistent results. It is believed this occurred within the unidirectional tape and not within the 8HS because the 8HS is more balanced. In unidirectional tape, all the fibers are woven in the same direction; the weave of 8HS is more complex. In 8HS the fill thread floats over seven warp threads, and then under one warp thread. Therefore, the 8HS is a more balanced weave pattern than UD, and it is better at distributing the stress relaxation developed within the resin.

The more balanced weave pattern and its greater ability to distribute the stresses developed in the matrix throughout the fibers can be attributed to the reason why 5320-8HS relaxed more than 5320 UDEO. In all cases where the flexural stress relaxation behavior of the composites were compared to one another, the 5320 UDEO was observed to relax significantly less than 5320-8HS. Because all the fibers in the weave of 5320 UDEO are in a single direction, it has maximum strength and stiffness in the [0°] direction. This maximization of stiffness is the reason why the unidirectional tape improved the stress relaxation behavior of the resin. In fact, this same link between fiber orientation and creep/stress relaxation behavior was observed by Rees et al. [20] who studied the creep behavior of carbon fiber epoxy composites.
As shown by Goertzen and Kessler, [18] stress relaxation/creep behavior can be used to postulate the lifetime of a polymer matrix composite. Hence, from the measured results in all cases 5320 UDEO prepared in the [0°] direction will have a longer lifetime than 5320-8HS prepared in [+-90°] or [+-45°] direction at constant strain/strain levels. This is an important matter for a designer to consider when choosing a material that will be exposed to constant stress/strain levels. Ultimately, although the main focus of the fibers within a polymer matrix composite is to reinforce the matrix, and help resist/distribute the stresses built within it, it does not always accomplish this goal. Both the weave patterns and the fiber directions must be considered because, depending on these components, the fibers may help, hurt, or not even affect the viscoelastic behavior of the matrix.

The complications seen with the shifted factors obtained in the present study and the predictions of the William Flerry Equation were consistent

with previous studies. The equation can be used to find shifted factors under the glass transition temperature, as long as the reference is also under the glass transition temperature. However, when trying to do this comparison with the shifted factors obtained in the study, there was no direct match observed. According to Brinson and Brinson[25] the equation best characterizes the time-temperature-superposition behaviors of polymers above the glass transition temperature and may have some inconsistencies below it. Hence, the William Flerry Equation is not always the best method to use for determining shifted factors necessary to use the principle of time-temperature-superposition for polymers.

Conclusion

In this study the relationship between stress relaxation behavior and fiber architecture within polymer matrix composites was investigated. Two weave patterns, 8HS and UD, and three different fiber orientations were used along with an epoxy resin for the matrix. Relaxation mastercurves were created by enforcing the time temperature superposition principle and calculating shifted factors manually or graphically. Also, the stress relaxation behavior of the pure resin was measured and compared with that of composite systems whose matrices were composed of the same resin. In order to ensure consistency of results, the materials were cured to several different degrees of cure then tested under similar conditions. Also, the glass transition temperature was measured for the materials, so that it could be slightly surpassed in stress relaxation testing. It was found that three point bending is not the most ideal testing apparatus because it may produce unrealistic results. Also the stress relaxation behavior is dependent on both the weave pattern and the fiber orientation. The fibers may decrease, increase or not affect the material's ability to relax over time, depending on the two factors.

When using carbon fiber reinforced epoxy composites for structural support there are several options to choose from. The results from this study suggest that the most important factor to consider is how many fibers are in the 0°/load direction, especially if the material will be exposed to constant stress/strain levels. For high mechanical strength and durability it is best to use composites with the most amount of fibers in the load direction. However, the biggest risk of having too many fibers in a single direction is the lack of flexibility. Hence, the fiber architecture of polymer matrix composites is important because it influences both mechanical and viscoelastic properties. Therefore, it is essential that designers are careful in their selection of such composites for structural applications.

For future work it is recommended that testing be done with either tension or compression to produce optimal results. Also the experimental data obtained is this study can be used to create mathematical models, which could predict the stress relaxation behavior of a composite. The model would include glass transition temperature, DOC, matrix type, weave pattern and fiber direction. Thus, instead of having to run several tests the results could be found more conveniently.

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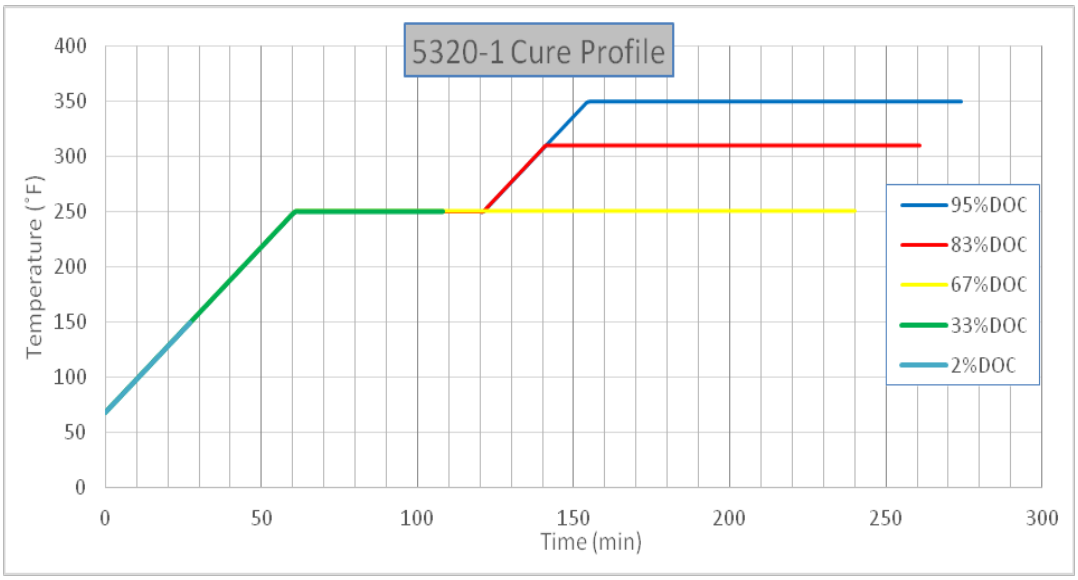
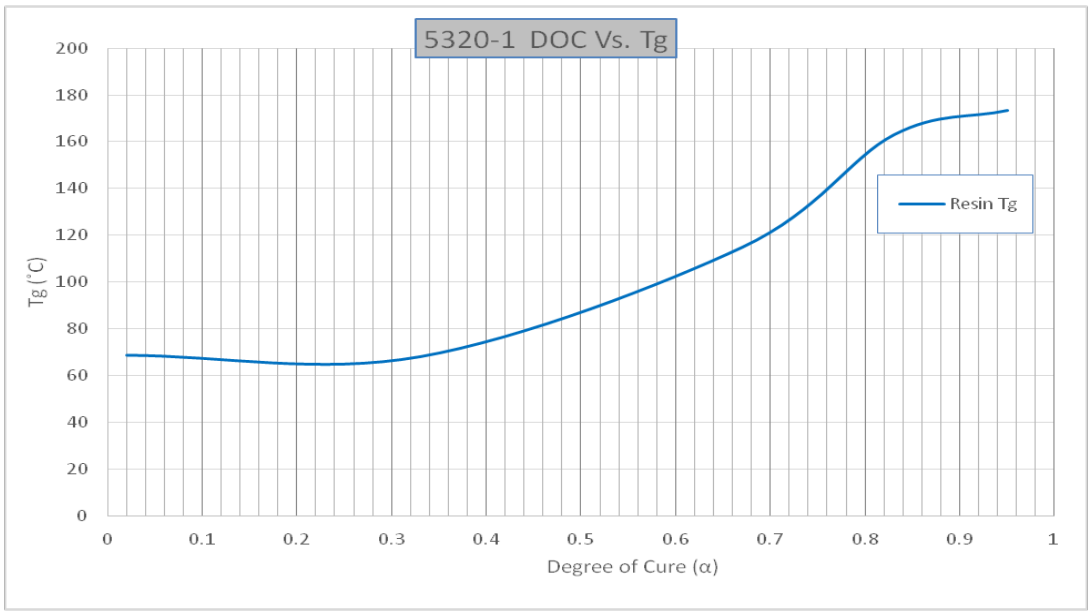
Appendix A



This graph shows the cure profile for 5320-1 epoxy resin that was used to cure it to various degress of cure.

Appendix B



This shows a graphical representation of how the glass transition temperature of 5320-1 epoxy resin chnages with DOC.

Appendix C

5320-1 Epoxy Resin Tg Comparison	
α (%)	Tg (˚C)
0.5	91.65
0.67	114.98
0.83	162.89
0.95	173.28

This shows a tabular representation of how the glass transition temperature of 5320-1 epoxy resin at vatious degrees of cure.

Appendix D

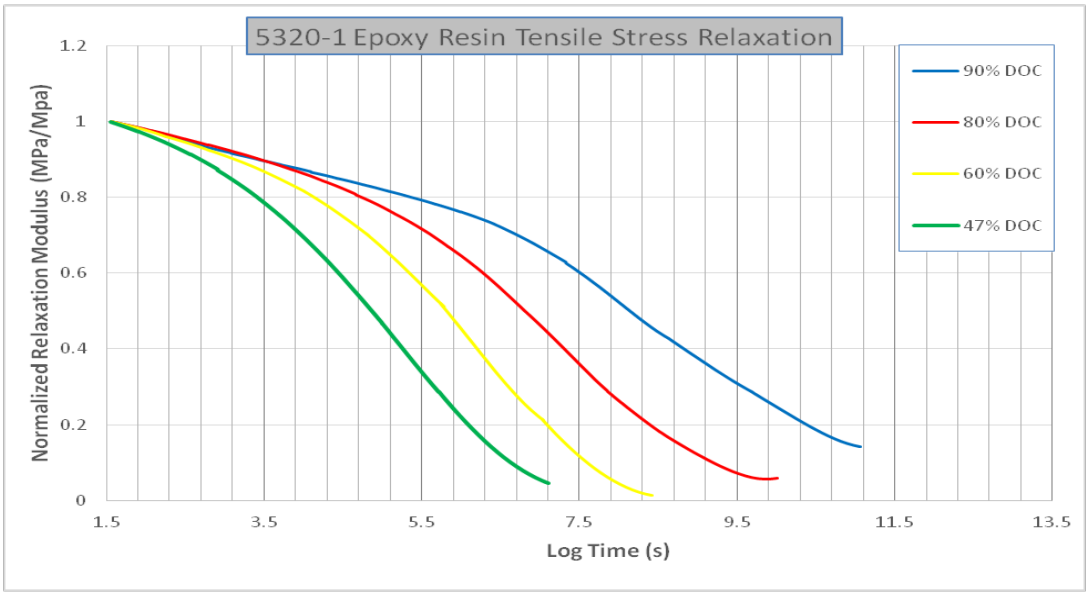
Degree of Cure Correction					
Desired DOC (%)	0	50	67	83	95
Heat of Reaction (J/g)	503.0	269.4	204.5	103.6	51.15
Ultimate Heat (J/g)	503.0	503.0	503.0	503.0	503.0
Acutal DOC (%)	0	46.44135	59.34394	79.40358	89.83101

This table shows the exspected degree of cure from the cure porfile and the corrected degreee of cure values that were found experiemntally using a diffiercial scanning caliorimetry.

Appendix E

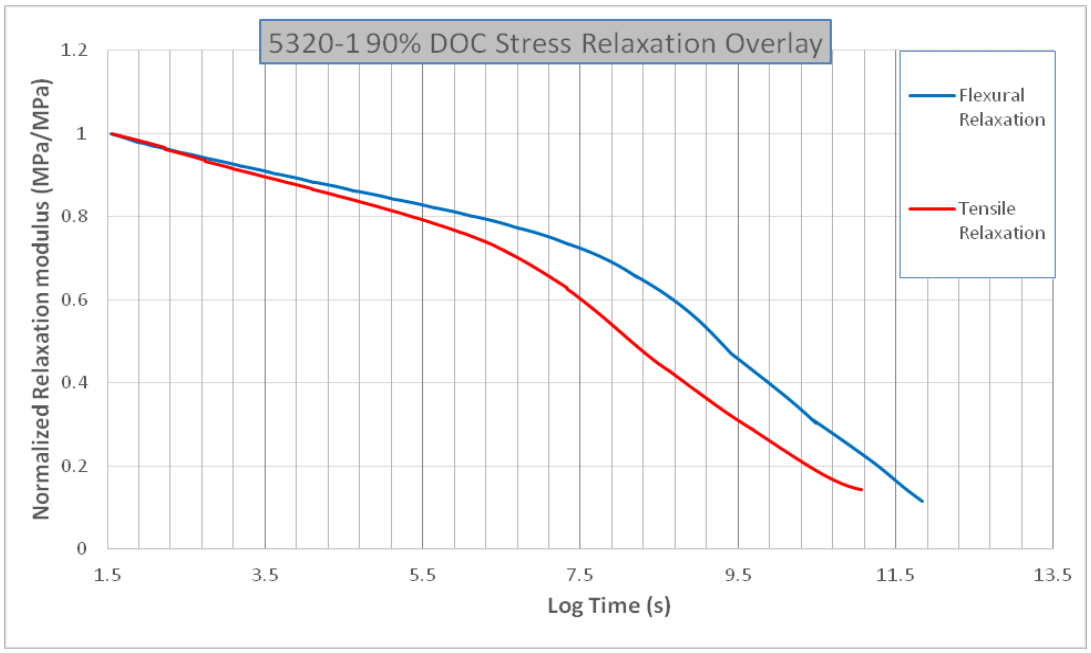
This graph shows the normalized flexural stress relaxation mastercurves of 5320-1 epoxy resin across various degrees of cure.

Appendix F



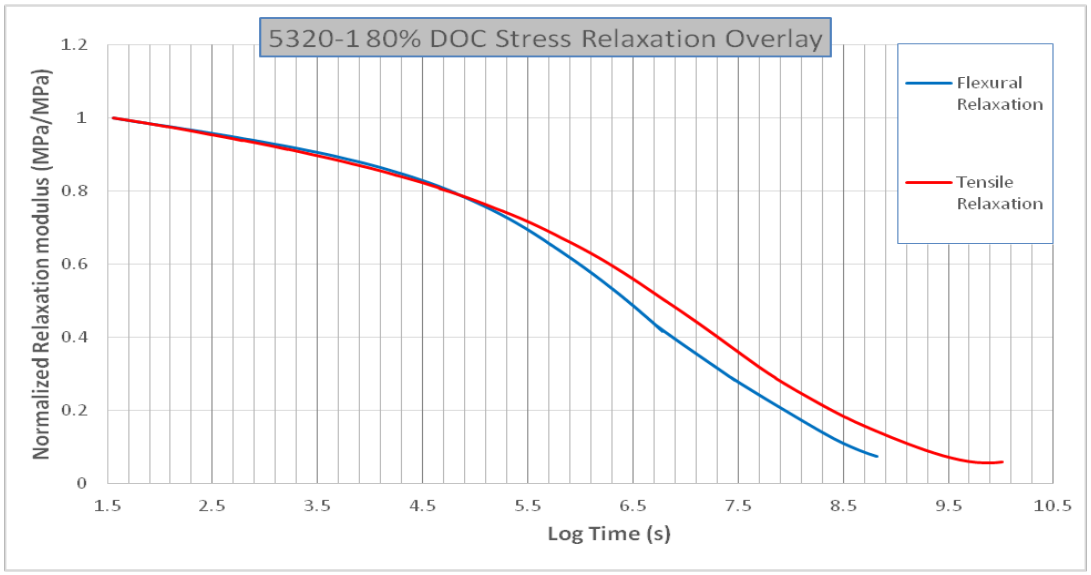
This graph shows the normalized tensile stress relaxation master curves of 5320-1 epoxy resin across various degrees of cure.

Appendix G



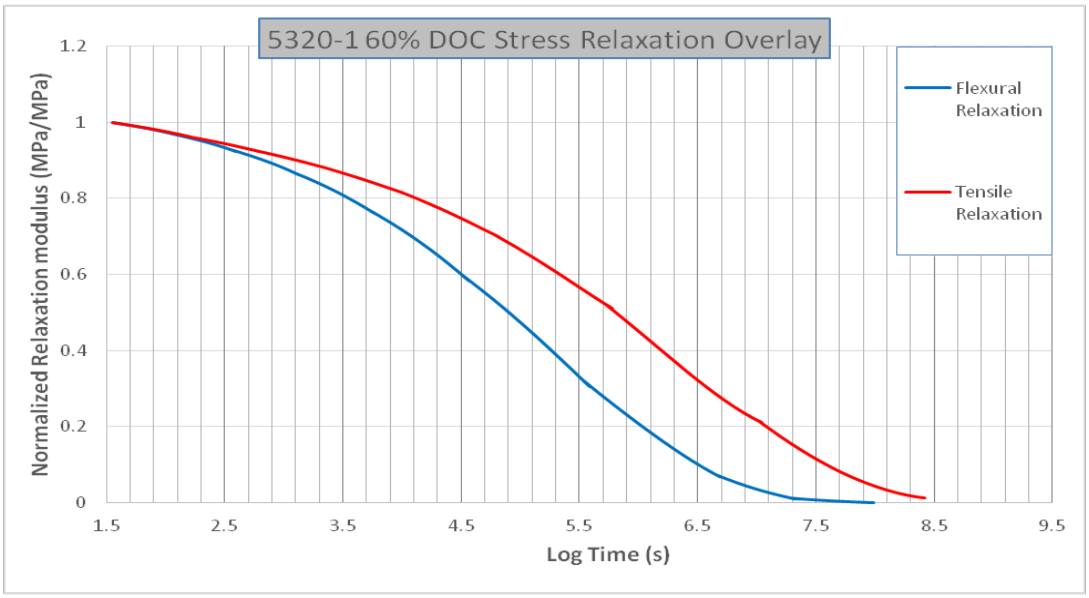
This graph shows the comparison of tensile and flexural stress relaxation mastercureves at 90% degree of cure.

Appendix H



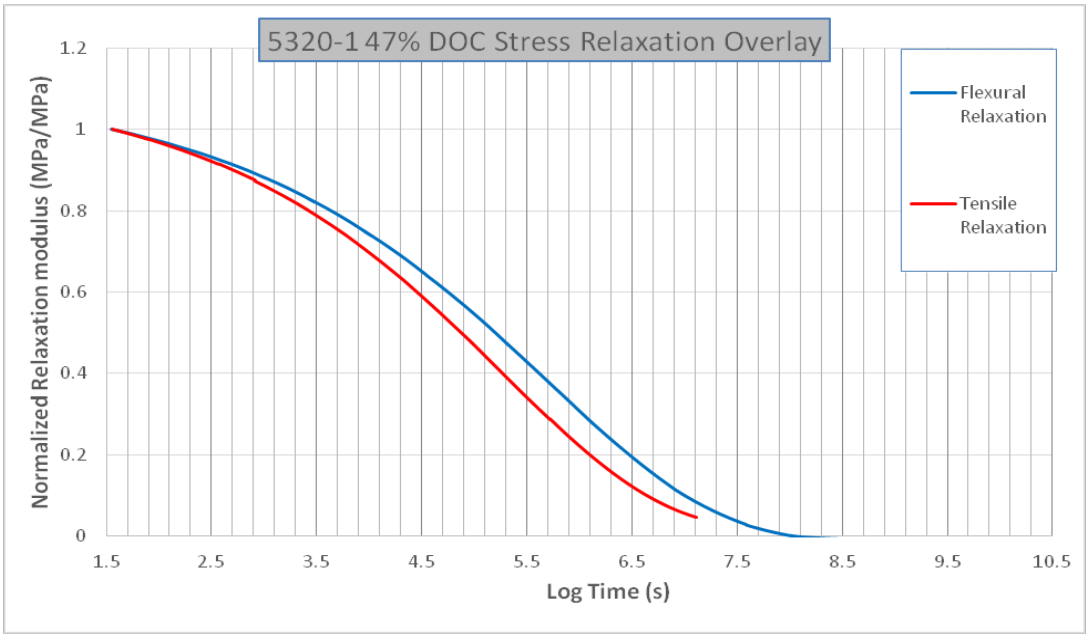
This graph shows the comparison of tensile and flexural stress relaxation mastercureves at 80% degree of cure.

Appendix I



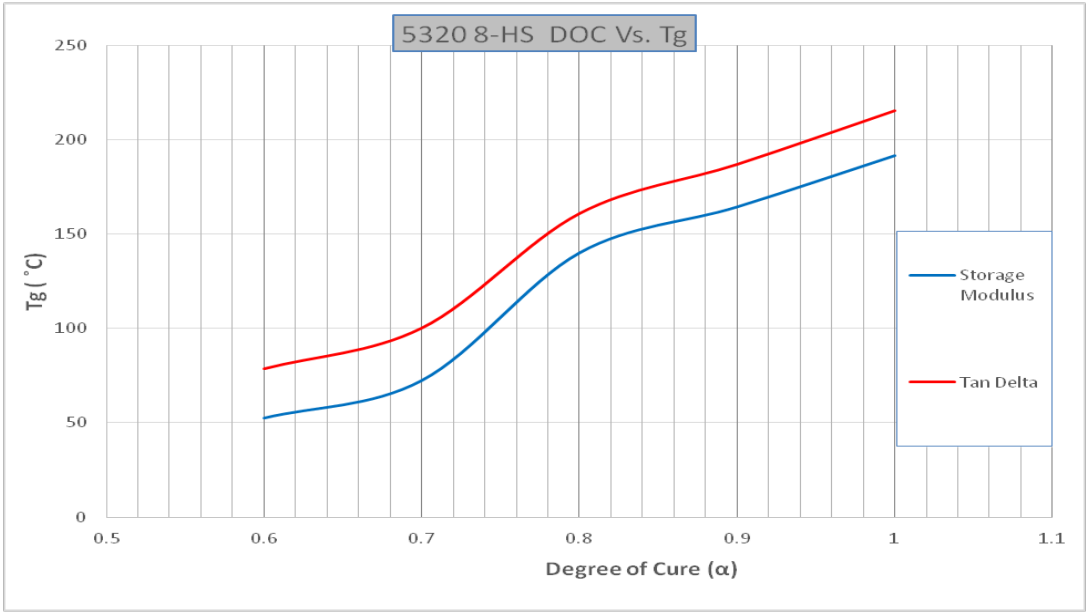
This graph shows the comparison of tensile and flexural stress relaxation mastercureves at 60% degree of cure.

Appendix J



This graph shows the comparison of tensile and flexural stress relaxation mastercureves at 47% degree of cure.

Appendix K



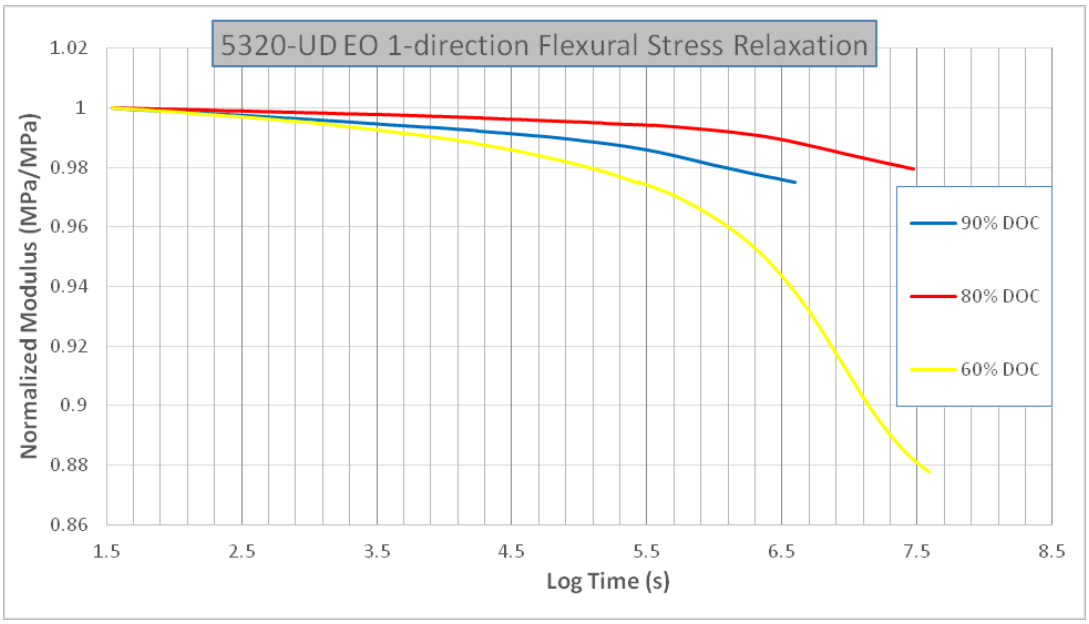
This gives a graphical representation of how experimental measurements of the glass transition temperarure for 5320-8HS vaies across degrees of cure using a method based of the stoage modlus and a method based of the tan delta.

Appendix L

5320-8HS Tg Comparison		
DOC (α)	Storage Modulus Tg (°C)	Tan Delta Tg (°C)
0.9	164.34	187.03
0.8	140.05	160.96
0.6	52.72	78.6

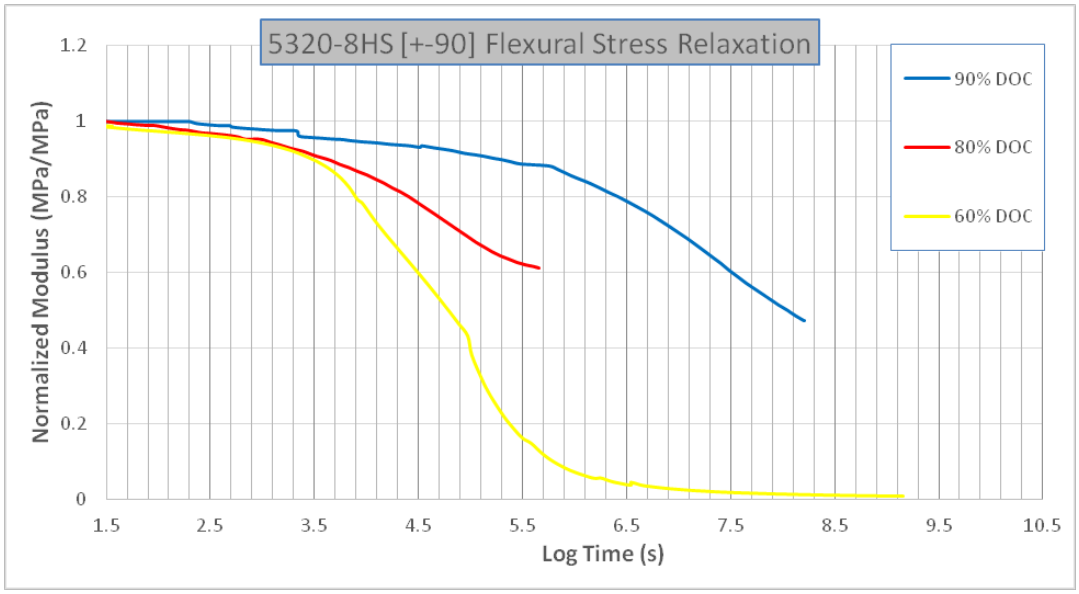
This gives a tabular representation of how experimental measurements of the glass transition temperarure for 5320-8HS vaies across degrees of cure using a method based of the stoage modlus and a method based of the tan delta.

Appendix M



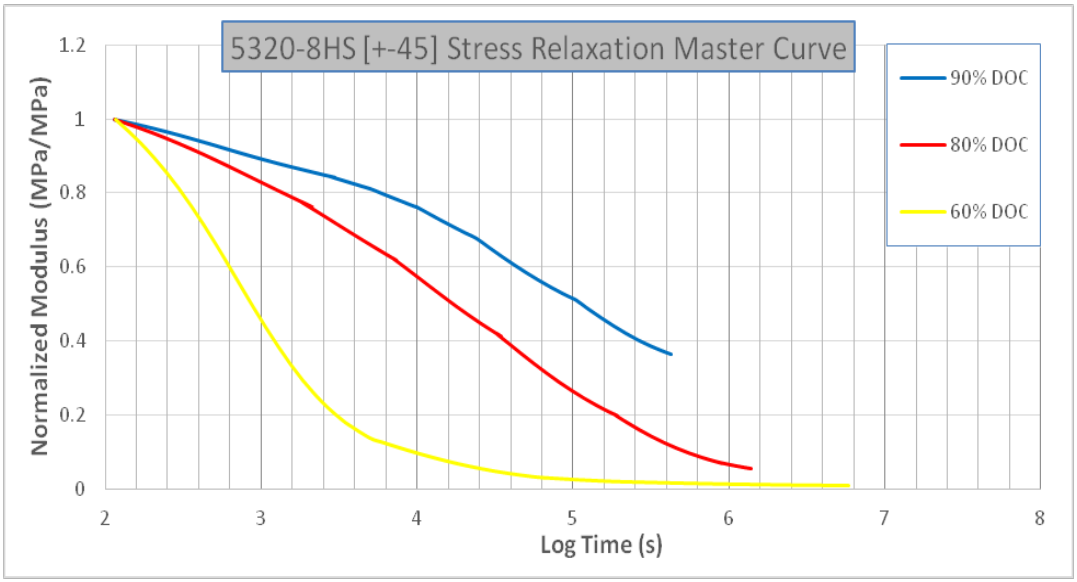
This graph shows the flexural stress relaxation mastercurves of 5320 UDEO composite in prepared in the 0° direction across various degrees of cure.

Appendix N



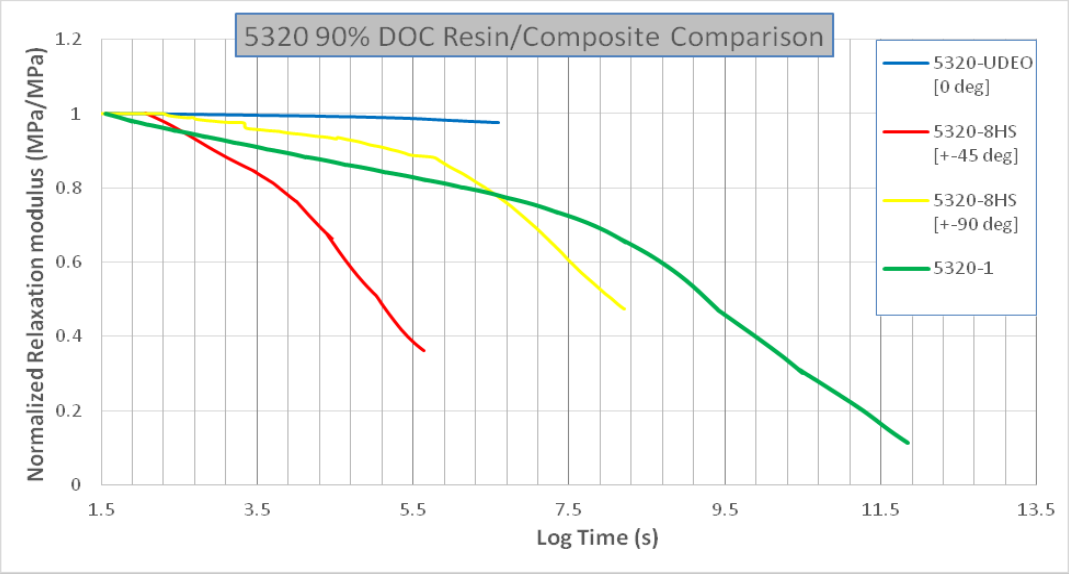
This graph shows the flexural stress relaxation mastercurves of 5320-8HS composite in prepared in the [+-90˚] direction across various degrees of cure.

Appendix O



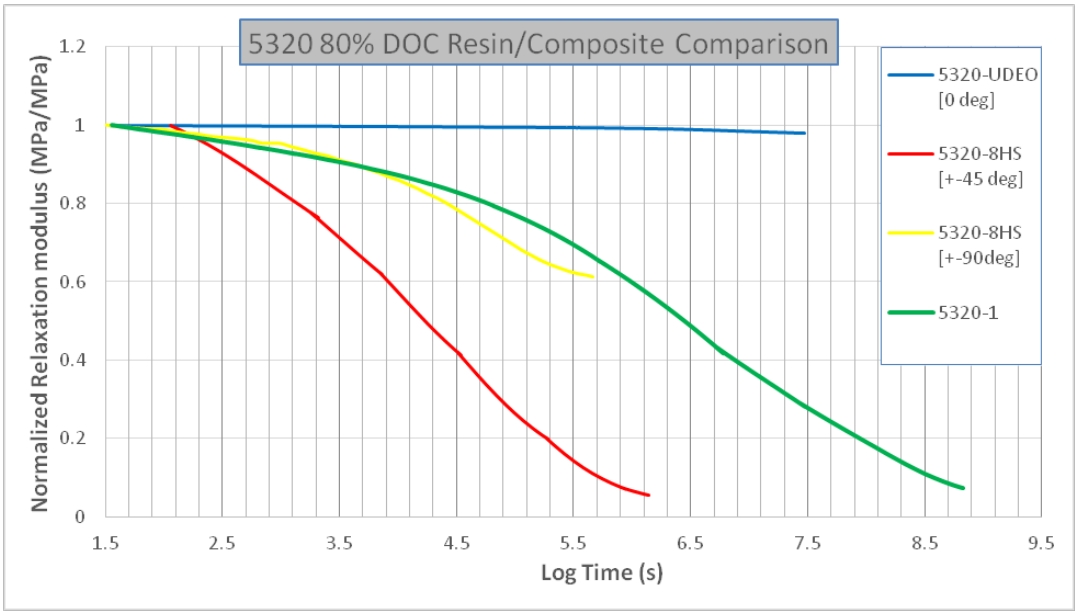
This graph shows the flexural stress relaxation mastercurves of 5320-8HS composite in prepared in the [+-45˚] direction across various degrees of cure.

Appendix P



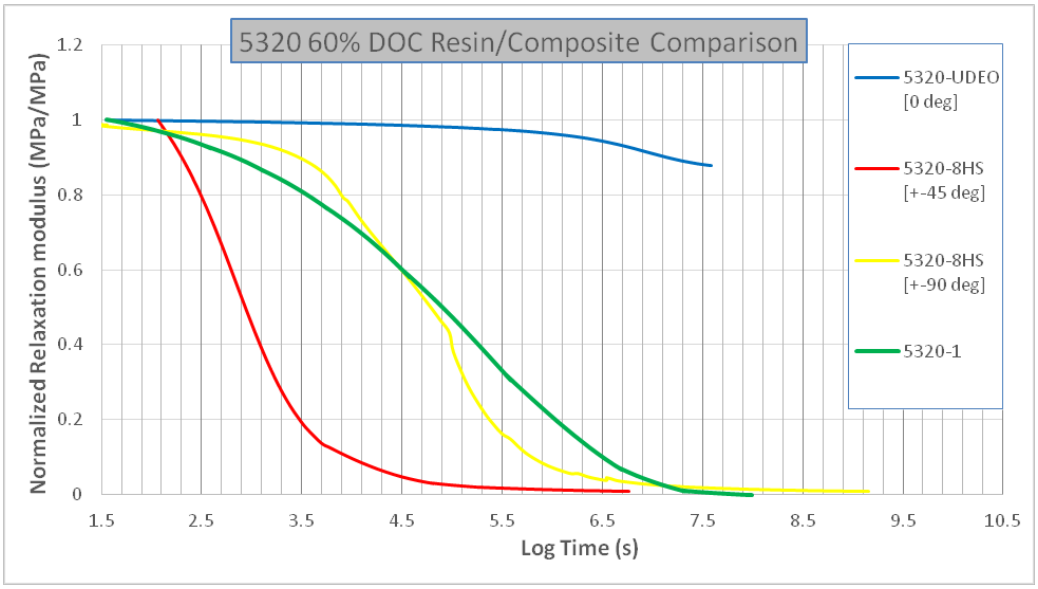
This graphs shows the comparison of flexural stress relaxation mastercurves between 5320-1 epoxy resin and 5320-UDEO and 5320-8HS carbon fiber reinfirced composites 90% Degree of Cure.

Appendix Q



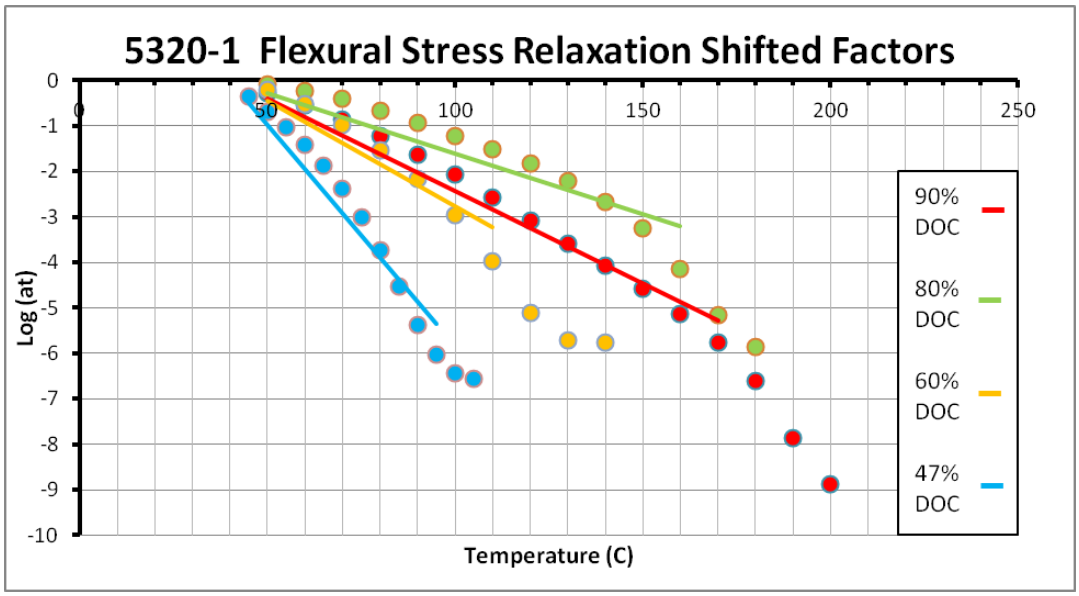
This graph shows the comparison of flexural stress relaxation mastercurves between 5320-1 epoxy resin and 5320-UDEO and 5320-8HS carbon fiber reinfirced composites 80% Degree of Cure.

Appendix R



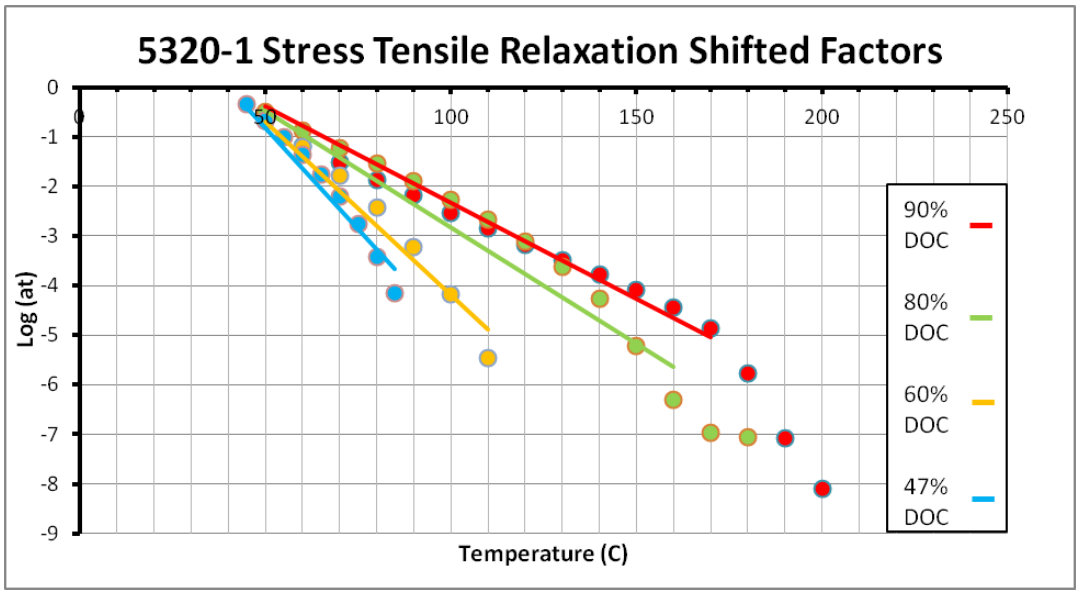
This graph shows the comparison of flexural stress relaxation mastercurves between 5320-1 epocy resin and 5320-UDEO and 5320-8HS carbon fiber reinfirced composites 60% Degree of Cure.

Appendix S



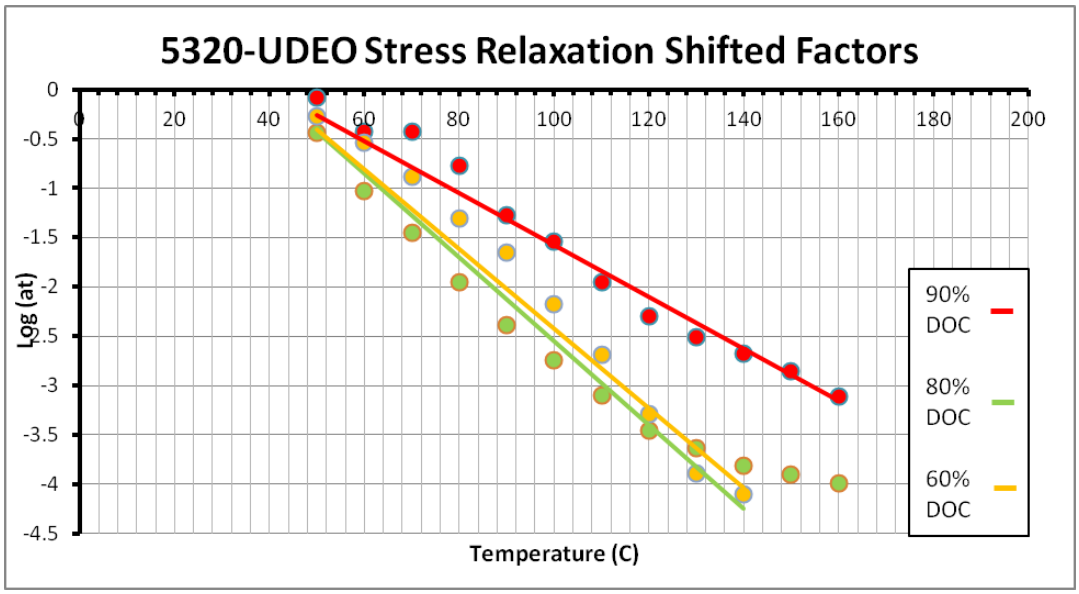
This graph shows how well the William Ferry's Equation fits the experimentally calculated shifted factors used to construct the flexural relaxation mastercureves for 5320-1 epoxy resin.

Appendix T



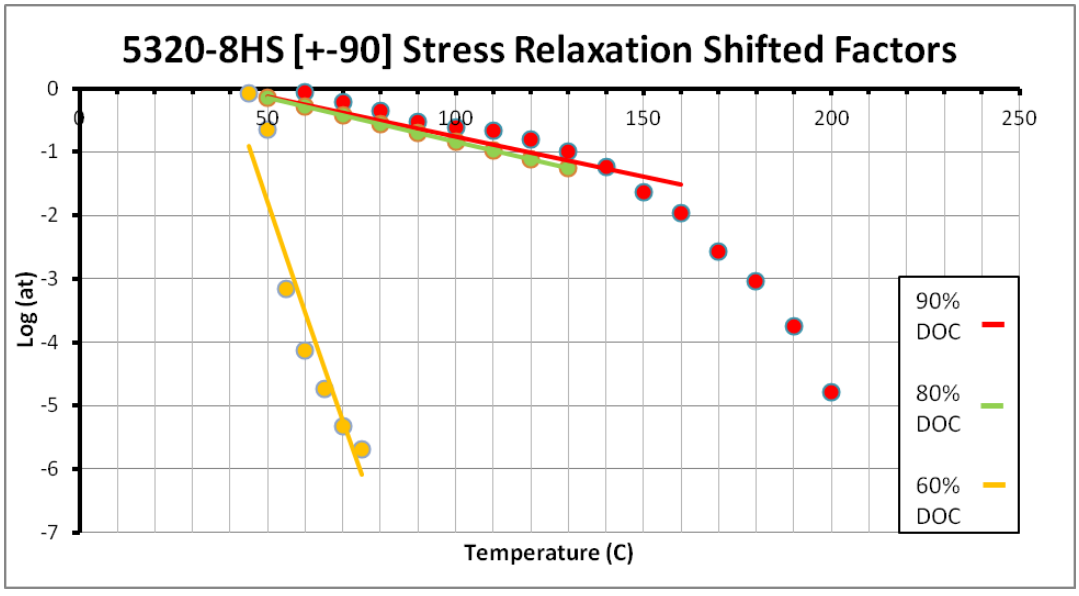
This graph shows how well the William Ferry's Equation fits the experimentally calculated shifted factors used to construct the tensile relaxation mastercureves for 5320-1 epoxy resin.

Appendix U

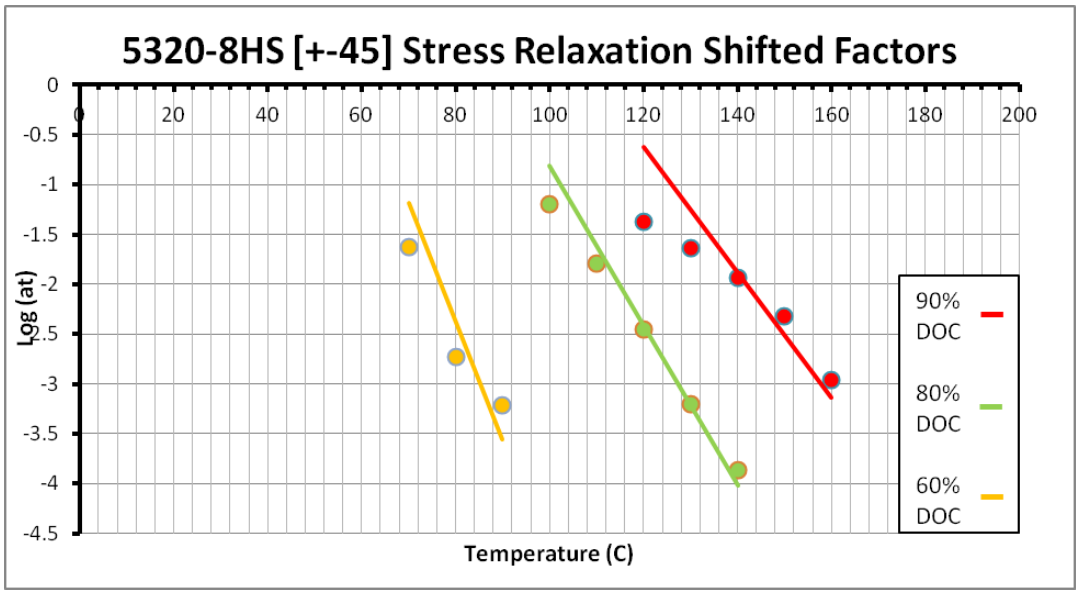


This graph shows how well the William Ferry's Equation fits the experimentally calculated shifted factors used to construct the flexural relaxation mastercureves for 5320-UDEO composite prepared in [0˚] direction

Appendix V



This graph shows how well the William Ferry's Equation fits the experimentally calculated shifted factors used to construct the flexural relaxation mastercureves for 5320-8HS composite prepared in [+-90˚] direction.



This graph shows how well the William Ferry's Equation fits the experimentally calculated shifted factors used to construct the flexural relaxation mastercureves for 5320-8HS composite prepared in [+-45˚] direction.

Appendix W

Material	Testing Method		DOC	Slope	y-Intercept
5320-1	Tension		0.9	-0.0387	1.5446
			0.8	-0.0469	1.8724
			0.6	-0.0696	2.7837
			0.47	-0.0816	3.2620
	Three Point Bending		0.9	-0.0405	1.6214
			0.8	-0.0267	1.0691
			0.6	-0.0459	1.8377
			0.47	-0.0972	3.8889
5320 UDEO [0°]	Three Point Bending		0.9	-0.0263	1.0533
			0.8	-0.0403	1.6138
			0.6	-0.0424	1.6967
5320 8HS [+-90°]	Three Point Bending		0.9	-0.0127	0.5071
			0.8	-0.0139	0.5578
			0.6	-0.1730	6.8615
5320 8HS [+-45°]	Three Point Bending		0.9	-0.0627	6.8991
			0.8	-0.0804	7.2372
			0.6	-0.1186	7.1136

This shows a tabular representation of the equation of the linear fit lines of the shifted factors created using the William Ferry's equation.

A Lost History: A Digital Ethnography of the Historic Dunbar Theatre

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Natalie S. Grant, Ed.D
Social Work, Wichita State University

Abstract

This research explores sense of place and generational values of an African American cohort from Wichita, Kansas. The cohort attended the Historic Dunbar Theatre following its opening in 1941 and through its 22-year operational period. Participants shared memories and feelings about their experiences in the community at the only fully integrated movie theatre during legalized segregation in Wichita. Utilizing digital storytelling as a qualitative method, researchers employed narrative inquiry and semi-structured interviews to elicit individually lived experiences and memories in the community from the cohort. Results indicated a strong sense of place among participants, reinforced by a sense of belongingness and generational values that emphasize the importance of community and human relationships. Implications for the use of digital stories in the community as a means to achieve social justice are explored. Digital storytelling is an emerging method of qualitative research, and this study elucidates how social workers and other community-based disciplines can engage African American communities to bring about a more Afrocentric perspective of their community's history. This study engages in critical reflection of those events with the added benefit of preserving oral history that might otherwise be lost for future generations.

Introduction

Stories of human experiences are a fundamental aspect of life and have historically shaped relationships, defined culture, and created history. Humans have shared experiences through generations as myths, legends, and fables, as well as tales, jokes, and historical reports. Storytelling is an opportunity to weave common threads of information that build mutual understanding regardless of location, generation, or experiences of individuals and groups (Vannini, 2009). The lived history of a group or community provides insight to variations and similarities of interpretations of shared experiences (Jackson, 1998; Denzin, 2000). Additionally, narratives of history and experiences illuminate personal and emotional connections and separations of the group as well as shared values. A group's history reinforces belongingness within a community, or a sense of place, and uncovers existing generational values that are passed on over time (Hay, 1988; Bird, 2002).

This research utilizes a multicultural ethnographic framework to gather oral narratives and interpret the lived history of a group of African American people. The cohort selected shared collective experiences at a historic theater before the Civil Rights Movement of the 1960s. Their lived history has not previously been documented in detail, and while urban renewal and historic theater restoration is at the forefront of many communities in America, this community's voice has historically been silenced through oppression and marginalization. The multicultural ethnographic framework, as defined by Congress and Gonzales (2005), is relevant because it not only values lived experiences but also stresses the imperative nature of the participant becoming a cultural guide while the researcher or clinician assumes the role of learner. This framework seeks to empower participants, and thus the community, by shifting the power balance from the researcher being "all knowing" to the participant being the expert.

In order to hear the voices within the community, the researchers utilized narrative inquiry and documented personal stories through in-depth interviewing. Additionally, archival document review provided information on Black history in the community and supplemented existing documentation. The goal of the study was to preserve the undocumented historical knowledge of this community, inform readers of the struggles and positive experiences specific to this community, and utilize the research as a form of social action against oppression and other social injustices.

Historical Background

Kansas. Kansas has a rich cultural and economic history that has been reflected upon as a double-edged product of American experience (Becker, 1966). Although prominently observed and spoken of Eurocentric/Ethnocentric American values of individualism and idealism prevail in the area, intolerance and oppression have also been a common thread (Becker, 1966).

Dating back to the westward expansion of the United States in the nineteenth century, Kansas had been in between hostile pro-slavery and anti-slavery political movements in the mid-1800s and gained admittance to the Union as a free state in 1861. Hawkins (1973) elucidates the conditions under which African American people, termed "Exodusters," migrated to Kansas from southern states largely in the late 1870s to escape the Ku Klux Klan, the White League, and the Jim Crow Laws. Anti-slavery activists such as John Brown and Susan B. Anthony had promoted Kansas as a new Promised Land, and the expansive land was attractive (Hawkins, 1973).

In 1874, Kansas became one of only three states in the union to pass legislation against discrimination based on race, color, or servitude (Van Delinder, 2001; Carmody, 2014). Issues surrounding race relations became apparent primarily through legislation regarding color-line practices, segregated schools, land ownership, and hiring practices. By 1902, Kansas stood at the forefront of controversy when African American parents began a desegregation of schools campaign in Topeka that, after a multigenerational effort, resulted in the historic 1954 Brown v. Board of Education decision (Van Delinder, 2001). The Brown v. Board of Education decision, though highly influential, was not the last significant contribution that came from Kansas. African Americans and their allies in the state continued to make significant contributions toward larger movements for equality in the United States during the Civil Rights movement and into the present.

Wichita. Set against the Arkansas River, Wichita has historically been a junction of activity. Wichita has long been a bi-way on the road between north, south, east and west, and has served as a center for entrepreneurial ventures. Beginning as a point of intersection for Native American trading and buffalo hunting, Wichita was home to multiple tribal groups. Later, as a point on the Chisholm Trail, Wichita was a popular stop for cattle drives between Texas and Kansas.

During the 1870s, the African American population in Wichita was small, about 100 men, women, and children, and they were welcomed and encouraged to participate in activities, economy, and development (Carmody, 2014). However, the "Exodusters," with intentions to move to Wichita, met with great rejection as the local newspaper editor, Marshall Murdock, spread fear that fifty African American people, contaminated with yellow fever, were being shipped to Wichita. After an emergency City Council approved quarantine, fourteen were shipped back to Topeka (Wolfenbarger, 2012). Despite efforts to thwart the migration, African Americans continued to come to Wichita.

Through the growth of Wichita as a city, African Americans experienced a growth in population, businesses, and community. They experienced many things that would later be described as progressive, including the first Black police officer in 1878, an interracial marriage that was reported by the *Eagle Beacon*, and the inclusion of Black Wichitans in church services at the Presbyterian Church (Carmody, 2014). Slowly, segregation crept in. During the twentieth century, Wichita earned recognition as the 'Air Capital of the World' for its aircraft pioneers, funded from oil investors, and established the aircraft industry (Moran's memo: A tradition of aviation excellence, 2012). Post-war growth of the aviation industry created employment opportunities, and Wichita saw its largest shift in the African American population between 1950 and 1970 (Wheeler, 1971). The number of African Americans increased from 8,082 in 1950 to 26,841 in 1970 (Miller, 2005).

These changes in population were reflected in the city's political and social movements. One well-known event of note occurred in 1958 when the first successful lunch-counter sit-in occurred at the Dockum Drug Store in downtown Wichita. In protest of segregated establishments, African American young people sat throughout the day at the lunch counter. After three weeks of protest, the owner agreed to serve black customers, and the Dockum sit-in provided a model for other community protests (Walters, 1996).

McAdams Neighborhood and Dunbar Theatre

In the 1940s, at the height of the golden age of movies, the McAdams Neighborhood also experienced its own cultural height. In 1941, the

African American community erected a movie theater in the McAdams Neighborhood to serve its segregated clients (Grand opening (advertisement), 1941). The theatre was named after the poet Paul Laurence Dunbar, an African American poet and author whose life story and writing inspired many through insight and emotion in reaction to the African American experience.

The name and history of Paul Laurence Dunbar is important to the identification of the Historic Theatre, as well as to African American communities throughout the country. He was the leader of a poetic movement, and his life was evidence that black men possessed great intelligence and communication skills, rejecting long-held stereotypes. While art and poetry are often thought to access a deeper level of consciousness, Dunbar questioned conflicts between traditional thinking and practices as well as religious thought. He communicated his deep awareness of unrecognized potential and unrealized dreams (Bone, 1975).

The Dunbar Theatre hosted second-run movies for African American patrons and served as a hub of community activity until the 1960s. The Civil Rights movement brought forth integration, which changed community activity, as American people were no longer forced to seek refuge from segregated public places. Although the theatre operated for approximately 20 years, the community impact was profound. When the theatre closed, the community cohesion changed.

Since the 1960s, the Dunbar Theatre has largely sat empty and deteriorated. It was placed on the endangered buildings list by the city in 1997 and purchased by the People Organized Working for Economic Recovery Community Development Center (P.O.W.E.R. C.D.C.) from local business Hall Industrial Development, LLC, in 2007 (United States Department of the Interior National Park Service, 2008). The P.O.W.E.R. C.D.C. applied to place the Dunbar Theatre on the Historic Registry and gained approval on July 2, 2008 (United States Department of the Interior National Park Service, 2008). The owners renamed the building the Historic Dunbar Theatre. Fundraising efforts have been devoted to restoration of the theater as a multi-purpose community teaching, learning, and performing center.

The area around the Dunbar Theatre, the McAdams community, has also declined. There are a large number of rental homes and older homes that receive few improvements. The community still shows signs of historical and systemic marginalization with no walking access to resources such as grocery stores, medical care, restaurants, retail establishments, and banks. Gang activity has cycled throughout the years, as well as low and mid-level crimes (theft, burglary, etc.) that have contributed to low community involvement. Job opportunities have decreased, local businesses have failed, and little interest has been raised in new business development.

Despite the seemingly difficult conditions in the McAdams neighborhood, many of the community members have an entrenched history with the community. Relationships have continued in community decision making, black arts development, community events, rallying around sports, barbershops, and food sharing. Children have attended schools in the area, large numbers of community members attend one of the multiple churches, and they have held on to their history and their stories; though, they have had little opportunity for sharing.

Theoretical Framework

Ethnography. Ethnography is the study and recording of human culture and race, and it is an opportunity to document the lived experiences of

people through research while building community through sharing attachments to spaces, places, race/ethnicity. It draws from the roots of anthropology. Ethnographic research utilizes a cultural framework and seeks to find meaning in the constructions of life as shared by participants (Rogers, 2014).

There are multiple reasons to utilize ethnography to understand the lived experiences of a group of people. Hopps, Pinderhughes, and Lowe (2007) suggest, "By following their personal experiences, the prism of race (or race consciousness) is one way that many might learn how to interpret their daily lives" (p. 228). This interpretation or understanding of daily lives and individual lived experiences provides an opportunity to build greater connection across and among homogenous and diverse groups. Additionally, this type of research does not allow participants to be discounted due to subjectivity and does not support power and control mechanisms in terms of determining who is right, wrong, accurate, or meaningful (Clark, 2003; Jordan, 1991).

The experiences of the cohort in this research, like most other communities, are individual and specific to the time in which they lived and the laws, practices, beliefs and values of the time. Burton (1997) asserts that, "Ethnography is the 'most important method' for elucidating phenomena that other approaches typically cannot," and claims it is the most effective form of explaining and interpreting human experiences using an individual's own language and communication (p. 214). The use of ethnography is ideal for obtaining a full, raw experience from cohorts that will aid in the understanding of their lived experiences.

Multicultural Ethnographic Theory.
Contemporary research with diverse groups requires researchers and practitioners to reject historical and current assumptions that people are all the same (Clark, 2003; Kadushin, 1990). This has been an element of institutional racism that supports Eurocentric/Ethnocentric mindsets and rejects difference, while also reducing the perceived need of cultural competency, especially in settings where multicultural or cross-racial relations may elicit researcher or clinician bias. The Multicultural Ethnographic Theory provides a framework whereby researchers and clinicians can view the participants or clients as experts in their own lives and develop mutual trust as the participant or client shares their experiences (Congress & Gonzalez, 2005; Green, 1998; Leigh, 2001). Additionally, multicultural ethnography is sensitive to power, control, prejudice, and oppression, and how experiences shape perceptions and feelings, especially when trauma is involved within a community for an individual (Keefe, 1979). Utilizing this framework allows researchers and clinicians to build understanding, knowledge, and cultural competency through the sharing process.

The human experience is valued in the social sciences and history. This theoretical framework emphasizes the participants' culture and experiences as the primary frame of reference, with other frames including the academic study of cultural history, local document review, and literature review on the diverse group traits and issues (LaFromboise & Foster, 1991; Sue & Zane, 1987; Clark, 2003). This allows the researchers to deepen their understanding of the system being studied, as well as record individuals' voices and experiences. This framework contributes to the goal of exploring the complexities of those lived experiences and is suited for multiculturalism as it is geared for diverse viewpoints, individualized assumptions, meaning making, and multiple voices (Clark, 2003).

Oral Narratives

Sense of Place. The study of sense of place helps researchers understand how subjects attach to and draw meaning or satisfaction from a physical setting or social construct (Stedman, 2003). In an attempt to understand sense of place in relation to the varying generations, we look to Shenk (2000) and research completed on aging African American women to understand how younger generations are perceived by their older counterparts.

Sense of place, especially place attachment to a physical setting, may be a nearly universal feeling to which most can easily relate. The most easily relatable example of this is to ask participants to identify where their home is. The concept of home and the associated attachments, meanings, and satisfaction from that physical setting or social construction is one's sense of place.

Generational Values. In ethnographic research, this concept is often referred to as the passing of generational values, whereas the sharing of a generation's history is passed to the next generation in a way that influences their community and helps younger generations develop a sense of place (Bird, 2002).

Methods

This research used qualitative methodology in order to produce narrative findings. The research procedures were formulated in advance and adhered to during data collection. The goal of the research was to gather personal narratives of the interpretations of individuals who experienced the Historic Dunbar Theatre between 1941 and 1963. The hope was to better understand and communicate the sense of place and generational values associated with this historic theatre before, during, and after the Civil Rights Movement.

Archival Document Review. The owners of the Historic Dunbar Theatre contracted with a Wichita-based design company, a planning and research company, and an engineering consulting firm in 2006 to develop a feasibility study that would project the plans to restore the theatre and transform it into a community-based teaching, learning, and performance center. This team produced a 78-page document outlining restoration plans and a market analysis. The document review process began with a thorough evaluation, which led to the outline of documents relevant and of interest to the study. The feasibility study recommended applying for the Dunbar Theatre's acceptance to the National Register of Historic Places.

This study obtained other data via the Dunbar Executive Director's personal archive. He maintained a collection of newspaper clipping and stories that provided a frame of reference of searching other newspapers. The *Wichita Eagle*, historically the *Daily Eagle* and *Eagle Beacon*, rendered no useable documents or stories about the Dunbar Theatre community. Wichita State University's library also served as a resource for the research. The study utilized online database searches and received resources and assistance from the Special Collections department of WSU's Ablah Library.

Archival searches showed that the *Negro Star* was available online in PDF format through the Wichita State University library. The Kansas State Historical Society holds one of the only sets of the newspaper on microfilm and strict limitations existed for time spent with the film; the researcher was able to rely on the PDF documents uploaded to NewsBank.com.

The *Negro Star* newspaper proved to be the best source. It provided a weekly development of the theatre's happenings from the day it opened until the mid-1950s. At one point, the theatre removed advertising shows and seemed to disappear from

the newspaper. This newspaper also provided a glimpse into community activities during the time period and provided a means to build rapport with the interviewees leading up to each of their interviews.

Ethnography. This allows the researchers to access the "lived experiences" of participants and utilize their responses as a "way of knowing" that assumes their knowledge holds meaning and exists within the context of their personal experiences with the Dunbar.

Oral Narratives. For this study, the researchers sought to gather personal accounts, memories, and stories about the Dunbar Theatre and the community. Questions were developed prior to the interview sessions in order to guide the interviews and glean feelings and memories associated with the historic theatre experiences. A total of 14 open-ended questions were ordered to gather relevant demographic information, memories of the theatre, events attended, feelings regarding the space and life during this time, memories of the impact of Civil Rights, and feelings regarding the current revitalization efforts.

All participants were instructed to answer only the questions they felt comfortable with, and participation was voluntary. Each adult participant provided written consent to the recording of video and audio, the process of the research, and the potential uses for the study and findings.

Thematic Analysis. Thematic analysis provides an opportunity to understand the commonalities and identify living and/or behavioral patterns. Gubrium and Turner (2011) explore thematic analysis in digital storytelling including incorporating traditional transcription and coding views as well as utilizing intertextual methods. Gubrium and Turner (2011) acknowledge that digital storytelling in research practice is still a young methodology, and that further developments are needed to strengthen the various methodologies.

Researchers listen purposefully for meaning throughout the process, and the listening supports the self-awareness and the reflexive work of the researchers. Ethnography and helping practitioners, known for the practice of listening for meaning in order to understand through feelings, words, actions, culture, and language, find that the process of analysis becomes a road of discovery (Green, 1995; Perlman, 1979). Along this road of discovery, the researchers consistently identify their own reactions to the interviews to ensure reflexivity within the research process. Ultimately, there is a translation of sorts that occurs and, by engaging in multiple roles (researcher, learner, reflexive participant), the researcher is more equipped to provide this translation.

Research Design and Quality

Participant Selection. As with the qualitative research tradition, the researchers were able to gather data from participants who have remained connected to the community and the P.O.W.E.R. C.D.C. organization. This access targets a smaller subgroup of the community but upholds the clear connection between the participants and the aim of the research. The participants chosen were identified through opportunistic measures (Saunders, 2012). This is a snowball sampling, where participants volunteer to participate and self-select based on their own interest in sharing their stories of the Dunbar history and the community. Researchers contacted participants, and then as they completed their interviews, they often suggested reaching out to another person whom they knew and identified as a person who might show interest.

The Dunbar Theatre, owned by a non-profit entity headed by Executive Director James Arbertha, Sr., provided a list and contact information for ten potential participants. All participants were agreed upon by the research team based on their proximity to the researchers, residing in the metropolitan Wichita, Kansas area, and all being of sound body and mind. Mr. Arbertha, Sr. identified all participants as having previously recalled an account involving the theatre. The researcher made three attempts to contact each participant, with four responding and attending an interview session. Each participant ranged in age from their thirties to 65 years old. Some parties elected not to disclose their exact age.

Informed Consent. Informed consent (Appendix A) was provided to participants in large font typeface, and each participant was advised of their options of disclosure, voluntary withdrawal from the study, potential impact of feelings related to sharing personal stories, and asked if they had any questions or concerns regarding the interviews. Each participant opted to participate voluntarily and was very energetic in their communications. The researcher obtained a signature from each participant and confirmed understanding of the informed consent.

Interviews. Researchers developed the questions for participant interview questions through the ethnographic-multicultural theoretical framework and addressed contextual and cultural dimensions of those who experienced the Dunbar Theatre as an institution. The questions were specifically directed toward their perceptions of the experiences at the Dunbar Historic Theatre from 1945 to 1963. A semi-structured process included a questionnaire of 14 questions (Appendix B) as a guide; however, participants were supported in any deviation from the questioning. The researcher's goal was to complete the list of questions to maintain consistency within the interviews, but used flexibility to ensure the interview environment remained attentive to the individual and their own story.
The study helped the researcher and adviser to gain insight into the local history and experiences of people who attended the Historic Dunbar Theatre. This information is useful for the Social Work department's connections to the community surrounding the university, and the research also informs diversity content. Working with community members, especially aging populations of color, requires that the researcher fully understand the implications associated with safety. Ethical considerations are crucial when working with aging populations of color, and vulnerability cannot be underestimated. Physical, mental, and emotional harm was avoided and safety was assured in the process by communicating that some personal topics may create uncomfortable emotions for the participants.

Technology Procedure. This research utilized an innovative and contemporary approach to qualitative data gathering and analysis. With a minimal budget, the researchers utilized technology that is widely available. Researchers recorded the interviews utilizing a Canon Rebel T3i DSLR camera equipped with a high capacity SDHC memory card and a lapel microphone. The camera was propped on a tripod. Small amounts of time were spent communicating to participants the use of technology and addressing any questions participants had regarding technology.

Upon completion, researchers transferred completed interviews to the computer where they were imported into Window's Movie Maker for review and analysis. The program provided flexibility to make "clips" of interviews while saving all raw footage.

The video review and editing process included several distinct steps. Researchers followed each step with every video consistently:
1. First, researchers viewed each interview in its entirety. The researcher sought to gain an overall

view of the tone of the interview and macro-view of the experiences of the participant. This first view allowed the researcher to observe from the 3rd person point of view and begin building an empathetic perspective.

2. Second, the researcher viewed each recording from the beginning and would begin slow analyses of watching and listening for body language, tonal shifts, or other verbal and/or non-verbal indicators. The goal was to identify significant statements of the participant. If the researcher identified a statement or action of interest, the researcher created a "clip" of what they were conveying from where they originated their statement through the end of the thought or statement.

3. Finally, each interview was viewed in its entirety again. If any new points, ideas, or themes emerged then a new clip would be made and adjustments to older clips would be subsequently be made if needed.

Researchers watched each video three times before the researcher would review the next interviewee's video. If an important theme or statement emerged from an interview, the researcher would review other interviews in search of support and reiteration of this point. This process continued through the interview videos for all participants.

These processes allowed the researchers to organize clips into themes while leaving the larger raw videos available for creating digital stories. Thematic analysis occurred during clip creation, centered on the identified themes, and coalesced with other interviewees' clips. The digital stories then highlighted the interviewees according to themes and echoed their voices with consistency.

Researcher's Stance. Researchers remained cognizant of their position within the research environment and social, educational, and class contexts of the McAdams community and Dunbar population. Both researchers are Caucasian women, a student-professor team between the ages of 30 and 40, both advantaged in terms of white privilege although both share empathy for struggle and overcoming great adversity, due to their own life experiences. The researchers both study and practice in the discipline of social work, and therefore, have passion for social and economic justice and utilizing empowerment practices.

The researchers made deliberate efforts to minimize any positioning of the researchers as experts on the community, African American experiences, or segregation and desegregation. In this cross-cultural environment, the researchers sought to approach the participants as the "knowers," and this is in line with the suggestions of Tyler, Sussewell, and Williams-McCoy (1985) and their suggested approaches for cross-cultural writing. Rather than engage in overgeneralizations or assumptions of culture and experience, the researchers decided to be open to asking for clarification and additional information regarding cultural, racial, or generational issues. The researcher's position was that of the "learner" (Anderson & Goolishian, 1992).

The researchers understood that cross-culture is highlighted not only by the external culture of individuals and groups but also by the internalized culture. This required the researchers to seek understanding from each individual and not place primary interview emphasis on this element because the culture being studied was that of the Dunbar Theatre patrons, which includes shared group membership.

The researchers utilized reflexivity throughout the research process in order to evaluate their personal biases and work through barriers, discuss their motives for pursuing this research, maintain commitment to the research, and to utilize an introspective analysis of their own process in reaction to their experiences within the

community over time (Ridley, Mendoza, Kanitz, Angermier, & Zenk, 1994).

Results

Thematic Analysis. The exclusively digital method of data analysis enhanced the researchers' ability to maintain context, meaning, and the integrity of the story told by the participants. Digital storytelling relayed the participants' experiences through an audio-visual or movie style format without any changes of context or meaning by the researcher. Thus, analytical integrity and preserving the full, raw experience became straightforward. Researchers' completion of analysis in an exclusively digital environment, via Windows Movie Maker and without transcription, encouraged the researcher to look and listen for meaning. This resulted in less meaning lost through transcription or interpretation of transcribed words.

Data Analysis

Paula Givens. Paula Givens's interview lasted approximately 30 minutes and was completed at the office owned by Mr. Arbertha, Sr. Data transfer indicated there was an equipment failure. Researchers relied on manually recorded responses and field notes to complete the analysis. Mrs. Givens has lived in Wichita for over 60 years and had her first experience at the Dunbar Theatre when she was approximately five years old. During her childhood, she resided one block from the theatre and has remained a resident of the neighborhood. She did not recall attending any movies but does recall Christmas parties held by various community groups and attended by her whole family. They dressed up for such events, and one of her fondest memories was receiving a doll as a gift at one of the events. In describing the environment, she talked about the Turner Drugstore that is located one building to the south of the theatre, a café down the street, the schools, barber shops, and the grocery store as all being thriving businesses during her childhood. She recalled the intersection of 9th and Cleveland, the corner where the theatre is located, as being a "place to be."

Prentice Lewis. Prentice Lewis's interview was completed in approximately 25 minutes at the office of and attended by Mr. Arbertha, Sr. Mr. Lewis was approximately 76 years of age at the time of the interview and chose to first tell his story and then allow the researcher to ask follow-up questions. Mr. Lewis, along with his mother and sister, moved to Wichita from Louisiana in 1943 and stayed at the Phyllis Wheatley Children's Home for a short duration while his mother secured a permanent residence that was later located three blocks north of the theatre.

Mr. Lewis described interactions from his youth typical of children his age, such as putting his arm around a girl's shoulder, meeting up with friends to go see a show, and participating in acts of mischief like sneaking into the movies. Mr. Lewis reported having to chaperone his sister and attend other events such as Halloween parties. At one point, Mr. Lewis recalled getting to clean the theatre and receiving a small amount of change and maybe any that he found on the floor as payment for his work. When describing the theatre, he said it was "the place to go."

Carla Jackson-Patton. Carla Jackson-Patton's interview was completed in the researcher's office in approximately 12 minutes, and she followed the prepared questions in order. Ms. Jackson-Patton was born March 3rd, 1949, and fondly recalls that she was born the day after her mother saw the film *Johnny Belinda* at the Dunbar Theatre. Her earliest memories are from the age of nine or ten and include Friday night movies being scary or horror films and attending Saturday chapter cartoons with her friends. She recalls one of her earliest dates with a boy being at the Dunbar Theatre, and she attended a Shriner's Christmas

party at the theatre during her childhood. When asked how she felt the Dunbar compared to other movie theaters she attended in town, Ms. Jackson-Patton stated, "African Americans sat in the balcony at the movies or at the back of the theatre. So it was like family. At the Dunbar we were at home."

Marvin Grant. Marvin Grant's interview was completed in his home and took approximately 40 minutes. The researcher and Mr. Arbertha, Sr., were present, and Mr. Arbertha, Sr., identified Mr. Grant as a relative of his. Mr. Grant took time before the interview to take down some notes about what he wanted to convey and utilized the back of an envelope with those notes to guide his narrative. Mr. Grant was approximately 80 years of age at the time of interview and fondly recalled seeing *Gone with the Wind* in the theatre, as well as Saturday chapter cartoons, talent shows, and Westerns. Mr. Grant's memories are vast, and he covered various topics directly and indirectly surrounding the theatre but tied all of the experiences back to the Dunbar or the community. Mr. Grant described the theatre and his experiences multiple times by saying it was "wonderful, just wonderful" and described the theatre as a "lifeline." Mr. Grant expressed heartbreak that the theatre has been left in disrepair.

Findings

Changes in sense of place and generational values are greatly influencing the strength of our communities. The goal of this research was to reach into the McAdams neighborhood and the community that experienced the Historic Dunbar Theatre to understand the relationship between generational values and sense of place in this historic community. We essentially asked the following: What is the relationship between generational values and sense of place during the 1940s through 1950s for African American residents of the historic McAdams Neighborhood who experienced the Historic Dunbar Theatre? The results of this study should show that those who experienced the theater at an older age have a stronger sense of place than those who were younger during their visits to the theatre.

These case studies provide a glimpse into the lived experiences of those who attended film showings, events, pageants, and gatherings at the Dunbar Theatre. Each story is unique, and they all shed light on many commonalities that residents experienced across the 22-year operational existence of the theatre.

Themes. Thematic analysis provides an opportunity to understand the commonalities and identify living and/or behavioral patterns (Aronson, 1994). The researchers listened for meaning in order to identify themes and cultural, racial, and communication patterns, as well as feelings of participants with regards to their Dunbar Theatre experiences or history within society. The first theme analysis occurred through the identification of repetition of words, phrases, or meaning. The themes that emerged from the initial interviews have been consistent with the theoretical framework and interview question design. Sense of community emerged as an overwhelming theme.

Sense of Place. Not all buildings are "places," but the Historic Dunbar Theatre has a name, and over its 22-year operational life, has a story. Frake (1996) explains that this place development "come[s] into being out of spaces by being named" (p. 235). The narratives of the participants who share experiences at the theatre build upon the strength of place development for the building. Each participant fondly recalled the theatre by name but also showed place development for other shops in the neighborhood. The participants remembered the neighboring Turner Drugstore, Mr. Moon's shoe shine, and the Sexton family's cleaners as all being

buildings that were "places" and not simply spaces.

Place development of the space is shared with the participants who develop their own sense of place through experiences with the Theatre and its community. Hay (1998) explained that sense of place develops for residents who have lived in a place for many years, feels at home and secure, and has feelings of belonging to and/or in a place. Participants noted their individual time as a resident and community member being cumulatively greater than 40 years. Ms. Jackson-Patton stated that the Dunbar was "like home" to her. Proshansky, Fabian, and Kaminoff (1983) noted the importance of physical places in the construction of the concept of the self and the influence that association and interactions with those physical places has on the development of place identity.

Generational Values. Shenk (2000) previously found participants', "… generational experience was unique because of the age at which they experienced these historical changes" (p. 124). Looking back to the Historic Dunbar Theatre, those who remain with us today were of varying ages while the theatre was open, and their unique experiences may shed light on life during this period of time.

Discussion

Implications. Challenging basic assumptions is a key component of growth as individuals and is vital in social work for encouraging growth in communities. When seeking a method, "Ethnographic research, in much the same way, gets below the surface and challenges assumptions made regarding a variety of topics" (United States Department of the Interior, n.d., para. 2). Practitioners within the helping professions, such as social work, nursing, education, and psychology, can benefit from this research and the ethnographic-multicultural framework utilized to conduct the research. Through this research and its challenges to any "otherness," it allows practitioners to hear the voices of people from their own frame of reference. There is no challenge to the realities of community workers or helpers; it is simply a study that allows the observer to put themselves in the shoes of participants and begin to feel and understand the participants' world and experiences. Social workers and other helping professionals can utilize historical African American communities for research and as a source for relationship-building as well as aiding in understanding generational values.

The intersection of ethnography and digital storytelling provides a unique opportunity to further the work of each individual area and to synthesize the two areas into a medium for social justice. Skouge and Rao (2009) view digital storytelling as a method to help influence themselves and others through the presentation of their stories as models of inclusion and self-determination (Grant & Bolin, 2014). Digital storytelling is emerging as a pedagogical method whereby students are learning cultural competency and engaging in social justice through advocacy as it emerges as a research methodology. Community level practitioners from multiple helping disciplines, including nursing, psychology, social work, and criminal justice can utilize digital storytelling to engage communities in an innovative way that is accessible to people across many different populations. Manning (2009) and Rolon-Dow (2011) explain how digital stories have given voice to different groups as well as provided a lens through which to view the world that will aid practitioners when crossing cultural divides, attempting to build mutual respect, and engaging communities of different races or ethnicities. Furthermore, there are the implied benefits to bringing forward the lived history of a community, in their own voice. In the case of a marginalized population, like African Americans, digital ethnography from a multicultural

ethnographic framework gives the community a means to preserve their oral history while retelling it from their own point of view.

Limitations. Literature often is reluctant to validate the experiences of people as documented through their own reflections of experiences and feelings, as this may not be quantifiable across populations. Authors such as Bird (2002) critique the pursuit of oral narratives. Bird (2002) states that local narratives are seldom at the forefront of peoples' minds, that their retellings "can often be somewhat artificial," and that the context in which narratives are retold may affect the details and precision and thereby affect the version of the story (p. 524). While a limitation such as this exists on a continuum, one would also argue that a critique of the stories and accounts of diverse groups, a discounting or rejection of their experiences, is an element of institutionalization of oppression, racism, sexism, classism, heterosexism, and ageism, etc. (Clark, 2003). Therefore, the researchers value the diverse perspectives shared through narrative development and have not sought quantifiable data to describe this group who shared experiences at a space and place that has been frozen in time. There is no desire to quantify the beautiful memories, painful memories, and hopes and dreams of people who have been historically silenced.

The practical limitations that existed with the study were primarily around scheduling and the ability to create safety and connection for the participants. There was a need to spend a number of months within the community, building a presence of the researchers, in order to gain access to the community members. White academics entering a diverse community asking questions and wanting something without reciprocation or possibly bringing trauma of some sort has been done before. There may have been a general lack of trust of academics and sometimes of white people that was prevalent at the onset, and the researchers were faced with planning their engagement process with the community. Participants were also elderly, and there was a need to understand the perspectives of participants from both of these angles.

The researchers engaged in multiple discussions regarding this time spent trust building and were challenged to become more informed on the need to attend to these implicit expectations. Diverse communities do not want to be seen as test subjects, do not want to be objectified, and do not want to be further misrepresented in media or literature. The researchers felt this was a good process to engage in, and it assisted in the researchers' rejection of any "all knowing" researcher stance. This trust building process also created a very rich environment when the interviews could to take place. It appeared as if there was a "letting in" to specialized knowledge that was fully owned by this group and released only on their terms, a sort of privileged information. This "letting in" process was itself not completely unambiguous, however. Some critics state that the participant engaging in a teaching role and revealing specialized knowledge is a form of exploitation (Scott & Borodovsky, 1990). Researchers walk some very fine lines with gathering knowledge from diverse groups and utilizing the knowledge for documenting, presenting, publishing, or otherwise benefiting from the stories and experiences of others. These researchers discussed these as possibilities for the data and shared the intent to promote a social, economic, and historical justice perspective throughout.

While this in itself may not be a limitation, future researchers should consider the time commitment it takes to build rapport with diverse groups. Consider the roles of trust and relationship building, researcher stance as expert, and the reasons that knowledge is preserved and protected. This type of work has a greater investment of time and relationship building than in quantitative work. These issues, somewhat a

limitation, created difficulty when arranging interviews, and many participants cancelled appointments, ultimately reducing the number of participants in the study.

Conclusion

This research serves as a collaborative effort between the Wichita State University School of Social Work and the community to bring forward the lived experiences of those who attended the Historic Dunbar Theatre and to keep alive the memory and connection to this historical landmark for Wichita's African American community. Ethnography and social work are well suited, as both disciplines seek to understand and share the human experience from a systemic, multicultural, and empowering perspective that is viewed through the lens of the participants (Goldstein, 1994).

It is suggested that further research be conducted within the ethnographic multicultural framework, as it will continue building a research and theory base for approaches that validate and empower the voices of groups who have been historically and traditionally marginalized in society and literature. Researchers also suggest further studies incorporate digital storytelling as the primary means of narrative inquiry in a completely digital environment in an attempt to move research methodologies forward and encourage the integration of advanced technologies in qualitative research.

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Consideration When Designing an Exoskeleton Prosthetic Hand

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Abstract

Paralysis is a serious medical diagnosis that can result from stroke, birth defects, or injuries to the spinal cord. Once the synapse connection of the spinal cord is broken, communication between the nervous system and the body is severed. As a result, motor function in the human body is significantly reduced or completely eliminated. Many people who suffer from paralysis can benefit from exoskeleton prosthetics. Similarly, prosthetic limbs can assist patients who have had amputations due to diabetes, military service, or severe injuries. These amputations affect the patient's ability to perform everyday activities. Information pertaining to prosthetic limbs can also be incorporated into exoskeleton designs. These contributions have led to the study of biomechanics. The purpose of this extended literature review was to collect data and assess literature that can assist in building a functional exoskeleton hand. Many factors affect hand movement. This study provides information that can be utilized to engineer an exoskeleton more accurate in mimicking the movements of a human hand. Having a more accurate exoskeleton or prosthesis will eliminate many problems between the user and the machine, thus making the mechanism more user friendly.

Summary

Paralysis is caused by problems in the spinal cord. The ability to move or control the body is lost when synapse connections are broken. With the synapse connection broken, communication within the nervous system is inhibited. Approximately six million people, as many as one in fifty, live with some type of paralysis (Christopher & Dana Reeve Foundation, 2015). Exoskeleton mechanisms can be utilized to help patients with limited motor functions. An exoskeleton is a type of prosthesis that provides support externally instead of being used as an implant, like a prosthetic limb. When designing exoskeletons, many factors need to be considered in order for the design to function properly. The purpose of this literature review is to study different considerations pertaining to designing an exoskeleton mechanism.

Functional prostheses are the backbone of rehabilitation robotics. There have been many discoveries involving prosthetics throughout history. For example, during the early 1500s, a scientist and knight named Gotz von Berlichingen designed a prosthesis known as the iron hand; the prosthesis used a spring and release system (Frumento, Christopher, Messier, & Montero, 2010). In 1696, a scientist named Pieter Verduy developed one of the first non-locking lower knee prostheses. In 1912, the first full aluminum artificial limb was created by Marcel Desoutter. Research in powered human exoskeleton devices began with a collaboration of two scientific organizations in the United States and Yugoslavia (Frumento et al., 2010). One of the most fundamental problems with exoskeleton suits is the lack of a functional interface that allows optimal communication between the mechanism and the human subject. The better the interface, the smoother the exoskeleton will function.

In order to deal with this issue, electromyography (EMG) has been implemented in prosthesis design. EMG proved to be useful for the development of exoskeleton mechanisms for rehabilitation applications (Frumento et al., 2010). The ability to pick up these muscle currents has allowed scientists to develop bio-cybernetic systems. An EMG extraction process includes three components: signal capturing, signal conditioning, and signal processing (Gopura, Bandara, Gunasekara, & Jayawardane, 2013).

EMGs can be divided into two groups: low frequency and high frequency (Gopura et al., 2013). Low frequency disturbances cannot be completely eliminated without also eliminating the myoelectric signal; however, disturbances can be filtered. Circuit amplifiers can be used to subtract the low frequency disturbances from the myoelectric signal (Riley, 2004). The differential amplifier concept by Gerald Haslinger is an excellent example of how to filter out disturbances (Haslinger, 2002).

Once the disturbances are eliminated, the signal is processed. In the computer processing component of the EMG extraction process, the signal is translated into data that is used to control exoskeletons. In order to produce movement in exoskeletons, actuators are used. These types of motors use linear power or rotational power to create mechanical movement. The actuator contains a memory component. Once the desired EMG signal is captured, conditioned, and processed, the output data is then stored in the actuator's memory component. Whenever this output is produced, the same actuator motion is created (Schilling, 2013).

Stability is an important factor to consider when designing an exoskeleton hand. Muscular movement is accomplished by fiber contractions, yet some muscles need the assistance of a stabilizing muscle in order to move. It is important to understand the anatomical relationship between different muscles and joints in exoskeleton designs to allow for the proper

stability to occur while the mechanism is being used. This also includes the relation between hand movement and finger movement.

A tapping motion is a simple and basic cyclic motion; however, this basic motion is assisted by contributions from the shoulder, elbow, and wrist (Qin et al., 2014). In the article by Qin et al. (2014), an experiment was conducted where six subjects typed a series of random seven-digit phone numbers using a single finger on a numbered key pad. Groups of three reflective markers were placed on the upper arm, forearm, and hand of the subject. In addition, one single marker was placed on the subject's finger. By using an infrared motion analysis system, the reflective marker was recorded during the typing motion on 3-D positions in the up-and-down, z-direction movement (Qin et al., 2014).

The purpose of the experiment conducted by Qin et al. (2014) was to determine the role of the shoulder, elbow, wrist, and metacarpophalangeal (MCP) joints have in typing with the index finger. The elbow contributed 27.7%, wrist 55.6%, and the shoulder 6.5% to the typing motion. A similar experiment was conducted by Dennerlein, Kingma, Visser, and van Dieën (2007). The difference was that the experiment studied the contribution of the wrist, elbow, and shoulder when performing five different typing exercises. Each exercise dealt with typing with the index finger, but different joints were utilized to perform the motion. The first motion was a freestyle exercise, the second exercise consisted of only using finger flexion-extension, the third exercise consisted of only using wrist flexion-extension, the fourth exercise consisted of only using elbow flexion-extension, and the last exercise only involved using shoulder flexion-extension. Compared to the experiment conducted by Qin et al. (2014), these were more detailed. What this information provided was evidence that even a motion as simple as typing with one finger requires contributions from other joints. Although the motions conducted in both experiments were not complex, the contribution patterns of the surrounding joints were inconsistent. For different movements, different means of stabilization were required. This information shows that there are many outside forces that help produce hand motion. In order to create an exoskeleton hand that correctly mimics the motion of a human hand, these outside forces and contributions need to be considered.

Biomechanics has come a long way, and throughout this growth, there have been countless scientific advancements involving exoskeletons. When designing an exoskeleton, there are many things that need to be considered and factored in. EMGs provide an excellent interface between the mechanism and human, allowing the mechanism to create motion. Another characteristic to consider is the anatomical contributions needed to produce the proper stability during the desired motion. However, there are still problems that can arise. The relations between all the muscles in the arm are difficult to analyze due to their inconsistent patterns of movement. By discovering a better way to analyze and study arm movements in any direction, an exoskeleton hand can be created with the capacity of moving in many different directions. Furthermore, EMGs have been beneficial in many ways, but they are disturbed easily, which can cause a dysfunctional movement. Creating a more efficient interface can raise the accuracy and precision of the desired movement in an exoskeleton hand.

Although this literature review states some of the considerations that need to be applied when designing exoskeletons, more information needs to be covered. For example, the materials needed to create the exoskeleton are an important factor. Materials can be expensive and can significantly raise the cost of manufacturing an exoskeleton, making it expensive for the patient. Also, the

physical and chemical compositions of the materials need to be considered to produce an exoskeleton that is more resistant to wear and tear. By considering the composition of materials used, the exoskeleton can be created to ensure the comfort of the patients. Implementing and improving the characteristics listed above will allow scientists to make improvements to the field of biomechanics. If a better interface is created, the communication between the mechanism and the human will be clear, creating a fast, fluid motion in the exoskeleton. Hand motions are complicated, but by continuing research and finding common patterns in hand motions exoskeletons can be created to mimic bodymovements more accurately.

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Wichita State University's Student's Perception of Police and the Effects of the Media

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Abstract

Over the past few years, police behavior has come under national scrutiny. News agencies tend to report only negative police behavior with continuous coverage of police misconduct. In contrast, crime-reality and crime-fiction shows portray police as heroic, which can leave citizens' opinions somewhere in between. This study assessed selected WSU students' perceptions of the police before and after a controlled contact with a police officer. Students who are currently enrolled at Wichita State University were chosen by random selection for this study. Each participant was asked to partake in a pre- and post-semi-structured qualitative interviews with the researcher about their perceptions of the police, with the post interview being conducted after participants attended an open forum discussion with an officer from the Wichita Police Department. This research investigated the role the media plays in shaping students' perceptions of the police to determine whether or not informal contact with a police officer would have a positive effect on peoples' perceptions of police. This research will provide insight into the relationships between the police and media, the media and community, and the police and the community as a whole.

Summary

According to Maxson, Hennigan, and Sloane (n.d.), there are five factors that contribute to perceptions of police. The factors are frequency of contact, prior crime victimization, media, demographics, and community perceptions of neighborhood. The first three factors were the focus of this study. Frequency of contact with police has the largest impact on the public's perception of police. This factor has two facets: formal contact and informal contact. Formal contact entails any contact with the police for the purpose of upholding the law, and informal contact involves everything else, such as conversations with police while on patrol or during community activities. Prior Crime Victimization is a type of formal contact with the focus being on interactions that officers have with the victims of crimes. Media has the second largest impact on police perception. Prior research done by Callanan and Rosenburger (2011) focused on four categories of crime-related media: television broadcasts, newspapers, crime-related television programs, and crime reality shows. Crime-related television programs consist of programs like *Law & Order: SVU*, while crime-reality shows consist of shows like *COPS* (Callanan & Rosenburger, 2011).

Callanan and Rosenburger (2011) also stated that "television news coverage of the police is disproportionately positive" due to officers often being shown acting in the line of duty (i.e. making arrests) (p.172). According to Sacco and Fair, this makes it appear as if the police "are more effective than official arrest data indicate" (as cited in Callanan & Rosenburger, 2011, p. 172). So even when news stations are reporting police misconduct, the community perceives the problem as a 'bad apple' issue rather than a systemic problem (Callanan & Rosenburger, 2011). This means that the community is more likely to attribute police misconduct to individual officers rather than treat it as a problem within the judicial system or law enforcement as a whole.

The purpose of this study was to assess selected Wichita State University students' perceptions of the police before and after a controlled contact with a police officer and determine whether controlled contact with a police officer would affect perceptions of police derived from media. Six Wichita State students, all 18 years of age or older and acquainted with the researcher, participated in a pre-interview, a group forum, and a post-interview. The pre-interview consisted of seven semi-structured qualitative questions which were used to gauge perceptions of law enforcement and the media's influence of those perceptions. Probing questions were included to encourage participants to expand their comments and clarify responses. The group forum served as a controlled interaction with law enforcement. The Wichita Police officer answered four questions about his job and what it is like to be a police officer. Participants were also allowed to ask questions of their own. The post-interviews were conducted to determine if the controlled contact had an effect on participants' perceptions. The post-interview questions were derived from the pre-interview questions. Participants were encouraged to expand or clarify their responses as needed. The pre and post-interviews were audio recorded, transcribed, and analyzed by the researcher.

The study yielded four emerging themes: post-perceptions of police, experience, media, and future improvements. Included in post-perceptions of police were two categories: increased breadth of knowledge and understanding and no change in perception. Three participants demonstrated a more positive view of law enforcement. Three participants appeared to have no change in perceptions of the police, stating similar perceptions in the post-interviews as the pre-interviews. Participants that

noted a change in their perception, noted an increase in knowledge about police. From this data, one can suggest that perhaps the content of contact with law enforcement was more important than the frequency of such contacts.

Categories included under the theme 'Experience' were pre-perceptions of police, situational, and personal acquaintances. Pre-perceptions of police showed how participants reported their perceptions coming into the study. Four participants reported a positive perception of police, one reported neutral, and one reported negative. Although the majority reported positive, when asked about their experiences with police, participants would recollect both positive and negative experiences, attributing the experience to either police behavior or the circumstances surrounding the experience. Understanding what factors have the greatest impact on an experience to the general populace during formal or informal contact could, in the future, help to restructure how law enforcement engages a citizen. Five out of the six participants in this study reported having ongoing personal acquaintances with law enforcement and some knowledge of the inner workings of law enforcement. Both could have had an influence on their perceptions of police, in accordance with prior research stating that frequency of contact with the police has the largest impact (Maxson et. al, n.d.)

Categories included under the theme media were: negative, understanding of few bad apples, lack of understanding, and social media. Four out of the six participants reported that media casts law enforcement in a negative light. Previous literature, however, reports that crime-related media shows law enforcement in a disproportionately positive light (Callanan & Rosenburger, 2011). The other two participants stated that media showed both. Five participants originally stated that media did not affect their view of law enforcement, four of which stated that media served as a reminder that even though they have seen positive things on various media sources, not all cops are good cops, and not all officers will behave the same in every situation. Another term used in reference to this concept was 'bad apples.' Two participants felt that there is a lack of understanding for the policies and procedures that police must follow; these participants suggested both media and the community as sources for these misconceptions. However, misinformation is not necessarily highlighted within prior research. When asked to define media, several answers were given, including television shows like *NCIS* and *COPS*, books, newspapers, magazines, and social media. Five out of the six participants specifically mentioned social media as a source they use to get information. Social media is of note because what is shown on social media is in large part due to the preference of the consumer. Any views attributed to social media consumption are indirectly by choice, as many ads and reports appear on various social media platforms based on a user's activity. Also, five participants originally stated that media did not affect their view of law enforcement, four of which stated that media served as a reminder of police activity. This suggests that while participants claimed media had little effect on their perceptions of police, they were ultimately aware of police activity reported around them; hence, they were affected in various degrees.

When asked about what changes they would make to how law enforcement performs their role, participants responded by offering the following ideas: community policing, communication with public, frequent controlled contacts, more training, and no change. Participants mentioned wanting to see more community involvement and more community-oriented practices because currently, according to participants, police are exclusively depicted negatively. One participant discussed her personal need for communication with officers.

Several participants discussed the mentality of law enforcement, feeling as though officers act as if they don't owe the general public an explanation for their actions. These participants also highlighted officers' belief that the public is responsible for knowing their own rights, without law enforcement having to explain actions during an arrest. Participants highlighted a perception that police officers are trying to fill quotas or that officers are out to arrest people maliciously. One participant, however, reported that she thinks police do their job just fine.

In conclusion, the group forum did have a positive effect on views of law enforcement as researchindicated contact with law enforcement would. From this study, content of the contact appeared to be just as important as the contact itself. If an experience with an officer was abrasive or unpleasant, then this ultimately influenced perceptions. The group forum represented a neutral contact with an officer, which may have been in stark contrast to participants' previously experienced negative contacts with officers. Due to the combined responses of participants, future implications from this study could focus on a community policing model that brings together police and community in a manner that allows both parties to foster dialogue. This would not result in either party, public and police officers, feeling attacked; rather, both would feel heard.

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Effectiveness of The Listening Program® in Children with Various Developmental Disabilities

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Abstract

The purpose of this study is to measure the effectiveness of The Listening Program ®(TLP). Seven children with various types of developmental disabilities (e.g. Autism Spectrum Disorder, Speech and Language Disorders, intellectual disability) participated in a 12-month longitudinal study using TLP®. TLP® is a popular sound therapy program in which a child listens to acoustically modified classical music for 15-30 minutes per day with the expectation that the listening will improve brain function. A Single-subject design was employed in which auditory speech and language behaviors were documented with video tapes and questionnaires completed by the child's parent before, during, and after daily administration of the listening program over one year. While previous research has indicated the effectiveness of TLP®, the researchers were affiliated with TLP®. Data from this initial project will be examined by people unaffiliated with TLP® in our study to avoid any potential bias. The goal of this study is to test the researchers' hypothesis that auditory speech and language behaviors will improve after administration of TLP®. This will be one of the first systematic research studies to measure the effectiveness of TLP® in children with developmental disabilities that was not conducted by developers and distributers of TLP®. This study can support or discount the research done by TLP® and give caregivers or health care professionals another perspective when deciding if TLP® is the best treatment option for their client.

Summary

Sound therapy is an alternative treatment for auditory hypersensitivity in children with developmental disabilities. The first sound therapy program was called the Tomatis method. It was named after an ear, nose, and throat physician named Dr. Alfred Tomatis in 1957. Dr. Tomatis had his patients first listen to classical music passively (i.e., doing nothing at the same time). He then had them listen to the music actively (i.e., they hummed or sang along to the music). Tomatis originally used sound therapy to improve the voice quality of patients that were opera singers, but he realized that his method improved more than his patients' voices. His patients also reported significant progress in various skills such as reading, writing, learning a new language, and spelling (Davis, 2004). All of these skills are linguistically-based and are stimulated by the auditory system. Accordingly, some people suggested it might be effective in improving linguistic skills of persons with developmental disabilities.

The Listening Program (TLP ®) is a sound therapy program created in the U.S. that claims to have positive results with a variety of clients with disabilities, ranging from Attention Deficit Hyperactivity Disorder and Autism Spectrum Disorder to Stroke and Dyspraxia. Advanced Brain Technologies, the provider of TLP®, hypothesizes "that as the brain learns to process a fuller spectrum of auditory information, this enhanced auditory processing will develop the user's ability to filter out 'extraneous' sounds, leading to greater ability to attend and concentrate" (Francis, 2011, p. 611). Clients with developmental disabilities could benefit from sound therapy, especially TLP®, because it aims to reach a broad spectrum of complex disabilities with a shared root cause in auditory processing. Previous research on TLP® was conducted by researchers affiliated with Advanced Brain Technologies. By studying TLP® from an unbiased perspective, unaffiliated researchers can support or contradict TLP®'s claims and can better inform caregivers and health professionals of the possible options for treatment.

In the current study, a single-subject design was utilized. Participants were surveyed and taped by parents for the initial five weeks without treatment. TLP® was then implemented, and the participants started listening to the all of the discs in order, starting with disc one and ending with disc 10 after 20 weeks. Meanwhile, parents surveyed and taped participants every five weeks. Following the completion of the ten discs, TLP® was withheld for five weeks, and again participants were taped and surveyed. Next, TLP® was administered for 20 weeks, and the child was not taped and surveyed until the final week. At the end of the treatments, all surveys were catalogued in graphs to see if each participant improved or declined in auditory behavior and language skills. Of the four participants, two showed improvement, one declined, and the last showed very little change in scores. This left the researchers with mixed results, leading them to conclude that TLP® affects children with developmental disabilities (DD) differently. The success of TLP® depends on the child, specifically the severity of the child's DD and other health situations that may contribute to success or failure.

Another discovery was which skills TLP® improved markedly. *The Children's Auditory Performance Scale (CHAPS)* was a survey given to participants of this study. *CHAPS* is a questionnaire used to assess the participant's listening skills in various situations. This survey is ideal for the current study, because of its ability to rate listening skills specifically. The *CHAPS* subtests are all related to listening in various situations, for example, listening in quiet. The scores for the *CHAPS* subtests had more obvious growth than most of the subtests included in the

TLP® Listening Checklist. The subtests for the *CHAPS* were all related to listening, whereas the *TLP® Listening Checklist* tested listening skills, level of energy, motor skills, and other skills not normally associated with auditory behaviors. When comparing *CHAPS* scores to *TLP® Listening Checklist* scores, all of the *CHAPS* subtest charts looked similar, and the only subtest for the *TLP® Listening Checklist* that looked similar to the graphs for the *CHAPS* was the graph for the Receptive Listening and Language subtest. Seeing the consistent progress among subjects 2 and 7 in all subtests related to listening supports that TLP® is an effective tool at improving listening skills in various environments, including quiet ones, ones with multiple inputs, and more.

The purpose of this study was to see if TLP® improved auditory behaviors and language among children with developmental disabilities. The current study did have a few limitations. Participants' parents were solely responsible for taping and surveying their children routinely, which resulted in inconsistencies in data. There was one group of participants in the current study, so the researchers didn't learn if the participants' auditory language and behaviors would improve without TLP®. Having a group of participants also having their hearing assessed but without receiving TLP® would be a necessary control in future research. Also, the severity of each subject's health and developmental disability was unknown to the investigators; therefore, some data couldn't be attributed to a definitive cause. It is now known that hypo- and hypersensitivity is a common issue among children with DDs, yet it is often ignored. Many parents and doctors are looking for the right solution for their patient and should be able to find unbiased research able to specify the possible outcomes of different forms of sound therapy, including TLP®. The current study had mixed results, unlike the studies on TLP®'s website which had only positive results.

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Religiosity and Sexual Shame among Young Women

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Abstract

For centuries, marriage has been rich in both cultural and religious tradition. According to the Pew Research Center (2014), 82% of married individuals identify as holding a religious affiliation. Marriage and divorce are regulated by legal policies, and religious bylaws also structure and shape practices within a congregation. The religious community has been influential in shaping public policy advocating for covenant marriage licenses and a return to fault-based divorce, but limited research studies have explored the circumstances in which divorce is permissible across religious denominations. When divorce and remarriage is acceptable in a religion, applicants are subject to the procedures within the corresponding religious denominations. According to the 2015 Census, in 42% of couples marrying within the past year, one or both partners entering the marriage had been previously married. Despite premarital education being a key provision of covenant marriage, little is known about faith-based marriage education, especially programs offered to remarried couples forming stepfamilies. This study involved a community needs assessment exploring the grounds for divorce and remarriage across denominations. The research also explored whether religious adherence influenced premarital practice and attitudes amongst college students. This study sought to enlighten the religious community about the need for premarital education that is specific to the needs of the couple forming a stepfamily.

Summary

In many societies, marriage is a social institution regulated by both legal policies and the religious bylaws that structure and shape coupling and uncoupling practices within a particular congregation. In fact, religious communities have been influential in shaping larger marriage policies, advocating for covenant marriage licenses and a return to fault-based divorce (Stewart, 1998). Hawkins & Fackrell (2009) found that "those who choose covenant marriage expand the meaning and strengthen the moral boundaries of their marriage" (p. 804). While religiosity may be a protective factor, research conducted by the Pew Research Center (2015) found that 70% of Christians, 20% of the religiously unaffiliated, and 5% of non-Christians reported experiencing a divorce or separation. Despite the intersection of religion and marriage institutions and the key provision for premarital education within covenant marriage arrangements, there are surprisingly few research studies that explore faith-based perspectives and approaches to marriage education and even less research about premarital education targeting stepfamilies specifically. The goal of the current study was to take one step toward remedying that gap.

Stepfamily Development. Each year in the United States "more than one million American children experience parental separation and divorce," and for some of these children, it will not be the first parental divorce they go through (Boyer-Pennington, Pennington, & Spink, 2001, p. 72). According to the 2015 Census, in 42% of couples marrying within the past year, one or both partners entering the marital bond had been previously married (Kreider, 2006). According to Kreider (2006), most men and women will remarry within five years of a divorce. Given the changing family dynamics, the stepfamily has increasingly piqued the interest of "clinicians,researchers,and educators"(Higginbotham, Miller, & Niehus, 2009, p. 316). Research on premarital education more generally suggests couples that prepare for marriage through some form of premarital counseling or education can lower the risk factors associated with divorce (Fox & Shriner, 2014). It stands to reason that premarital education would be even more important for remarrying couples. Higginbotham et al.'s (2009) research has identified differences between the dynamics of the stepfamily and the dynamics of traditional biological family. These identifiable differences are risks factors that can contribute to the higher divorce rates among remarried couples (Fox & Shriner, 2014). For these reasons it is increasingly important that family scholars investigate what types of resources, if any, are provided to stepfamilies, especially within faith-based communities considering that 82% of married individuals identify as holding a religious affiliation (Pew Research Center, 2014) and the deep roots of marriage tradition within religious ideology.

Marital Preparation. Premarital counseling is designed to address areas such as background and context, the individual, and couple and family dynamics within the relationship (Sauerheber & Bitter, 2013, p. 307). Not surprisingly, premarital education is a requirement of covenant marriage policies. In fact, Halford, Markman, Kline, and Stanley (2003) assert that a continued issue with premarital education scholarship is the fact that most "relationship education programs offered . . . have not been systematically evaluated" (p. 385). Even less is known about faith-based marriage education programming, or whether specific programs are being offered to remarried couples. It is likely the content of premarital educational materials should vary with the potential needs of different target groups, such as those whose marriage will result in the development of a future stepfamily. Fox and Shriner (2014) assert that many forms of premarital education have not been sympathetic toward the needs of remarried couples.

Methods/Results. The purpose of the current study was to gain a better understanding of pastor/clergy views about remarriage and stepfamily dynamics and to assess current areas of strength, as well as gaps, in remarriage and stepfamily programming provided within faith-based communities. Faith-based leaders residing in the Midwest who were over the age of 18 were recruited to participate in this study which consisted of a 24-item online survey utilizing Google Docs software. The survey included three sections asking about participants' Church Affiliation and Circumstances for Recognizing Divorce, Educational & Counseling Services offered by their denomination, and faith-based leaders' perceptions about Stepfamily Dynamics. Potential participants were recruited via posts advertising the study on relevant public faith-based Facebook groups or by an email invitation sent to faith leaders identified using the Wichita Christian Business directory. A snowball sampling method, meaning people viewing the posts were asked to share the recruitment materials with others they know meeting the study criteria, was encouraged in order to reach a larger audience.

Unfortunately, our data collection attempts faced several methodological barriers which resulted in no usable data being collected. Given the difficulties encountered, we were unable to fully assess whether the data collection limitations of the current study were purely technological, meaning software related issues that prevented participants from fully completing the survey, or methodological, meaning the method of recruiting participants itself. Given our research timeframe, it was not possible to have a revised methodology, relying on either paper and pencil surveys or telephone surveys, approved by the IRB. Such methodological questions warrant additional investigation in future research.

Conclusions/Future Directions. Despite the obstacles faced with data collection, the intended purpose of this study was to gain increased insight into the premarital resources being offered to remarrying couples in faith communities. As family sociologists Higginbotham et al.'s (2009) research suggests, remarried couples and their resulting stepfamilies endure many more stressors and conflicts than are experienced by those entering a first time marital union. Given the increased risk of dissolution, premarital education targeting remarried couples forming stepfamilies has the potential to not only create awareness around the potential stressors common when developing stepfamily arrangements, but also to provide helpful tools that may assist the couple in lowering their risks for subsequent divorce (Fox & Shriner, 2014).

With the growing frequency of divorce and remarriage rates in the United States, it is likely that higher percentages of congregations will consist of stepfamilies as well. The lack of research on faith-based perceptions and acceptance of stepfamilies may be partially due to ideological differences in religious acceptance of remarriage. We expected to find that resources offered to stepfamilies would be dependent on the reasons, if any, divorce was acceptable within a denomination which would mediate whether that denomination performed remarriage ceremonies in the first place. Denominations not acknowledging divorce as appropriate would be less likely to provide resources for remarrying/stepfamilies. We further anticipated that faith-based leaders more accepting of remarriage would be more knowledgeable about stepfamily dynamics and would be more likely to likely to report that there are unique supports that faith-based communities can provide stepfamilies. These hypotheses warrant further investigation. Gaining such knowledge is a necessary step in identifying ways in which faith-based communities can better support stepfamilies in the future.

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Differences in Human Gait while Carrying a Load at Different Positions on the Back

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Abstract

Most people are introduced to backpacks when they are students. As they age, these bags usually grow in terms of size and load. This study sought to determine the differences in human gait patterns when individuals walk with and without a weighted backpack. In addition to backpack weight changes, the experiment placed packs at two different heights on subjects' backs to determine the impact of backpack position on human gait. The hypothesis for the study was that while carrying a weighted backpack, the differences in the gait would be noticeable as weight of load and position of the backpack changed. Data was collected from 10 subjects walking with and without weighted backpacks positioned at two different locations on their backs. Reflective markers were placed on the subjects to track body movement, and a treadmill was used to simulate natural walking. No significant changes were found in the three walking conditions measured: no weighted backpack, 17 %BW in backpack placed high on back, and 17% BW in backpack placed low on back. One significant find was that knee angle had a similar value on carriers of two-sided strapped backpacks while walking and carriers of one-sided strapped backpacks while walking. By understanding the differences in the gait associated with walking with and without the extra weight of a backpack, as well as effects of styles of carrying and positioning on the back, it will be possible to make weight limit recommendations for the population at risk of overexertion, which includes young children, heart attack and stroke survivors, and the elderly.

Summary

Many people often neglect the importance of backpacks, but they are an essential tool for carrying loads. People of all ages, especially students, use backpacks to carry objects such as notebooks, textbooks, and other necessities for school. As a result, many concerns have often arisen regarding backpacks' loads and the stress they put on carriers' bodies. The position of the backpack on a person's back can also have various effects on the body. The purpose of this study was to determine the differences in human gait while carrying a load at different positions on the back.

A recent study was conducted in order to determine the weight limit that a person should carry [1]. The researchers used craniovertebral angle (CVA) as a measurement for the experiment. The results showed that with 10% body weight (BW) load, a decrease in CVA did not occur immediately, as opposed to 15% BW and 20% BW load, where a decrease in CVA occurred instantly. This indicated that a forward head action occurred immediately for 15% and 20% BW. Moreover, more than 50% of the subjects reported discomfort at 15% and 20% BW. The researchers concluded that 10% of body weight should be the limit for a backpack's weight. Several studies [2, 3, 4] have supported the idea that while a person carries a weighted backpack, his or her body tends to lean forward corresponding to the increased load in order to adjust to the body's center of mass.

Two studies [5,6] used a computational method to determine kinematic variables. They both found that the computational method was a reliable method to provide results for those studies conducted with limited equipment. Our study had limited equipment as we were unable to measure kinematics such as acceleration, velocity, and marker positions. The objective of our study was to find the difference in the hip angle, knee angle, and ankle angle between three walking conditions: with an empty backpack, with a backpack placed at a high position on the back and containing 17% BW, and with a backpack placed at a low position on the back and containing 17% BW.

Seven healthy subjects volunteered for the project. Each subject was carefully weighed by the researcher to determine his or her BW, and then the backpack weight was adjusted to 17% of each individual's mass. Next, each subject's preferred walking speed was determined by having the subjects walk down a hallway. The subjects were then tested with each of the three aforementioned backpack conditions while walking in two-minute trials for each on a treadmill, maintaining the previously designated self-selected speed as derived from each subject's monitored hallway walking [8]. Software called Cortex, controlling eight motion capture cameras, was used in this experiment [9].

The level of significance was set at $p=<0.05$. After statistical analysis, P-values of each joint angle were recorded. The P-value of the hip angle showed 0.999 with a peak of 125.2 in no-weight condition, 124.7 in high-weight (high placement with 17% BW) condition, and 124.8 in low-weight (low placement with 17% BW) condition. As the P-value was bigger than 0.05, there were no observed differences in the hip angle across three walking conditions. Similarly, for the knee angle, the P-value showed 0.0877, which indicated there were no observed differences in the knee angle across three walking conditions. In addition, the hip angle showed a peak value of 66.6 in the no-weight condition, 68.8 in high-weight condition, and 69.2 degree in low-weight condition. The P-value of the ankle angle showed 0.324, which indicated there were also no observed differences in the ankle angle across the three walking conditions. The peak value of ankle angle was 201.7 in no-weight condition, 200.9 in high-weight condition, and 201.5 in low-weight condition.

The key finding of this study was that no significance was found in joint angles between these three walking conditions. Some limitations could have impacted the results of this project. The sample size of this study might not have been large enough to observe the differences in the hip angle, the knee angle, and the ankle angle between the three walking conditions. The usage of the treadmill was another limitation of this study because it imposed a constant designated speed rather than allowing a more natural gait, as would be observed had the subjects walked over ground. The last limitation of this study was the calculation of the hip angle. In this study, the hip angle was calculated based on the vector from the hip to the knee marker positions in relation to the horizontal plane, instead of the vector from the hip to the shoulder joint. This is a potential limitation because when the hip angle is calculated based on the vector from the hip to the knee marker in relation to the horizontal plane, it ignores the angle of the torso in the calculation of the overall hip angle; therefore, one would not be able to see the effect of torso lean in the angle defined by the hip to knee in relation to the horizontal plane. Moreover, when we compared the results of the knee angle peak value with a separate study [7], we came across a significant finding from our data. The knee joint angle behaves very similarly when a person walks with a two-strapped backpack or with a one-strap backpack. Though we originally set out to discover how hip angle, knee joint angle, and ankle angle were affected by different walking conditions, we instead observed how knee joint angle data could potentially be used in conjunction with results of a separate study [7] exploring the role of one- and two-strap backpacks.

This study sought answers about backpack weight limit and positioning in order to help people avoid injuries resulting from carrying inappropriate weights at unhealthy positions. A previous study [1] has recommended that the load carried should be limited to 10% of the carrier's body weight while carrying a two-strap backpack. In future studies, some areas need to be revised in order to yield better results. This includes having subjects walking over ground instead of the treadmill, thus, allowing subjects to walk at their own pace rather than a set speed derived from monitored walking pre-trial. Further research into the field of backpack kinematics as it pertains to stress on carriers' bodies can help to alleviate unnecessary health ailments in the general population.

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pH Sensitive Conformational Change Monitored by Tryptophan Quenching of Fluorescence

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Abstract

Anthrax toxins are the main virulence component in bacterium Bacillus anthracis, a lethal agent for livestock and humans. Bacillus anthracis is composed of several polypeptide chains: the receptor-binding moiety protective antigen (PA) and Enzymatic moieties lethal factor (LF) and edema factor (EF) (Pilpa, Bayrhuber, Marlett, Reik, & Young, 2011). This study examined the PA membrane and the expanding pores with emphasis on the mechanism of the pre-pore to pore formation of mutant protein D425A in comparison to wild type protein A350; a fluorospectrometer reading was used to measure the effects of the pH on the mutant protein, and then the reading was compared to that of the wild type protein. The kinematics approach was used to measure the rate of transition of the proteins from pre-pore to pore. Recent findings suggest that PA intermediates as mechanisms for pre-pore to pore formation. The details of how the PA pre-pore to pore mechanism forms an intermediates and translocate toxins are not yet known. In our lab we incorporated single tryptophan residues into the peptide segments that play key roles in the conformational change in the D425A mutant and the A350 wild type protein. This allowed us to explore the pH stability of anthrax Protective Antigen to figure the conformational changes on the PA. The results of this study will give scientists a better understanding of Anthrax toxins, with the data contributing to the development of a new therapeutic.

Summary

Anthrax toxin is a virulence factor secreted by the pathogenic strain *Bacillus anthracis*, an AB toxin component system that forms an intracellular pore that releases lethal components to a host. Fatal consequences can occur if the host is left untreated. In this two component system, the B component is the receptor-binding site protective antigen (PA), and the A component comprises two different enzymatic factors: lethal factor (LF) and edema factor (EF) (Pilpa, Bayrhuber, Marlett, Reik, & Young, 2011). This study examined the PA membrane and its expanding pores with emphasis on the mechanism of the pre-pore to pore formation of mutant protein D425A. A fluorospectrometer reading was used to measure the effects of the pH on the mutant protein compared to the effects on the wild type protein A350. The kinematics approach was used to measure the rate of transition from pre-pore to pore. Recent findings suggest that PA intermediates as a mechanism for pre-pore to pore formation. The details of how PA pre-pore to pore intermediates and translocates toxins are not yet known. This research explored the pH stability of PA to understand the conformational changes on the PA. The results of this study will give scientists a better understanding of Anthrax toxins, with the data contributing to the development of more effective treatment options.

Bacillus anthracis, like other pathogenic bacteria, weakens the host's immune system. Pathogenic bacteria have evolved strategies for accomplishing their goal. In this pathogenic pathway, PA is the binding anchor for host Atx receptors, [$ANTXR_1$] or [$ANTXR_2$]. Upon furin-catalyzed cleavage, PA converts to a proteolytically activated form. Activated PA spontaneously dissociates, self-assembling itself to form ring-shaped heptameric and octameric pre-pores which act as the anchor for either LF or EF. These toxins are internalized in the endosome, and then structural changes triggered by acidic conditions occur, leading to the translocation of enzymic toxins into the host cytosol (Mechaly et al., 2012; Pilpa et al., 2011).

A close examination of PA pore structure gives a better understanding of *Bacillus anthracis* intoxication. Evidence presented by Jiang, Pentlute, Collier, and Zhou (2015), shows that the pore formed by PA_{63} is a heptameric mushroom-shaped pore measuring $80\mathring{A}$ with 14-stranded B-barrel $100\mathring{A}$ long. This structure is characterized by four protomer domains referred to as D1, D2, D3 and D4. Domains 1, 3, and 4 construct the round top of the mushroom-shaped pore, named the corolla. Domain 2 is the most critical domain when it comes to pore formation. D2 provides the mobilization from the round top entry in the pre pore to the stem at the bottom, named the calyx or the exit of the pore.

Given the following background information, our goal was to determine the structure of the intermediate pore state. To do this, we looked at mutant D425A because data presented by Janowiak, Finkelstein, and Collier (2009) showed evidence for this mutant's negative effect on pore formation, inhibiting PA activity almost completely. The D425A mutant resides in D2, more specifically, in the critical loop $2\beta_{10}$ - $2\beta_{11}$, which is hypothesized to trigger the formation the phenylalanine clamp (phe-clamp). It does so by sensing the low pH conditions needed for the conformational changes, leading to the release of toxins into the host cytosol. D425A mutant is of special interest due to the findings by scientists Janowiak et al. (2009); in their planar lipid bilayer studies, D425A did not alter the shape of the pre-pore during protein folding.

Our study measured the maturation of the mutant and wild type pores with temperature dependent kinetics studies using an Applied Photophysics SX.18MV-R Stopped Flow Spectrofluorimeter. Proteins were incubated at the pH 5 buffer (50 mM sodium phosphate buffer, 150 mM NaCl, 2.5 mM $MgCl_2$). Excitation was set at 350 nm, and the rates were collected in split time base mode at 2 seconds and 20 seconds. All data points collected represent an average of at least two shots acquired by the stopped flow instrument. We used this to obtain the kinetic change, focusing on the initial change of both the wild type protein and the mutant D425A protein.

Kinetic data revealed that the end state of pore formation was indeed the formation of the phe-clamp. For both the A350 and D425, an initial structure change occurred. In both of these proteins, higher temperature led to increased rate of formation. The only differences noted were how the wild type protein continued pore formation after one second. This indicated that the β_{10} - β_{11} loop in D425A sensed a signal for pore formation, but also suggested that the $2\beta_{10}$ - $2\beta_{11}$ loop can adapt into separate conformations. If so, the mutation of D425A, known to block pore formation, may stabilize a structure that does not lead to a pore. More studies are needed to determine the meaning of this structure. Our main interest was understanding the mechanism behind D425A blockage in pore formation as a hint for an approach to a new therapeutic to defend from diseases caused by AB two-component systems.

In our studies of this mutant protein, we have found that at pH 5, the D425A mutant, is capable of forming an intermediate pore structure. This intermediate has similar initial kinetic profiles as the wild type protein. Effects of conformational change of both wild type A350 and D425A mutant protein were measured by kinetic data incubated in acidic conditions at various temperatures in 5 μM concentrations. While more studies are needed for the development of a new therapeutic, our discovery of an intermediate pore state in the mutant protein brings new information about the mutant's mechanism that is known to block pore formation. This discovery will contribute to a wider body of research dedicated to advancing therapeutics in the field of anthrax research.

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A New Porcine Follicle-Stimulating Hormone Glycoform as a Potential Candidate for Superovulation in Animals

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Abstract

Follicle-stimulating hormone (FSH), a pituitary glycoprotein, plays a central role in reproduction in humans and animals. In females, it acts on ovarian follicles producing mature oocytes at ovulation. Glycosylation variants of FSH show different bio-activities. Hypo-glycosylated $hFSH^{21}$ is more active than fully-glycosylated $hFSH^{24}$, but its blood concentrations are going down during aging, as fertility decreases in women. FSH glycoforms have been observed largely in primates, including humans, rhesus monkeys, and Japanese macaques. Ovine, porcine, and bovine FSH preparations appear to possess only FSH^{24}, while horse FSH is 90% FSH^{21}. In cattle, follicle-stimulating hormone is used for superovulation. Folltropin®, a porcine pituitary-derived follicle-stimulating hormone, marketed by Bioniche Animal Health USA, is the only FDA-approved FSH for superovulation of cattle in the U.S. Current methods of purification and production of Folltropin® from porcine pituitaries for use in cattle have not been evaluated for differences in glycosylation of FSH. Hypothesizing that hypo-glycosylated FSH co-purifies with luteinizing hormone (LH) as it was shown for human analog, we evaluated porcine LH preparations using FSH β-subunit Western blotting. Porcine hypo-glycosylated FSH was found in porcine LH-rich fractions. Hypo-glycosylated porcine FSH could be evaluated for efficacy in stimulating superovulation in cattle and other domesticated animals. Superovulation in cattle is important for the production of meat and milk. Improving current methods of cattle superovulation will aid in the production of genetically superior calves.

Summary

Superovulation stimulates the ovary to induce multiple ovulations, particularly in species that naturally ovulate a single follicle per cycle. In cattle, maturation of the follicle requires both follicle-stimulating hormone (FSH) and luteinizing hormone (LH). Pregnant Mare Serum Gonadotropin (PMSG) is a glycoprotein hormone found in the blood serum of pregnant mares. An investigation by Cole and Hart (1930) led to the discovery of PMSG, and since then it has been used in superovulation protocols. Biological activity of PMSG is similar to the combined biological activities of FSH and LH (Licht et al., 1979). However, in equids, PMSG has largely LH-like activity. Compared to FSH, PMSG has a longer half-life, and can persist in bovine circulation for up to 10 days as compared to five hours for FSH (Bo' & Mapletoft, 2014). Longer half-life of PMSG results in the prolonged release of estradiol from unovulated follicles, resulting in an imbalance of hormones (Gordon, 2014). Additional problems with PMSG include an enlarged ovary and the continuation in folliculogenesis after ovulation.

Today FSH is the preferred method of superovulation in cattle (Bo' & Mapletoft, 2014). FSH glycoforms have been observed largely in primates, including humans, rhesus monkeys, and Japanese macaques. Examination of FSH preparations from ovine, bovine, and porcine pituitaries reveals only FSH^{24}, while horse FSH is 90% FSH^{21}. Because there are indications that hypo-glycosylated FSH variants also exist in ovine, bovine, and porcine pituitary glands, the goal of this research was to establish that hypo-glycosylated FSH exist in the porcine pituitary. Our working hypothesis was that hypo-glycosylated FSH co-purifies with LH, the other pituitary gonadotropin. During purification of pFSH, hypo-glycosylated FSH was noted in side fractions rich in LH. We evaluated these partially purified and purified LH preparations from porcine pituitaries for the presence of hypo-glycosylated FSH using Western blotting.

FSH samples are crude preparations contaminated with varying amounts of LH. Studies examining the effects of increasing the amount of LH and energy uptake in cows revealed that high levels of LH resulted in low fertilization rates and poor embryo quality (Bender et al., 2014). One problem with FSH is the need for multiple administrations due to its short half-life of five hours.

FSH is decorated with 3-4 N-glycans attached to four highly conserved glycosylation sites. Each site is occupied with a glycan population composed of about 30 neutral core structures and terminated with a variable number of negatively charged residues, typically sialic acid (Bousfield, Jia et al., 2006; Bousfield, Butnev et al., 2015). Glycosylation variants of FSH are called isoforms or glycoforms. The former term refers to variants that differ by overall charge of the glycan moieties, so-called oligosaccharide microheterogeneity. These are determined by the number of negatively charged sialic acid or sulfate residues that terminate oligosaccharide antennae (Ulloa-Aguirre, Midgley, Beitins, & Padmanbhan, 1995). Several isoform variants of follicle-stimulating hormone have been identified on the basis of differences in charge (Green & Baenziger, 1988) and biological activity (Ulloa-Aguirre et al., 1995).

Macroheterogeneity, or variation in N-glycosylation site occupancy, has been observed in FSH beta-subunit (Bousfield et al., 2007; Walton et al., 2001). N-linked oligosaccharides on the FSH beta subunit can be found on both Asn^{7} and Asn^{24}. In the

horse, two forms of glycosylated eFSHbeta have been found. One of the two eFSHbeta variants possesses both Asn^{7} and Asn^{24} oligosaccharides, and the other contains glycosylation exclusively on Asn^{24} (Bousfield, Butnev, Gotschall, Baker, & Moore, 1996). In humans, a non-glycosylated beta-subunit was identified (Walton et al., 2001). This form of FSbeta possesses no carbohydrate and is designated $FSHbeta^{15}$ due to the M_r 15,000 band observed in Western blots (Bousfield, Butnev, Butnev, et al., 2014). Other variants in glycosylation in the beta subunit of hFSH have been identified (Davis, Kumar, May, & Bousfield, 2014). One FSHbeta glycosylation variant is $hFSH^{18}$, which possesses a single carbohydrate at beta Asn^{24}. Human FSH^{21} contains the only carbohydrate on beta Asn^{7} and is commonly referred to in this paper as hypo-glycosylated FSH. FSH^{24}, commonly referred to as fully-glycosylated FSH in this paper, contains carbohydrates at both Asn^{7} and Asn^{24}.

Hypo-glycosylated FSH was assumed to be a minor variant in human FSH preparations (Dahl, Bicsak, & Hsueh, 1988). However, recent studies suggest glycoform abundance can be much higher and is determined by physiological changes. Glycan abundance and ratio changes in follicle-stimulating hormone appear to be a result of physiological and age-related changes (Bousfield, Butnev, Rueda-Santos, et al., 2014). Both fully-glycosylated hFSH and hypo-glycosylated hFSH have been found in postmenopausal urine samples (Bousfield, Butnev, Butnev, et al., 2014; Bousfield et al., 2007). In humans between the ages of 21 and 23, hypo-glycosylated FSH is more abundant than fully-glycosylated FSH (Bousfield, Butnev, Rueda-Santos, et al., 2014). The ratio changes to roughly 50:50 by age 39, and $hFSH^{21}$ abundance drops to less than 20% after menopause (Walton et al. 2001; Bousfield, Butnev, Rueda-Santos, et al., 2014). Thus, there is a loss of more active hypo-glycosylated FSH in the pituitary when infertility is known to increase (Bousfield, Butnev, Rueda-Santos, et al., 2014).

Studies comparing the biological activities of hypo- and fully-glycosylated FSH preparations have revealed that the former is more active than the latter both *in vivo* and *in vitro* (Davis et al., 2014). In receptor-binding assays, hypo-glycosylated FSH binds the FSH receptor immediately, while there is a delay before fully-glycosylated FSH begins to bind (Bousfield, Butnev, Butnev, et al., 2014). Even at concentrations close to saturating the FSH receptor, hypo-glycosylated FSH binds at least twice as many rat, bovine, and human FSH receptors as fully-glycosylated FSH (Butnev, et al., 2015).

Results from Western blotting showed the CMC-D fraction contained luteinizing hormone at the 15 kDa band. In the same fraction, anti-FSHbeta revealed 21 kDa bands. The molecular weights of hypo-glycosylated FSH are 18 and 21 kDa. Taken together, the results of LHbeta and FSHbeta Western blots showed that at least one hypo-glycosylated porcine FSH glycoform, $pFSH^{21}$, existed in the porcine pituitary and co-purified with LH. The RFSH20 blot was an attempt to compare the mobilities of fully-glycosylated human FSHbeta 24 with pFSH glycoform bands in the porcine pituitary fractions CMC-D. However, the pFSHbeta bands were not detected. This was a surprise because other laboratory members previously demonstrated that pFSHbeta is more highly immunoreactive to monoclonal antibody RFSH20 than hFSHbeta.

USDA porcine pituitary sample contains fully-glycosylated FSH. Hypo-glycosylated porcine FSH was not detected in the USDA porcine

pituitary sample.

Conclusion. Improving methods involved with superovulation will aid in the production of genetically superior calves. The only FDA-approved FSH product for superovulation in cattle is Folltropin® which contains a low amount of LH, according to the manufacturer's website.

Porcine FSH preparations appeared to be exclusively fully-glycosylated FSH. Our findings resulted in the identification of hypo-glycosylated porcine FSH that co-purifies with LH. Previous studies comparing biological activities revealed that hypo-glycosylated FSH is more active *in vitro* and *in vivo* than fully-glycosylated FSH (Davis et al., 2014). While an observed delay in receptor-binding assays exists for fully-glycosylated FSH, hypo-glycosylated FSH binds the receptor immediately (Bousfield, Butnev, Butnev, et al., 2014). Given our findings, hypo-glycosylated porcine FSH could be evaluated for its efficacy with superovulation protocols in cattle.

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Characterizing Boundary Conditions of Self-Adjoint Operators

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Abstract

In cases where the domain of the function under consideration is, itself, a function space, the function is considered an operator. Self-adjointness is an important property of many operators. There are cases where it is possible to coerce an operator into being self-adjoint by carefully choosing its boundary conditions. These choices of boundary conditions, called self-adjoint extensions, are the focus of this study. We seek to characterize these extensions by looking at how these boundary conditions are determined. To achieve this, we had looked at several methods of determining the length of a given curve as well as the area of the surface produced by rotating the curve about the x-axis. During these calculations, we assumed the curve was fixed. We were able to derive generalized formulae for describing the length of an arbitrary curve as well as the surface area of revolution. If we turn this viewpoint around, where the curve is no longer fixed but is, itself, the variable, we are able to apply the results of the aforementioned calculations to a wide range of problems. In many important physical situations, the equations which appear are called self-adjoint. After determining the minimizer for both the length and surface area of revolution, we will define this notion and discuss the relationships among self-adjointness, integration by parts, and the determination of boundary conditions.

Summary

Self-adjoint operators play a crucial role in the fields of functional analysis and quantum mechanics[1]. One such example is the *Hamiltonian* operator, *H*, in which a particle's position and momentum are represented as the self adjoint operators $\hat{p}$ and $\hat{x}$, respectively [3].

$$H[\Psi] = \frac{\hat{p}[\Psi]}{2m} + \frac{1}{2} \cdot k \cdot \hat{x}[\Psi]$$

The space over which a given operator, L, is self-adjoint will possess an orthonormal basis set of eigenvalues of L. These eigenvalues represent the natural frequencies of the system being modeled by the operator. For example, the eigenvalues associated with the Halmiltonian represent the total energy of the particle at the corresponding state [3].

The boundary conditions of an operator's domain play a crucial role in the self-adjointedness of that operator. Through restricting the domain by imposing conditions on its boundary, an operator can be coerced into being self-adjoint. In particular, we will be working with the space L^2, which consists solely of integrable functions.

A conceptual understanding of integrability can be developed by first considering the problem of finding the area beneath any given curve. The question is this: given two points, *a* and *b*, that lie on the curve *f*, can the length of *f* between *a* and *b* be determined? This problem can be approached by elementary means. By making use of a shape for which the area can easily be determined, an approximation of the length of the curve between *a* and *b* can be obtained. By dividing the domain of the curve into multiple partitions, we can increase the accuracy of the approximation. By letting the number of partitions grow to infinity we obtain

$$\lim_{n\to\infty} \sum_{i=1}^{n} f(x_i^*)\Delta x_i$$

This is an exact solution to our area problem. If the above limit exists, the function that produced the curve is said to be *integrable* and we can write

$$\lim_{n\to\infty} \sum_{i=1}^{n} f(x_i^*)\Delta x_i = \int f(x)dx$$

The space L^2, as mentioned earlier, consists solely of functions for which the above limit exists. However, not only must the above limit exist, the member functions of L^2 must also satisfy the following condition

$$\left(\int_a^b f^2(x)dx \right)^{\frac{1}{2}} < \infty$$

This is called the L^2 *norm*. This space was chosen specifically because it possesses an *inner product*. This was important as the adjoint of an operator is only defined in relation to an inner product. The L^2 inner product is of the form

$$\langle u, v \rangle = \int_a^b u(x) \cdot v(x)dx$$

Let $f,g \in L^2([a,b])$ and M be the operator $M = \sum_{i=0}^{n} \frac{d^i}{dx^i}$ defined over $L^2([a,b])$. The adjoint of M is defined as the operator denoted M^* such that

$$\langle M[f], g \rangle = \langle f, M^*[g] \rangle$$

If $M = M^*$, then the operator is said to be *formally self-adjoint*. The form of M^* can be found by integrating $\int_a^b M[f] \cdot g dx$ by parts. In doing so, we obtain

$$\int_a^b M[f] \cdot g dx = \sum_{i=1}^{n} \left[(-1)^{i-1} \frac{d^{n-i}}{dx^{n-i}} f(x) \cdot \frac{d^{i-1}}{dx^{i-1}} g(x) \right] \Bigg|_a^b + (-1)^n \int_a^b f(x) \cdot \frac{d^n}{dx^n} g(x) dx$$

Here, we see that $M^* = (-1)^n \frac{d^n}{dx^n}$. Thus, for $M = M^*$, n must be even. If n is even, then we can choose the functions f and g such that

$$\sum_{i=1}^{n} \left[(-1)^{i-1} \frac{d^{n-i}}{dx^{n-i}} f(x) \cdot \frac{d^{i-1}}{dx^{i-1}} g(x) \right] \Bigg|_a^b \equiv 0$$

In doing so, we were able to find the conditions necessary for our initial operator to be considered *truly self-adjoint*.

Our discussion of the subject has been strictly limited to the 1-dimensional, real case. However, these concepts can be extended into higher dimensions as well as the complex case. Our focus on the 1-dimension real case was chosen in the interests of simplicity.

Future work will lead us to consider the role in which self-adjoint operators play in Sturm-Liouville theory, in particular, the influence that the boundary conditions necessary for self-adjointedness have on the values contained within this basis. As stated above, it is necessary that the order of the operator is even for it to be self-adjoint. Sturm-Liouville theory states that operators of even order possess an orthonormal basis set of eigenvalues [2]. This basis set of eigenvalues can be used to construct solutions to a given problem that has been modeled using a Sturm-Liouville type problem. One such example of this is the distribution of heat throughout a material. This can be modeled using a Sturm-Liouville type operator. Furthermore, the elements in this basis set are *eigenfunctions* of the operator for which the (*D,X*) boundary value problem had been created. These eigenfunctions correspond to the *naturalfrequencies* related to many physical problems [2].

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Laser Surface Treatment to Enhance Biointegration of Orthopedic Implants

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Abstract

Many implanted biomedical devices cause patients to suffer from infections that develop post-surgically on the device surface or in surrounding tissue. These infections not only cause device failure but could also spread systematically. To promote success of an orthopedic implant, quick host tissue integration is required for timely healing. The research explored the role of laser micro-nano machining in creating surface topographies on orthopedic implant surfaces, and evaluated whether or not these topographies would be conducive to simultaneous bone integration and antimicrobial therapeutic delivery. Current orthopedic biomaterials, such as titanium, 316L stainless steel (SS), and cobalt chromium alloys, were modified using laser machining to create varying surface topographies. Host cell adhesion to the materials was evaluated using L-929 fibroblast and MC3T3-E1 osteoblast cells, tissue cells involved in bone growth. This research provides information required to evaluate laser surface treatment against other patterning methods regarding biocompatibility, quick tissue integration, and postoperative infection prevention. This study also contributes to research concerning laser treated surfaces on multiple biometals, which is currently lacking. These additions to the surface modification field could lead to minimization of postoperative infection due to implanted medical devices.

Summary

Postoperative orthopedic implant infections cause major complications in the medical field (Popat, Eltgroth, LaTempa, Grimes, & Desai, 2007). Patients who must be given reconstruction or support surgeries are in need of un-harmful, functional, and safe orthopedic implant placement. The medical implants used must be functional, structurally sound, and compatible with the patient. Infection of tissue surrounding the medical device often compromises the function of the implant. Additionally, infection may lead to device failure, among other problems (Gallo, Holinka, & Moucha, 2014; Tang et al., 2011). Many methods have been used in an attempt to increase bone integration and decrease postoperative infection. This review identified studies involving bone cell adhesion to altered biomaterials in order to evaluate if an implant could be created with surface topographies that would be conducive for simultaneous bone integration and antimicrobial therapeutic delivery. We specifically studied patterning through the use of laser surface treatment as a method of creating topographies.

To promote success of an orthopedic implant and minimize infection, quick host tissue integration is required before bacteria is able to adhere to the implant surface (Braem et al., 2013; Guocheng & Zreiqat, 2010; Ribeiro, Monteiro, & Ferraz, 2012). Competition for growth between bacteria and tissue cells is discussed as a race for the surface; biocompatibility will occur if the tissue is integrated before bacterial cell attachment, and failure occurs if the bacterial cells adhere to the implant before host tissue integration (Gallo et al., 2014). A rough interface is known to positively affect host tissue cell growth by increasing surface area of the implant and consequently increasing mechanical interlocking of cells and implant interface (Oshida, Tuna, Aktören, & Gençay, 2010; Palmquist, Johansson, Suska, Branemark, & Thomsen, 2013). A rough surface is also thought to mimic the natural body and increase cell adhesion (Palmquist et al., 2013). Although most types of patterning could be used in order to provide these beneficial results, manipulation of the implant surface using laser nano-machining could promote decreased infection, greater acceptance by the host body, and manufactural ease for implant production.

In general, laser machining as a method of surface texturing is contamination free, uses no media, and is a non-contact process (Oshida et al., 2010). It allows for site-specific alteration and melting of surface locally as well as the ability to control pit spacing, size, and depth (Oshida et al., 2010; Palmquist et al., 2013). Currently, titanium is the most widely evaluated biomaterial patterned by laser treatment, but other current orthopedic biomaterials such as 316L stainless steel (SS) and cobalt chromium alloys have potential for use with laser patterning. These biomaterials are commonly used because of the way they behave in the human body; they make up the bulk of the device while the surface can be changed to improve cellular interaction at the interface.

Laser treatment is an attractive technique for patterning biometal surfaces because it allows for advantageous alteration of the bulk metal. Stress created on the implant due to a laser causes residual compression just below the surface which strengthens and refines grains of bulk metal (Vora & Dahotre, 2013). Laser treatment also has other notable manufactural advantages which makes it a better choice than other patterning methods. It was found to be quicker, cleaner, and easier to use on

complex geometric materials (Hallgren, Reimers, Chakarov, Gold, & Wennerberg, 2003). Compared to commercially pure machined titanium and acid treated samples, laser treatment influenced bone cell growth on the implant surface directly. Protein absorption, cell proliferation, cell differentiation, and deposition of bone matrix were caused and resulted in more stable interlocking, faster tissue integration, and improved bone-implant retention due to laser surface treatment as a patterning method (Queiroz et al., 2013). Using a laser allows for easily created nano-scale patterning which is beneficial because cell growth is more successful on a nano rough surface due to its biomimetic effect (Mendonça, Mendonça, Aragão, & Cooper, 2008).

Although laser patterning shows many promising characteristics, it has not yet been sufficiently assessed in many specific areas. There is not much evidence comparing laser machining to methods other than machined titanium samples or acid etched samples. Research has not sufficiently compared the success of different types of laser used for ablation, and evidence investigating laser treatment on materials other than titanium is not yet available in a suitable amount. Research involving osteoblast growth on patterned titanium surfaces has been investigated thoroughly, while growth on patterned surfaces of stainless steel and cobalt chromium alloys is lacking (Braem et al., 2013; Palmquist et al., 2013). Additional research is also required in order to validate the optimal height and spacing of texture for bone fixation.

The overall enhanced results created by laser surface treatment are the main goal when an implant is placed. Increasing the accuracy or speed of the cell processes discussed increases the chance of implant success and decreases chance of infection in the host body (Gallo et al., 2014). By continuing the study of laser surface treatment as a patterning method, researchers may obtain data to further qualify the technique in order for it to be used in future studies and for designing enhanced orthopedic implants. These additions to the field of biomaterial surface modification could lead to minimization of postoperative infection due to implanted medical devices.

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Exploring Informal Sources of Information and Women's Use of Preconception Health Services

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Abstract

Preconception care refer to a set of interventions that aims to modify and reduce risks to women's health during childbearing years, increasing healthy behaviors in women and reducing the risks of birth defects and infant mortality. Prior research suggests that various cultural and social factors may play a role in women's views and beliefs about preconception care. Findings from an extended literature review revealed that women often receive information from culture, family, and friends in the form of suggestions and advice. In addition, media, particularly the internet, is a major source of information for women regarding preconception care. Further, an understanding of the informal and formal sources of information that women use to make decisions about using preconception health services is key to engaging, informing, and educating women. For the present study, focus groups were conducted with 40 reproductive-age women in Kansas. The purpose of this study was to identify the informal information sources that influence's women's decisions about using preconception health services. The preliminary findings from this study will be presented; and the limitations and directions for future research focused on women's preconception care will be discussed.

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Summary

The purpose of this review of literature was to attempt to identify the informal information sources women use in deciding to use preconception health services. Preconception care refers to a set of interventions that aim to increase healthy behaviors in women and reduce the risks of birth defects and infant mortality. Preconception care includes services such as regular wellness checkups, smoking and alcohol cessation, social and mental health awareness, and developing a variety of behaviors that support a healthy lifestyle (Johnson et al., 2006)

Although many studies have investigated women's knowledge and use of preconception care, there is a need for more specific information regarding the informal sources that influence women's preconception care utilization. This gap in information about informal influences, if filled, could be used to better educate and reach women that may be hesitant to seek out formal sources, such as general practitioners, or those who do not receive adequate preconception care services.

A focus on preconception care may be a key approach to preventing poor birth outcomes. In 2006, the Centers for Disease Control and Prevention (CDC) identified several preconception risk behaviors and health risk indicators that can directly contribute to poor birth outcomes. For example, the prevalence of overweight status, diabetes, and asthma was high among women of childbearing age (Johnson et al., 2006). Moreover, national data shows that smoking and alcohol use during the three months prior to conception increased between 2004 and 2006 (Robbins et al., 2014). Little improvement in other key preconception health indicators such as nutrition, physical activity, chronic conditions, reproductive health, and family planning suggests the need for a continued focus on preconception care for the improvement of women's healthy behaviors and the improvement of birth outcomes (Robbins et al., 2014).

Women's Knowledge and Utilization of Preconception Care. An overwhelming amount of research shows that there may be a serious problem regarding women's knowledge of preconception health and utilization of preconception care services. It is estimated that only one-third of women may be receiving routine physical exams or screening services prior to pregnancy (Hillemeier, Weisman, Chase, Dyer, & Shaffer, 2008). Moreover, existing literature suggests that many physicians may not be providing the recommended counseling or preconception care services to all women (Johnson et al., 2006). Considering the risky behaviors that women of childbearing age may expose themselves to, it is crucial to ensure that all women receive preconception care.

One of the clearest trends found within currently available research on preconception care is that there is a general and widespread lack of knowledge about preconception care and its benefits (McCorry, Hughes, Spence, Holmes, & Harper, 2012). Studies have shown that women, particularly those who are not planning for a pregnancy, may not view preconception care as a necessity (McCorry et al., 2012). For example, one study revealed that women did not seek preconception care because they did not have current health problems and did not see the need to seek care prior to conception (Canady, Tiedje, &

Lauber, 2008). Canady et al. (2008) also showed that there may be a general lack of knowledge about what preconception care is and how it is beneficial to not only women's general health, but also the health of a potential fetus (Canady et al., 2008). The literature indicated that busy medical clinics might contribute to this lack of knowledge, possibly through a lack of physician time or through patients' hesitance to access preconception care information (McCorry et al., 2012). Interestingly, prior studies have consistently shown that although women agree that health prior to pregnancy is important, there are persistent gaps in knowledge of preconception care regardless of racial and ethnic backgrounds (Temel et al., 2013; Tuomainen, Cross-Bardell, Bhoday, Qureshi, & Kai, 2013). Several factors that play a role in women's preconception care knowledge and utilization have been identified in the literature: culture, social networks, and media.

The Role of Culture, Ethnicity, and Race. Although limited awareness of preconception health and care is consistent across ethnic and cultural groups, research does show that women's preconception care choices are influenced by their cultural and ethnic background (Canady et al., 2008). For example, a study with predominately African American women showed a cultural and social distinction between themselves and other cultural and ethnic groups when deciding to plan pregnancy and use preconception care (Canady et al., 2008). Other studies have found racial or cultural differences in women's beliefs regarding pressure to have a 'perfect baby' (Temel et al., 2013) and health practices (e.g., avoiding raw dairy products) (Dunlop, Logue, Thorne, & Badal, 2013). It is important to identify culturally relevant informal information sources that women can use when making preconception care decisions. This information can better provide a means to convey preconception care information to a broad and culturally/ethnically diverse audience.

The Role of Social Networks: Family and Friends. Multiple studies support the idea that family and friends play a key role in women's decision to utilize preconception care. For example, women in a focus group study of preconception care and pregnancy planning among African-American women affirmed that male partners play a pivotal role in influencing women's views of preconception care (Canady et al., 2008). Additionally, in a consumer study of preconception care services, several study participants noted the importance of social support for making choices to engage in healthy behaviors. They agreed that having a supportive partner and a good support network of family and friends made it easier to engage in these healthy behaviors (Squiers et al., 2013). Family, friends, and even neighbors are shown, for women of varying cultural backgrounds, to be a strong influence in healthy lifestyle choices, planned pregnancy, and preconception care. One of the most significant findings revealed in this literature was the role that a male partner plays in women's pre- and post-conception care choices. For example, in one study African-American women revealed that involvement of their partners in these choices was very influential (Canady et al., 2008). This study has been supported in other studies with women of various ethnic and cultural backgrounds (Temel et al., 2013). Family, friends, and people in close association with women of childbearing age may be key informal sources used to make preconception care choices.

The Role of Media. Radio, commercials, and particularly the internet have been shown in the literature to be highly influential informal sources for women to get information about preconception care. Dixon-Gray, Mobley, McFarlane, & Rosenberg (2013) established a cultural and community support base for increasing the knowledge of preconception care in women and found that the use of media, such as Facebook, Myspace, commercials, and radio novellas were found to be a relevant form of increasing knowledge of preconception care in second generation Latina Americans (Dixon-Gray et al., 2013). This study suggests that these modes of informal sources could be beneficial in increasing public health awareness of preconception care in a form that is relevant to the targeted culture and ethnic group (Dixon-Gray et al., 2013). Prior research has shown that women prefer to receive preconception care information or general health information through television commercials and programming (Squiers et al., 2013), radio novellas (Dixon-Gray et al., 2013), and the internet (Agricola et al., 2014). The internet in particular is cited as a great source for reaching women, particularly those who do not have access to a regular healthcare professional (Squiers et al., 2013). Another interesting finding of the literature is that the focus groups themselves that are used throughout the research appear to be yet another informal source used by women to gain knowledge about preconception care (Spence, Alderdice, Harper, McCance, & Holmes, 2010).

Conclusion. There is a strong need to fill knowledge gaps about preconception care in women across all boundaries. This literature has identified many informal sources that women use when making preconception care choices, such as the internet, social media, family, friends, and the prevailing cultural/social norms. By targeting women through the use of these informal sources, interventions may be more effective at reaching a larger number of women, including those who do not see a physician regularly. This provides the opportunity to focus on those informal sources to plan interventions for women about preconception care, to help decrease risky preconception behaviors, to lower infant mortality rates, and to encourage women to make healthy lifestyle choices. Additionally, by conducting further research to determine which types of sources most affects which women, the most effective sources can be implemented to design interventions in preconception care to reach the most women more effectively and improve overall birth outcomes.

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